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HEAT-TRANSFER CHARACTERISTICS OF FLOWING AND STATIONARY
PARTICLE-BED-TYPE FUSION-REACTOR BLANKETS
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HEAT-TRANSFER CHARACTERISTICS OF FLOWING AND STATIONARY
PARTICLE-BED-TYPE FUSION-REACTOR BLANKETS

by

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APPENDIX 1

PHYSICAL PROPERTIES OF MATERIALS USED IN THIS STUDY

Data for the various physical properties used in this study were obtained from the literature. In order to aid computation, some of these data were first fitted to straightforward equations. The equations that were used, whether presented in the literature or fitted by the author, will be listed here.

A1.1 Physical Properties of the Soda-Lime Glass Particles

The data for k_p presented by Touloukian, Powell, Ho, and Klemens (1970) were fitted over the range of temperature from 100 to 700^oK:

$$k_p = (0.0021 \text{ W/mK}^2)t + 0.37 \text{ W/mK} \quad (\text{A1.1-1})$$

The data for c_{pp} were presented by Touloukian and Buyco (1970). Over the range of temperature between 100 and 700^oK, the data were fitted to within 1% by the equation:

$$c_{pp} = (-7.230 \times 10^{-6})(700 - t[\text{K}^{-1}])^{1.8} \text{ Ws/gK} + 1.117 \text{ Ws/gK} \quad (\text{A1.1-2})$$

A1.2 Physical Properties of Air

The data for k_g presented by Touloukian, Liley, and Saxena (1970) were fitted to within 3% over the range of temperature from 400 to 700^oK:

$$k_g = (1.475 \times 10^{-4})(t[\text{K}^{-1}])^{0.898} \text{ W/mK} \quad (\text{A1.2-1})$$

Touloukian and Makita (1970) presented the equation used for the specific heat:

$$c_p = (1.0447 - 3.1597 \times 10^{-4} t [K^{-1}] + 7.0791 \times 10^{-7} t^2 [K^{-2}] - 2.7034 \times 10^{-10} t^3 [K^{-3}]) \text{ Ws/gK} \quad (\text{A1.2-2})$$

The data for μ_g presented by Touloukian, Saxena, and Hestermans (1975) were fitted to within 1% over the range of temperature between 350 and 800°K:

$$\mu_g = (4.023 \times 10^{-4} \text{ cp}) (t [K^{-1}])^{0.675} \quad (\text{A1.2-3})$$

Weast (1971) presented the density of dry air as:

$$\rho_g = \frac{(0.001293 \text{ g/cm}^3)}{1 + 0.00367(t [K^{-1}] - 273)} \quad (\text{A1.2-4})$$

A1.3 Physical Properties of the Stainless Steel Tubes

The linear coefficient of thermal expansion was obtained from the Carpenter Stainless Steels Catalog:

$$\alpha_T = (0.002609(t [K^{-1}] - 273) + 17.000) \times 10^{-6} K^{-1} \quad (\text{A1.3-1})$$

The electrical resistivity obtained from Touloukian, Kirby, Taylor, and Desai (1975) was fitted and the electrical resistivity coefficient was obtained as $0.015 K^{-1}$.

APPENDIX 2

THERMAL ENTRANCE LENGTH NUSSELT NUMBER VARIATIONS

In Chapter 5, the variations of the local Nusselt number for a pseudofluid with fully developed velocity profiles in the thermal entrance region of a circular tube with a constant wall heat flux were presented. Theoretical solutions based upon both fully developed parabolic and flat velocity profiles were used extensively in comparisons with the experimental data. The Nusselt number variation for a fluid with a fully developed parabolic velocity profile is well known and is reviewed in Section A2.1. For a flat velocity profile, the axial Nusselt number expression can be analytically derived. The results developed by the author are presented in Section A2.2.

A2.1 Fully Developed Parabolic Velocity Profile

The axial Nusselt number profile for a fluid with a fully developed laminar profile in the thermal entrance region of a circular duct is well known. The fluid is assumed to be isothermal at the entrance of the heated section. Heating of the fluid is achieved by an applied constant wall heat flux.

Sellers, Tribus, and Klein (1956) presented the solution in terms of the nondimensional axial distance as:

$$N_{Nu}^{loc} = \left[\frac{1}{4.364} + \frac{1}{2} \sum \frac{\exp(-2\gamma_m^2 x^+)}{A_m \gamma_m^4} \right]^{-1} \quad (A2.1-1)$$

where:

$$x^+ = \frac{x}{2R} \left[N_{Re} N_{Pr} \right]^{-1} \quad (A2.1-2)$$

Here x was the distance from the inlet to the heated section. The eigenvalues γ_m^2 and the normalization coefficients A_m for the first three values of m are listed in Table A2.1-1.

Sellars, Tribus, and Klein used an indirect approach to the uniform wall heat flux problem by using the results from the uniform wall temperature problem. Siegel, Sparrow, and Hallman (1958) used a direct method to obtain the solution. The method of separation of variables and Sturm-Liouville theory were used to obtain the eigenvalue solution which was found to be nearly identical to Equation (A2.1-1):

$$N_{Nu}^{loc} = \left[\frac{1}{4.364} + \frac{1}{2} \sum_n c_n R_n(1) \exp(-2\beta_n^2 x^+) \right]^{-1} \quad (A2.1-3)$$

Here, the $R_n(1)$ were the radial eigenfunctions evaluated at the tube wall and the c_n were the normalization coefficients. It was necessary for Siegel, Sparrow and Hallman to obtain the eigenvalues and eigenfunctions by use of a computer. The first seven values of β_n^2 , $R_n(1)$, and c_n along with the expression for the limiting value of β_n for large n are presented in Table A2.1-2.

A2.2 Fully Developed Flat Velocity Profile

For the case of a fully developed flat velocity profile, the axial Nusselt number variation can be analytically derived. The method used

by Siegel, Sparrow, and Hallman was used by the author to derive this expression and will be presented here.

The differential equation and boundary conditions for a pseudofluid with a flat velocity profile are given by:

$$\frac{1}{r} \frac{\partial}{\partial r} \left(r \frac{\partial t}{\partial r} \right) = \frac{v_0}{\alpha_e} \frac{\partial t}{\partial x} \quad (\text{A2.2-1})$$

$$@ r = 0, \frac{\partial t}{\partial r} = 0 \quad (\text{A2.2-2})$$

$$@ r = R, \frac{\partial t}{\partial r} = q_0'' / k_e \quad (\text{A2.2-3})$$

Here, α_e and k_e are the effective properties for the pseudofluid.

In the thermal entrance region, t is written as a sum of the fully developed and difference temperatures t_{fd} and t^+ , respectively:

$$t = t_{fd} + t^+ \quad (\text{A2.2-4})$$

The differential equation and boundary conditions for the fully developed temperature profile become:

$$\frac{1}{r} \frac{\partial}{\partial r} \left(r \frac{\partial t_{fd}}{\partial r} \right) = \frac{v_0}{\alpha_e} \frac{\partial t_{fd}}{\partial x} \quad (\text{A2.2-5})$$

$$@ r = 0, \frac{\partial t_{fd}}{\partial r} = 0 \quad (\text{A2.2-6})$$

$$\text{at } r = R, \frac{\partial t_{fd}}{\partial r} = q_0''/k_e \quad (\text{A2.2-7})$$

Thus, the differential equation and boundary conditions for the difference temperature in the thermal entrance region are:

$$\frac{1}{r} \frac{\partial}{\partial r} \left(r \frac{\partial t^+}{\partial r} \right) = \frac{v_0}{\alpha_e} \frac{\partial t^+}{\partial x} \quad (\text{A2.2-8})$$

$$\text{at } r = 0, \frac{\partial t^+}{\partial r} = 0 \quad (\text{A2.2-9})$$

$$\text{at } r = R, \frac{\partial t^+}{\partial r} = 0 \quad (\text{A2.2-10})$$

The fully developed temperature profile is derived as follows.

For the constant wall heat flux case, $\frac{\partial t_{fd}}{\partial x}$ is a constant and Equation (A2.2-5) is integrated with aid of the first boundary condition to obtain:

$$t_{fd} = \frac{v_0}{\alpha_e} \frac{\partial t_{fd}}{\partial x} \frac{r^2}{4} + C_2(x) \quad (\text{A2.2-11})$$

Since $\frac{\partial t_{fd}}{\partial x}$ is a constant, Equation (A2.2-11) can be differentiated to

obtain an expression for this constant.

$$\frac{\partial t_{fd}}{\partial x} = \text{constant} = \frac{dC_2(x)}{dx} \quad (\text{A2.2-12})$$

The second boundary condition given by Equation (A2.2-7) may be

used to give an expression for $\frac{dC_2(x)}{dx}$:

$$\frac{dC_2(x)}{dx} = \frac{2\alpha_e q_0''/k_e}{v_0 R} \quad (\text{A2.2-13})$$

Equation (A2.2-13) is integrated so that the fully developed temperature profile is now expressed as:

$$t_{fd} = \frac{q_0'' R}{2k_e} \left(\frac{r}{R}\right)^2 + 8 \frac{q_0'' R}{k_e} x^+ + C_4 \quad (\text{A2.2-14})$$

where the definition made by Equation (A2.1-2) is utilized. This expression is next integrated over the tube cross section to give the cup-mixed average temperature of the pseudofluid at a position x downstream from the inlet to the heated section.

$$\bar{t}_{fd} = 9 \frac{q_0'' R}{k_e} x^+ + \frac{q_0'' R}{4 k_e} + C_4 \quad (\text{A2.2-15})$$

An energy balance over this section of fluid x in length in terms of the inlet temperature t_0 and $\bar{t}_{fd}$ gives an expression for the constant C_4 .

$$C_4 = t_0 - \frac{q_0'' R}{4 k_e} \quad (\text{A2.2-16})$$

Thus, the fully developed temperature is given as:

$$t_{fd} = \frac{q_0'' R}{k_e} \left[8x^+ + \frac{1}{2} \left(\frac{r}{R}\right)^2 - \frac{1}{4} \right] + t_0 \quad (\text{A2.2-17})$$

The solution for the difference temperature profile in the thermal entrance region is taken to be of the form assumed by Siegel, Sparrow, and Hallman:

$$t^+ = \left(\frac{q_0'' R}{k_e} \right) \sum_n C_n R_n(r) \exp(-\beta_n^2 x^+) \quad (\text{A2.2-18})$$

Thus, β_n and $R_n(r)$ are the eigenvalues and eigenfunctions of:

$$\frac{d^2 R_n}{d\xi^2} + \frac{1}{\xi} \frac{dR_n}{d\xi} + \omega_n^2 R_n = 0 \quad (\text{A2.2-19})$$

where $4\omega_n^2 = \beta_n^2$ and again $\xi = r/R$. With the boundary conditions given by Equations (A2.2-9) and (A2.2-10), the solution is an ordinary, zero order Bessel function. The eigenfunctions are thus given by:

$$R_n(r) = J_0(\omega_n r/R) \quad (\text{A2.2-20})$$

where the eigenvalues are solutions of:

$$J_1(\omega_n) = 0 \quad (\text{A2.2-21})$$

Thus, the temperature difference is given by:

$$t^+ = \left(\frac{q_0'' R}{k_e} \right) \sum_n C_n J_0(\omega_n r/R) \exp(-4\omega_n^2 x^+) \quad (\text{A2.2-22})$$

The normalization coefficients are determined by evaluating Equation (A2.2-22) at $x = 0$:

$$\text{at } x = 0, t^+ (0, r) = t_0 - t_{fd} (0, r) \quad (\text{A2.2-23})$$

giving:

$$\sum_n C_n J_0(\omega_n \xi) = -\left(\frac{1}{2} \xi^2 - \frac{1}{4}\right) \quad (\text{A2.2-24})$$

Equation (A2.2-24) is multiplied by $\xi J_0(\omega_n \xi) d\xi$ and integrated over $0 \leq \xi \leq 1$ to obtain the expression for the coefficients.

$$C_n = \frac{-2}{\omega_n^2 J_0(\omega_n)} \quad (\text{A2.2-25})$$

The temperature profile is now known; evaluating it at the tube boundary yields the local wall temperature:

$$t_w(x) = t_0 + \frac{q_0'' R}{k_e} \left[8x^+ + \frac{1}{4} + \sum_n C_n J_0(\omega_n) \exp(-4\omega_n^2 x^+) \right] \quad (\text{A2.2-26})$$

Now the local average temperature of the pseudofluid is given by:

$$\bar{t} = \bar{t}^+ + t_{fd} \quad (\text{A2.2-27})$$

where $\bar{t}_{fd}$ is given by Equations (A2.2-15) and (A2.2-16). Integrating Equation (A2.2-22) and introducing orthogonality of the eigenfunctions shows that $\bar{t}^+ = 0$. With this known, the local Nusselt number variation may be defined as:

$$N_{Nu}^{loc} = \left(\frac{q_0'' R}{k_e} \right) \frac{2}{t_w - \bar{t}} \quad (A2.2-28)$$

The final expression is thus:

$$N_{Nu}^{loc} = \left[\frac{1}{8} + \frac{1}{2} \sum_n C_n J_0(\omega_n) \exp(-4\omega_n^2 x^+) \right]^{-1} \quad (A2.2-29)$$

Equation (A2.2-29) is the desired form. Since the C_n are defined in terms of the ω_n , all that is needed are the roots to Equation (A2.2-21). The first twenty nonzero roots are obtained from Abramowitz and Stegun (1965) and are listed in Table A2.2-1. Equation (A2.1-3) and Equation (A2.2-29) are plotted for comparison in Figure A2.2-1. Note the similarities in both the form of Equations (A2.1-3) and (A2.2-29) and the resulting curves. Both predict N_{Nu}^{loc} to be infinite for $x = 0$. However, the asymptotic value of the Nusselt number in a pseudofluid with a flat velocity profile is equal to 8 while the value obtained with a parabolic profile is equal to 48/11. Such differences were important when explaining the experimental results of Chapter 5.

Table A2.1-1 γ_m^2 and A_m for the Thermal Entrance Nusselt
Number Variation with Fully Developed Parabolic Velocity
Profile as Reported by Sellars, Tribus, and Klein (1956)

m	γ_m^2	A_m
1	25.639	-0.008854
2	84.624	-0.002062
3	176.40	-0.0009435

Table A2.1-2 β_n^2 , $R_n(1)$, and C_n for the Thermal
Entrance Nusselt Number Variation with Fully Developed
Parabolic Velocity Profile as Reported
by Siegel, Sparrow, and Hallman (1958)

n	β_n^2	$R_n(1)$	C_n
1	25.6796	-0.492517	0.403483
2	83.8618	0.395508	-0.175111
3	174.167	-0.345872	0.105594
4	296.536	0.314047	-0.0732804
5	450.947	-0.291252	0.0550357
6	637.387	0.273808	-0.043483
7	855.850	-0.259852	0.035597

For large n , $\beta_n^2 = 4n + 4/3$

Table A2.2-1 ω_n for the Thermal Entrance Nusselt Number
Variation with Fully Developed Flat Velocity Profile:
The First Twenty Nonzero Roots of $J_1(\omega_n) = 0$

n	ω_n
1	3.83171
2	7.01559
3	10.17347
4	13.32369
5	16.47063
6	19.61586
7	22.76008
8	25.90367
9	29.04683
10	32.18968
11	35.33231
12	38.47477
13	41.61709
14	44.75932
15	47.90146
16	51.04354
17	54.18555
18	57.32753
19	60.46946
20	63.61136

Figure A2.2-1. Local Nusselt number variation in the thermally developing region of a circular tube with a constant wall heat flux and fully developed parabolic or flat velocity profile.

APPENDIX 3

STATIONARY PARTICLE BED TEMPERATURE VARIATIONS

In Chapter 6, the radial temperature profile for a pseudofluid in any axial plane beyond the thermal entrance region of an annular packed particle bed was presented. Theoretical solutions were used extensively in comparisons with the data to obtain the error-minimized overall effective conductivity for each experimental case. The expression for the temperature profile can be easily derived; the results developed by the author are presented in Section A3.1.

A3.1 The Temperature Profile

For the case of a fully developed thermal profile, the temperature solution can be analytically derived. The method used by Quinton and Storrow (1956) as modified by the author to derive this expression applicable to an annular bed will be presented here.

The differential equation for a pseudofluid with a flat velocity profile is given by:

$$\frac{1}{r} \frac{\partial}{\partial r} \left(r \frac{\partial t}{\partial r} \right) = \frac{G_0 c_p}{k_0} \frac{\partial t}{\partial z} \quad (\text{A3.1-1})$$

For the constant wall heat flux case, $\partial t / \partial z$ is constant throughout the bed independent of position. Equation (A3.1-1) is easily integrated across the bed cross section in any axial plane above the thermal entrance region:

$$t = \frac{G_0 c_p}{k_0} \left(\frac{\partial t}{\partial z} \right) \frac{r^2}{4} + \frac{C_1}{k_0} \ln r + C_2 \quad (\text{A3.1-2})$$

Instead of q_0'' , the outer wall boundary condition is written in terms of the temperature of the bed at the wall; the inner wall boundary condition is similarly expressed:

$$\text{at } r = R, \quad t = t_R \quad (\text{A3.1-3})$$

$$\text{at } r = R', \quad t = t_R' \quad (\text{A3.1-4})$$

Use of the first boundary condition eliminates C_2 from Equation (A3.1-2):

$$t - t_R = - \frac{\partial t}{\partial z} \frac{R^2 G_0 c_p}{4k_0} (1 - \xi^2) + \frac{C_1}{k_0} \ln \xi \quad (\text{A3.1-5})$$

Use of the second boundary condition gives an expression for the maximum temperature difference in terms of C_1 :

$$t_R' - t_R = - \frac{\partial t}{\partial z} \frac{R^2 G_0 c_p}{4k_0} \left[1 - \left(\frac{R'}{R} \right)^2 \right] + \frac{C_1}{k_0} \ln \left(\frac{R'}{R} \right) \quad (\text{A3.1-6})$$

Equation (A3.1-6) is finally inserted into Equation (A3.1-5) to give the solution for the temperature profile:

$$\frac{t-t_R'}{t_R-t_R'} = 1 - \frac{\partial t}{\partial z} \frac{R^2 G_0 c_p}{4k_0 (t_R-t_R')} (1-\xi^2) - \left[1 - \frac{\partial t}{\partial z} \frac{R^2 G_0 c_p}{4k_0 (t_R-t_R')} \right] \left[1 - \left(\frac{R'}{R} \right)^2 \right] \left\{ \frac{\ln \xi}{\ln (R'/R)} \right\} \quad (\text{A3.1-7})$$

Equation (A3.1-7) is the desired form; it is expressed in terms of experimentally known parameters and the unknown k_0 . Equation (A3.1-7) is plotted in Figure A3.1-1 as a function of the nondimensional effective conductivity. The shape of the temperature profile is altered significantly with a small change in the overall effective conductivity. Such results were important when discussing the results of Chapter 6.

Figure A3.1-1. Nondimensional radial temperature profiles as functions of nondimensional axial temperature gradient.

APPENDIX 4

FALLING BED EXPERIMENTAL DATA AND CALCULATIONS

Immediately following is the program used to make all calculations for the flowing particle bed experiment. The bulk of this appendix is then a listing of all experimental data, except the radial exit temperature profiles, and the solutions to these calculations for each of the one hundred thirty experiments. The radial exit temperature profiles collected in fifty-two of the cases studied are presented in the last four pages of this appendix; recall that prior to plotting these profiles, the centerline is obtained from the tabulated nondimensional positions by locating the minimum bed temperature.

```

REAL ID1, ID, NUPAR, NUFLAT, NUEXP
INTEGER TEST
DIMENSION ZNODE(16), WALLT(16), PARTMP(16), OD(16), ID(16), RRRATIO(16),
210T(16), HALF1(16), HALF2(16), ORAD(16), OCONV(16), HRAD(16), HCONV(16),
3, AXPOS(16), NUPAR(6, 16), NUFLAT(6, 16), NUEXP(6, 16), PECLET(6),
4EFCON(6), XPLUS(6, 16), EXPNU(6)
CALL DROFFILE(0)
CALL LINK('UNIT5=(D, OPEN), UNIT6=(F, CREATE, TEXT), UNIT7=(MIDDATA1,
20PEN)')
C****
C**** READ TEST NUMBER
C**** READ(5, 10) TEST
10 FORMAT(A6)
C****
C**** EMISS=TUBE EMISSIVITY, N=NUMBER OF NODAL PAIRS, ID1=COLD TUBE
INSIDE DIAMETER (IN), ODI=COLD TUBE OUTSIDE DIAMETER (IN),
Q=POWER (W), PARTMP(1)=BULK PARTICLE INLET TEMPERATURE (F),
FLOW=MASS FLOW (G/S), RHO=BULK PARTICLE DENSITY (G/CM**3),
VOID=VOID FRACTION, MNPART=MINIMUM PARTICLE SIZE (MICRON),
MXPART=MAXIMUM PARTICLE SIZE (MICRON)
C****
C**** READ(5, 20) Q, PARTMP(1), FLOW
20 FORMAT(F7.1, F4.0, F7.3)
C**** READ(5, 30) EMISS, N, ID1, ODI, RHO, VOID, MNPART, MXPART
30 FORMAT(F4.1, I3, 4F7.4, 2I4)
C****
C**** ZNODE(1)=LENGTH OF EACH NODE (IN), WALLT(1)=WALL TEMPERATURE FOR
NODE 1 (F), HALF1(1)=FRACTION OF NODAL LENGTH ABOVE NODE,
HALF2(1)=FRACTION OF NODAL LENGTH BELOW NODE
C****
C**** DO 100 I=1, N
READ(7, 40) ZNODE(I), HALF1(I), HALF2(I)
40 FORMAT(3F7.4)
100 CONTINUE
C**** READ(5, 50) (N, (WALLT(I), I=1, N))
50 FORMAT(*F5.0)
C****
C**** CALL TCoeff TO COMPUTE ELONGATION OF NODAL LINEAR DIMENSIONS AND
COMPUTE RATIO OF NODAL TO TOTAL TUBE RESISTANCE, ALL AS FUNCTIONS
OF TEMPERATURE.
C****
C**** CALL TCoeff(OD1, ID1, ZNODE, WALLT, OD, ID, N, RRRATIO)
C****
C**** CALL FLUX TO CALCULATE THE LOCAL HEAT FLUX AS IT DEPENDS ON
THE RESISTANCE RATIO.
C****
C**** CALL FLUX(Q, N, RRRATIO, ID, ZNODE, QTOT)
C****
C**** CALL PROFIL TO CALCULATE AVERAGE BED AND GAS CONDUCTIVITIES, CONDP
AND CONDG (W/MK), THE AVERAGE PARTICLE SPECIFIC HEAT, SPECIH
(W/SGK), AND THE PARTICLE BULK TEMPERATURE PROFILE (K).
C****
C**** CALL PROFIL(PARTMP, ZNODE, RRRATIO, FLOW, Q, N, HALF1, HALF2, CONDG, CONDP,
2SPECIH)
C****
C**** CALL LOCAL TO CALCULATE THE LOCAL RADIATIVE AND CONVECTIVE HEAT
FLUXES AND HEAT TRANSFER COEFFICIENTS.
C****
C**** CALL LOCAL(WALLT, PARTMP, QTOT, ORAD, OCONV, HRAD, HCONV, EMISS, N)

```



```

380 FORMAT(11X,"AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA")
WRITE(6,380)
390 FORMAT(11X,"GAS",14X,"PARTICLE",9X,"PARTICLE",10X,"HEAT",10X,
2"HEAT TRANSFER")
WRITE(6,391)
391 FORMAT(11X,"CONDUCTIVITY",5X,"CONDUCTIVITY",5X,"SPECIFIC HEAT",5X,
2"FLUX",10X,"COEFFICIENT")
WRITE(6,392)
392 FORMAT(11X,"(W/MK)",11X,"(W/MK)",11X,"(WS/GK)",11X,"(W/M**2)",6X,
2"(W/H**2K)**")
WRITE(6,400) CONDO,CONDP,SPECHP,OAVE,HAVE
400 FORMAT(11X,F8.3,9X,F7.4,10X,F7.4,11X,F9.2,5X,F8.2)
WRITE(6,410)
410 FORMAT(11X,"AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER
2COEFFICIENT PROFILES")
WRITE(6,420)
420 FORMAT(11X,"AXIAL",8X,"WALL",12X,"PARTICLE",8X,"RADIATIVE",5X,
2"CONVECTIVE",5X,"RADIATIVE",5X,"CONVECTIVE")
WRITE(6,421)
421 FORMAT(11X,"POSITION",5X,"TEMPERATURE",5X,"TEMPERATURE",5X,
2"HEAT FLUX",5X,"HEAT FLUX",5X,"H T COEFF",5X,"H T COEFF")
WRITE(6,422)
422 FORMAT(11X,"(CH)",9X,"(C)",13X,"(C)",13X,"(W/M**2)",6X,"(W/H**2)",
27X,"(W/H**2K)",5X,"(W/M**2K)")
DO 430 I=1,N
WRITE(6,425) AXPOS(I),WALLT(I),PARTMP(I),GRAD(I),OCONV(I),HRAID(I),
2HCONV(I)
425 FORMAT(11X,F7.3,6X,F7.2,9X,F7.2,9X,F8.3,6X,F10.2,5X,F7.3,7X,F9.3)
430 CONTINUE
WRITE(6,465)
465 FORMAT(11X,"DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AU
2THORS")
WRITE(6,470)
470 FORMAT(11X,"YAGI",7X,"KUNII",6X,"WILLHITE",5X,"KRUPICZKA",5X,
2"SPECCHIA",5X,"SPECCHIA")
WRITE(6,471)
471 FORMAT(11X,"KUNII",6X,"SMITH",6X,"KUNII",8X,"(1967)",8X,"BALDI",
28X,"SIGARDI")
WRITE(6,472)
472 FORMAT(11X,"(1957)",5X,"(1960)",5X,"SMITH",22X,"SIGARDI",6X,
2"(1930)")
WRITE(6,473)
473 FORMAT(11X,22X,"(1962)",21X,"(1900)")
WRITE(6,480)
480 FORMAT(11X,"THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W
2/MK)")
WRITE(6,490) (EFCON(I),I=1,6)
490 FORMAT(11X,2(F7.4,4X),F7.4,6X,F7.4,7X,2(F7.4,6X))
WRITE(6,495)
495 FORMAT(11X,"PSEUDOHOMOGENEOUS PEGLET NUMBER")
WRITE(6,496) (PEGLT(I),I=1,6)
496 FORMAT(11X,2(F7.1,4X),F7.1,6X,F7.1,7X,2(F7.1,6X))
WRITE(6,500)
500 FORMAT(11X,"AVERAGE EXPERIMENTAL NUSSELT NUMBER")
WRITE(6,500) (EXPNU(I),I=1,6)
505 FORMAT(11X,2(F7.3,4X),F7.3,6X,F7.3,7X,2(F7.3,6X))
WRITE(6,507)
507 FORMAT(11X,//////11X,"TEST NUMBER ",A6)
WRITE(6,510)
510 FORMAT(11X,"LOCAL NUSSELT NUMBER PROFILES")

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520 WRITE(6,520)
520 FORMAT(11X,"YAGI AND KUNII (1957)",35X,"KUNII AND SMITH (1960)")
WRITE(6,521)
521 FORMAT(11X,"N D",8X,"EXPERIMENTAL",3X,"THEORETICAL",3X
2"THEORETICAL",5X,"N D",8X,"EXPERIMENTAL",3X,"THEORETICAL",3X,
3"THEORETICAL")
WRITE(6,522)
522 FORMAT(11X,"POSITION",18X,"FLAT",10X,"PARABOLIC",7X,"POSITION",10X
2"FLAT",10X,"PARABOLIC")
DO 550 I=1,N
WRITE(6,540) XPLUS(I,1),NUEXP(I,1),NUFLAT(I,1),NUPAR(I,1),
2XPLUS(2,1),NUEXP(2,1),NUFLAT(2,1),NUPAR(2,1)
540 FORMAT(11X,2(F8.5,3X,F8.3,7X,F8.3,6X,F8.3,8X))
550 CONTINUE
WRITE(6,620)
620 FORMAT(11X,"WILLHITE, KUNII, AND SMITH (1962)",23X,"KRUPICZKA (196
27)")
WRITE(6,521)
WRITE(6,522)
DO 650 I=1,N
WRITE(6,540) XPLUS(3,1),NUEXP(3,1),NUFLAT(3,1),NUPAR(3,1),
2XPLUS(4,1),NUEXP(4,1),NUFLAT(4,1),NUPAR(4,1)
650 CONTINUE
WRITE(6,720)
720 FORMAT(11X,"SPECCHIA, BALDI, AND SICARDI (1980)",21X,
2"SPECCHIA AND SICARDI (1980)")
WRITE(6,521)
WRITE(6,522)
DO 750 I=1,N
WRITE(6,540) XPLUS(5,1),NUEXP(5,1),NUFLAT(5,1),NUPAR(5,1),
2XPLUS(6,1),NUEXP(6,1),NUFLAT(6,1),NUPAR(6,1)
750 CONTINUE
STOP
END

SUBROUTINE TCOEFF(OD1, ID1, ZNODE, WALLT, OD, ID, N, RRATIO)
REAL ID1, ID
DIMENSION ZNODE(N), WALLT(N), OD(N), ID(N), RRATIO(N), CROSAK(16)
PI=4.*ATAN(1.)

C***
C*** CONVERSION OF WALL TEMPERATURES TO KELVIN.
C***
DO 20 I=1,N
20 WALLT(I)=(WALLT(I)-32.)/1.8)+273.

C***
C*** CALCULATION OF THERMAL EXPANSION OF OD, ID, AND LENGTH OF EACH
C*** NODE (CONVERSION TO CM). A THERMAL COEFFICIENT OF LINEAR
C*** EXPANSION (1/K).
C***
DO 40 I=1,N
A=(0.002600*(WALLT(I)-273.1)+17.1)*1.E-06
OD(I)=2.54*OD1*(1+A*(WALLT(I)-293.))
ID(I)=2.54*ID1*(1+A*(WALLT(I)-293.))
40 ZNODE(I)=2.54*ZNODE1*(1+A*(WALLT(I)-293.))

C***
C*** CALCULATION OF RATIO OF RESISTANCE OF EACH NODE TO TOTAL TUBE
C*** RESISTANCE. C=RESISTIVITY COEFFICIENT (1/K). RESISTIVITY DOES NOT
C*** APPEAR IN THE RATIO AND IS THUS NEGLECTED IN THE CALCULATION.

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C=0.00150
RTOT=0
DO 60 I=1,N
  CROSAR(I)=PI*((O(I)**2)-(ID(I)**2))/4.
  RRATIO(I)=ZNODE(I)*(1+C*(WALLT(I)-293.))/CROSAR(I)
60 RTOT=RTOT+RRATIO(I)
DO 80 I=1,N
  RRATIO(I)=RRATIO(I)/RTOT
80 RETURN
END

SUBROUTINE FLUX(Q,N,RRATIO,ID,ZNODE,QTOT)
  REAL ID
  DIMENSION RRATIO(N),ID(N),ZNODE(N),QTOT(N)
  PI=4.*ATAN(1.)
C****
C**** CALCULATION OF LOCAL HEAT FLUX, QTOT (W/M**2).
C****
  DO 10 I=1,N
  10 QTOT(I)=(10000.*Q*RRATIO(I))/(PI*ID(I)*ZNODE(I))
  RETURN
END

SUBROUTINE PROFIL(PARTMP,ZNODE,RRATIO,FLOW,Q,N,HALF1,HALF2,CONDG,
2CONDP,SPECHP)
  DIMENSION PARTMP(N),ZNODE(N),QLOC(16),RRATIO(N),HALF1(N),HALF2(N)
C****
C**** CONVERT PARTICLE BULK INLET TEMPERATURE TO KELVIN.
C****
  PARTMP(1)=(PARTMP(1)-32.)/1.8+273.
C****
C**** COMPUTE AVERAGE BED TEMPERATURE, TBAR, AND PARTICLE BULK EXIT
C**** TEMPERATURE (K), USING TEMPERATURE DEPENDENT SPECIFIC HEAT OF
C**** SODA-LIME GLASS GIVEN BY C=-A*(700-T/K)**1.8+D. A=7.230E-06 WS/GK
C**** B=1.117 WS/GK.
  TBAR1=100.
  A=7.230E-06
  B=1.117
  20 C=-A*((700.-TBAR1)**1.8)+B
  PARTMP(N)=PARTMP(1)+(Q/(FLOW*C))
  TBAR2=TBAR1
  TBAR1=(PARTMP(1)+PARTMP(N))/2.
  DELTA=TBAR2-TBAR1
  DELTA=ABS(DELTA)
  IF (DELTA.GE.0.1) GO TO 20
  TBAR=TBAR1
C****
C**** CALCULATION OF AVERAGE PARTICLE AND GAS CONDUCTIVITIES (W/KK), AND
C**** AVERAGE PARTICLE SPECIFIC HEAT (WS/GK).
C****
  CONDP=(2.1E-03)*TBAR+0.37
  CONDG=(1.475E-04)*(TBAR**0.898)
  SPECHP=(-7.230E-06)*((700.-TBAR)**1.8)+1.117
C****
C**** FIRST ESTIMATE OF PARTICLE TEMPERATURES ASSUMING A LINEAR
C**** VARIATION.

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      ZTOT=0.
      DO 40 I=1,N
40     ZTOT=ZTOT+ZNODE(I)
      J=N-1
      ZLOC=0.
      DO 60 I=2,J
      K=I-1
      ZLOC=ZLOC+HALF2(K)*ZNODE(K)+HALF1(I)*ZNODE(I)
      PARTMP(I)=(PARTMP(N)-PARTMP(1))+ZLOC/ZTOT+PARTMP(1)
C****
C     CALCULATION OF PARTICLE BULK TEMPERATURE PROFILE USING AN ENERGY
C     BALANCE OVER EACH NODE.
C****
      DO 100 I=1,J
      K=I+1
      QLOC(I)=Q*(HALF2(I)*RRATIO(I)+HALF1(K)*RRATIO(K))
      TBARI=(PARTMP(I)+PARTMP(K))/2.
80     C=A*((700.-TBARI)**1.0)*B
      PARTMP(K)=PARTMP(I)+(QLOC(I)/(FLOW*C))
      TBAR2=TBARI
      TBARI=(PARTMP(I)+PARTMP(K))/2.
      DELTA=TBAR2-TBARI
      DELTA=ABS(DELTA)
      IF (DELTA.GE.0.1) GO TO 80
100    CONTINUE
      RETURN
      END

      SUBROUTINE LOCAL(WALLT,PARTMP,OTOT,ORAD,QCONV,HRAD,HCONV,EMISS,N)
      DIMENSION WALLT(N),PARTMP(N),OTOT(N),ORAD(N),QCONV(N),HRAD(N),
      2HCONV(N)
C****
C     CALCULATION OF LOCAL RADIATIVE AND CONVECTIVE HEAT FLUXES (W/M**2)
C     AND LOCAL RADIATIVE AND CONVECTIVE HEAT TRANSFER COEFFICIENTS
C     (W/M**2K). SIGMA=STEFAN-BOLTZMAN CONSTANT, 5.729E-08 W/M**2K**4.
C****
      SIGMA=5.729E-08
      DO 50 I=1,N
      ORAD(I)=EMISS*SIGMA*((WALLT(I)**4)-(PARTMP(I)**4))
      QCONV(I)=OTOT(I)-ORAD(I)
      HRAD(I)=ORAD(I)/(WALLT(I)-PARTMP(I))
80     HCONV(I)=QCONV(I)/(WALLT(I)-PARTMP(I))
      RETURN
      END

      SUBROUTINE AVERAGE(WALLT,PARTMP,QCONV,HALF1,HALF2,ID,ZNODE,N,CAVE,
      2HAVE,FLOW,RHO,IDI,VEL)
      REAL LMTD,IDI,IDI
      DIMENSION WALLT(N),PARTMP(N),QCONV(N),ID(N),ZNODE(N),HALF1(N),
      2HALF2(N)
      PI=4.*ATAN(1.)
C****
C     CALCULATION OF THE LOGARITHMIC-MEAN-TEMPERATURE-DIFFERENCE BASED
C     ON ALL BUT THE END NODES (K).
C****
      J=N-1
      K=N-2
      LMTD=(WALLT(J)-PARTMP(J)-WALLT(2)+PARTMP(2))/

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      2*(ALOG((WALLT(J)-PARTHP(J))/(WALLT(2)-PARTHP(2))))
C****
C*** CALCULATION OF CONVECTIVE HEAT FLUX THROUGH ALL BUT THE END NODES
C*** (W/M**2).
      AREA=PI*ID(2)*ZNODE(2)*HALF2(2)/10000.
      CONV=CONV(2)*AREA
      AREAJ=PI*ID(J)*ZNODE(J)*HALF1(J)/10000.
      CONV=CONV+CONV(J)*AREAJ
      AREA=AREA+AREAJ
      DO 50 I=3,K
      AREAJ=PI*ID(I)*ZNODE(I)/10000.
      CONV=CONV+CONV(I)*AREAJ
50    AREA=AREA+AREAJ
      QAVE=CONV/AREA
C****
C*** CALCULATION OF AVERAGE CONVECTIVE HEAT TRANSFER COEFFICIENT
C*** (W/M**2K)
      HAVE=QAVE/LMTD
C****
C*** CALCULATION OF THE BULK PARTICLE VELOCITY BASED UPON THE COLD TUBE
C*** INSIDE DIAMETER (CM/S).
      VEL=(4.*FLOW)/(PI*RHO*((2.54*ID1)**2))
      RETURN
      END

SUBROUTINE YK57(VOID,CONDP,CONDO,EFCON)
      DIMENSION EFCON(6)
C****
C*** CALCULATION OF THE STATIC EFFECTIVE THERMAL CONDUCTIVITY (W/MK),
C*** ACCORDING TO METHOD OF YASU-KUNITI (1957) WITH BETA=GAMMA=1.
      EFCON(1)=((1.-VOID)*CONDP)/((CONDP/CONDP)+0.01*((VOID/0.2)**1.79))
      RETURN
      END

SUBROUTINE K360(VOID,CONDP,CONDO,EFCON)
      DIMENSION EFCON(6)
C****
C*** CALCULATION OF THE STATIC EFFECTIVE THERMAL CONDUCTIVITY (W/MK),
C*** ACCORDING TO THE METHOD OF KUNITI-SMITH (1960) WITH BETA=1 AND
C*** GAMMA=1/3.
      X=CONDP/CONDO
      PHI1=(0.240/X**0.213)+0.0029
      PHI2=0.0922/(X**0.256)
      PHI=PHI1*(PHI1-PHI2)+((VOID-0.260)/(0.216
      EFCON(2)=(VOID*(1.-VOID)/(PHI+2./3.*X)))*CONDO
      RETURN
      END

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SUBROUTINE WK562(VOID, CONDP, CONDG, EFCON)
  DIMENSION EFCON(6)
C****
C    CALCULATION OF THE STATIC EFFECTIVE THERMAL CONDUCTIVITY (W/MK),
C    ACCORDING TO THE METHOD OF WILLHITE-KUNIT-SMITH (1962).
C****
  X=CONDP/CONDG
  Y=(15.03-25.26*VOID)/(1.91-1.91*VOID)
  E1=(1.-1./Y)
  T1=(1.-1./X)**2)/(2.*Y)
  T2=X*(X-1.)*SQRT(E1)
  T3=(1.-1./X)*(1.-SQRT(E1))
  ALPHA=T1/(ALOG(T2)-T3)
  EFCON(3)=(1.+(1.-VOID)*(1.-1./X)+2.*(1.-1./X)**2)*(1.-VOID)/
  2(3.*ALPHA))*CONDG
  RETURN
END

SUBROUTINE XG7(VOID, CONDP, CONDG, EFCON)
  DIMENSION EFCON(6)
C****
C    CALCULATION OF THE STATIC EFFECTIVE THERMAL CONDUCTIVITY (W/MK),
C    ACCORDING TO THE METHOD OF KRUPICZKA (1967).
C****
  A=0.280-0.757*ALOG10(VOID)
  B=-0.057
  X=CONDP/CONDG
  E=A+B*ALOG10(X)
  EFCON(4)=(X+E)*CONDG
  RETURN
END

SUBROUTINE SRS30(VOID, CONDP, CONDG, EFCON)
  DIMENSION EFCON(6)
C****
C    CALCULATION OF THE STATIC EFFECTIVE THERMAL CONDUCTIVITY (W/MK),
C    USING THE KUNIT-SMITH (1960) MODEL WITH THE CORRELATION FOR PHI
C    GIVEN BY SPECCHIA-BALDI-SICARDI (1980).
C****
  X=CONDG/CONDP
  PHI=0.220*(VOID**2)
  EFCON(5)=(VOID*(1.-VOID)/(2.*X/3.+PHI))*CONDG
  RETURN
END

SUBROUTINE SS80(VOID, CONDP, CONDG, EFCON)
  DIMENSION EFCON(6)
C****
C    CALCULATION OF THE STATIC EFFECTIVE THERMAL CONDUCTIVITY (W/MK),
C    ACCORDING TO THE METHOD OF SPECCHIA-SICARDI (1980).
C****
  X=CONDG/CONDP
  PHI=0.130*(VOID**1.44)
  EFCON(6)=(VOID/1.5)*(1.-VOID)/(2.*X/3.+PHI))*CONDG
  RETURN
END

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SUBROUTINE NUSELT(SPECHP,EFCON,XPLUS,VEL,RHO,PECLET,N,ID,
21D1,ZNODE,I CONV,AXPOS,HALF1,HALF2,NUPAR,NUFLAT,NUEXP)
REAL ID1,ID,NUPAR,NUFLAT,NUEXP
DIMENSION ID(N),ZNODE(N),I CONV(N),AXPOS(N),HALF1(N),HALF2(N),C(7),
2R1(7),BETA2(7),NUPAR(6,N),NUFLAT(6,N),NUEXP(6,N),
3BLAMDA(20),FECLET(6),EFCONT(6),XPLUS(6,N)
C****
C**** CALCULATION OF PECLET NUMBER BASED UPON COLD TUBE INSIDE DIAMETER.
C****
DO 10 I=1,6
PECLET(I)=2.54.*SPECHP*ID1*VEL*RHO/EFCON(I)
10 CONTINUE
C****
C**** GENERATION OF THE NODAL AXIAL POSITIONS (CM).
C****
AXPOS(1)=0.
DO 20 J=2,N
J=J-1
20 AXPOS(J)=AXPOS(J)+HALF2(J)*ZNODE(J)+HALF1(J)*ZNODE(J)
C****
C**** CALCULATE THE NONDIMENSIONAL NODAL AXIAL POSITIONS.
C****
DO 40 I=1,6
DO 30 J=1,N
XPLUS(I,J)=(AXPOS(J)-2.54*ID1)/(PECLET(I)*(ID(J)**2))
30 CONTINUE
40 CONTINUE
C****
C**** DEFINE THE EIGENVALUES AND CONSTANTS FOR THE NUSSELT NUMBER
C**** VARIATION IN THE THERMALLY DEVELOPING REGION WITH A FULLY
C**** DEVELOPED PARABOLIC VELOCITY PROFILE.
BETA2(1)=25.6706
BETA2(2)=83.6618
BETA2(3)=174.167
BETA2(4)=296.536
BETA2(5)=450.947
BETA2(6)=637.387
BETA2(7)=855.850
R1(1)=0.402517
R1(2)=0.391508
R1(3)=0.315872
R1(4)=0.314047
R1(5)=0.291252
R1(6)=0.273053
R1(7)=0.259052
C(1)=0.403403
C(2)=-0.175111
C(3)=0.105594
C(4)=-0.0732004
C(5)=0.0550357
C(6)=-0.043483
C(7)=0.035597
C****
C**** CALCULATE THE NUSSELT NUMBER PROFILE WITH A PARABOLIC VELOCITY
C**** FLOW ASSUMPTION.
C****
DO 105 J=1,6
DO 100 K=1,N
SUM=0.

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DO 50 L=1,7
EXPT=- (2.*BETA2(L)*XPLUS(J,K))
50 SUM=SUM+C(L)*RT(L)*EXP(EXPT)
100 NUPAR(J,K)=2./(SUM*(11./24.))
105 CONTINUE
C****
C*** DEFINE THE EIGENVALUES FOR THE NUSSELT NUMBER VARIATION IN THE
THERMALLY DEVELOPING REGION WITH A FULLY DEVELOPED FLAT VELOCITY
C*** PROFILE.
BLAMDA(1)=3.83171
BLAMDA(2)=7.01559
BLAMDA(3)=10.17347
BLAMDA(4)=13.32369
BLAMDA(5)=16.47063
BLAMDA(6)=19.61586
BLAMDA(7)=22.76008
BLAMDA(8)=25.90367
BLAMDA(9)=29.04603
BLAMDA(10)=32.18968
BLAMDA(11)=35.33231
BLAMDA(12)=38.47477
BLAMDA(13)=41.61709
BLAMDA(14)=44.75932
BLAMDA(15)=47.90146
BLAMDA(16)=51.04354
BLAMDA(17)=54.18555
BLAMDA(18)=57.32733
BLAMDA(19)=60.46946
BLAMDA(20)=63.61136
DO 110 I=1,20
BLAMDA(I)=BLAMDA(I)**2
110
C****
C*** CALCULATE THE NUSSELT NUMBER PROFILE WITH A FLAT VELOCITY FLOW
C*** ASSUMPTION.
DO 210 J=1,6
DO 200 K=1,N
SUM=0.
DO 150 L=1,20
EXPT=- (4.*BLAMDA(L)*XPLUS(J,K))
150 SUM=SUM+2.*EXP(EXPT)/BLAMDA(L)
200 NUFLAT(J,K)=2./(SUM*0.25)
210 CONTINUE
C****
C*** CALCULATE THE NUSSELT NUMBER PROFILE BASED UPON THE EXPERIMENTAL
CONVECTIVE HEAT TRANSFER COEFFICIENTS AND THE TUBEL
C*** DETERMINATIONS FOR THE STATIC EFFECTIVE THERMAL CONDUCTIVITY.
DO 250 J=1,6
DO 250 I=1,N
NUEXP(J,I)=HCONV(I)*ID(I)/(100.*EFCON(J))
250 CONTINUE
250 RETURN
END

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```
SUBROUTINE AVENU(EXPNU,HAVE,IOI,EFCON)
REAL IOI
DIMENSION EXPNU(6),EFCON(6)
DO 10 I=1,6
10 EXPNU(I)=HAVE*2.54*IOI/(100.*EFCON(I))
RETURN
END
```

TEST NUMBER AA-4-1
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 ID (CM) 1.42875 1.37795 0.300
 EMISSIVITY
 PARTICLE SIZE RANGE (MICRONS)
 177-250
 EXPERIMENTAL VARIABLES
 POWER (W) 601.40
 VELOCITY (CM/S) 11.78
 DENSITY (G/CM³) 1.455
 VOID FRACTION 0.405
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS CONDUCTIVITY (W/MK) 0.02593
 PARTICLE CONDUCTIVITY (W/MK) 1.0340
 PARTICLE SPECIFIC HEAT (WS/GK) 0.7930
 HEAT FLUX (W/M²) 25443.91
 HEAT TRANSFER COEFFICIENT (W/M²K) 379.46
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M ²)	CONVECTIVE HEAT FLUX (W/M ²)	RADIATIVE H T COEFF (W/M ² K)	CONVECTIVE H T COEFF (W/M ² K)
0	47.78	28.33	40.271	23226.28	2.071	1194.597
3.177	71.11	29.90	96.150	23025.21	2.338	581.744
7.944	85.67	32.52	137.806	24384.22	2.546	450.315
12.713	103.89	35.09	191.321	24003.18	2.790	361.706
17.483	110.00	37.70	209.665	25061.81	2.900	348.628
22.253	117.22	40.31	232.904	23270.10	3.028	328.559
27.024	127.78	42.94	272.175	25550.87	3.208	301.384
31.796	137.78	45.59	312.296	25848.59	3.388	280.390
36.560	138.33	48.24	308.974	23850.67	3.430	287.157
41.341	149.44	50.91	358.189	26175.38	3.635	265.634
46.114	150.00	53.57	354.766	26196.53	3.679	271.670
50.888	158.33	56.24	392.956	26424.20	3.849	258.026
54.070	155.56	58.02	373.301	26355.18	3.828	270.208

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII BALDI
 (1957) (1960) SMITH (1962) SICARDI (1980)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2553 0.1589 0.1846 0.1554 0.3026 0.0031
 PSEUDOHOMOGENEOUS PECLET NUMBER
 7394.9 1178.2 10138.9
 AVERAGE EXPERIMENTAL NUSSELT NUMBER 12043.8 6105.8 6179.7
 20.485 32.916 28.318 33.636 17.277 17.249

TEST NUMBER 44-4-1				LOCAL MUSSELT NUMBER PROFILES			
YAGI AND KUNII (1957)				YAGI AND KUNII (1957)			
POSITION	EXPERIMENTAL	THEORETICAL FLAT	THEORETICAL PARABOLIC	POSITION	EXPERIMENTAL	THEORETICAL FLAT	THEORETICAL PARABOLIC
0.00031	64.502	204.815	21.360	0.00031	59.122	204.815	21.360
0.00078	31.438	224.161	18.360	0.00078	43.434	204.815	18.360
0.00125	18.595	227.584	15.360	0.00125	39.597	204.815	15.360
0.00172	13.777	229.940	12.360	0.00172	35.777	204.815	12.360
0.00219	10.522	231.300	9.360	0.00219	32.522	204.815	9.360
0.00266	8.157	232.657	6.360	0.00266	29.157	204.815	6.360
0.00313	6.034	234.014	3.360	0.00313	26.034	204.815	3.360
0.00360	4.155	235.371	0.360	0.00360	23.155	204.815	0.360
0.00407	2.536	236.728		0.00407	20.536	204.815	
0.00454	1.197	238.085		0.00454	18.197	204.815	
0.00501	0.068	239.442		0.00501	16.068	204.815	
0.00548		240.799		0.00548	14.068	204.815	
0.00595		242.156		0.00595	12.068	204.815	
0.00642		243.513		0.00642	10.068	204.815	
0.00689		244.870		0.00689	8.068	204.815	
0.00736		246.227		0.00736	6.068	204.815	
0.00783		247.584		0.00783	4.068	204.815	
0.00830		248.941		0.00830	2.068	204.815	
0.00877		250.298		0.00877	0.068	204.815	
0.00924		251.655		0.00924		204.815	
0.00971		253.012		0.00971		204.815	
0.01018		254.369		0.01018		204.815	
0.01065		255.726		0.01065		204.815	
0.01112		257.083		0.01112		204.815	
0.01159		258.440		0.01159		204.815	
0.01206		259.797		0.01206		204.815	
0.01253		261.154		0.01253		204.815	
0.01300		262.511		0.01300		204.815	
0.01347		263.868		0.01347		204.815	
0.01394		265.225		0.01394		204.815	
0.01441		266.582		0.01441		204.815	
0.01488		267.939		0.01488		204.815	
0.01535		269.296		0.01535		204.815	
0.01582		270.653		0.01582		204.815	
0.01629		272.010		0.01629		204.815	
0.01676		273.367		0.01676		204.815	
0.01723		274.724		0.01723		204.815	
0.01770		276.081		0.01770		204.815	
0.01817		277.438		0.01817		204.815	
0.01864		278.795		0.01864		204.815	
0.01911		280.152		0.01911		204.815	
0.01958		281.509		0.01958		204.815	
0.02005		282.866		0.02005		204.815	
0.02052		284.223		0.02052		204.815	
0.02099		285.580		0.02099		204.815	
0.02146		286.937		0.02146		204.815	
0.02193		288.294		0.02193		204.815	
0.02240		289.651		0.02240		204.815	
0.02287		291.008		0.02287		204.815	
0.02334		292.365		0.02334		204.815	
0.02381		293.722		0.02381		204.815	
0.02428		295.079		0.02428		204.815	
0.02475		296.436		0.02475		204.815	
0.02522		297.793		0.02522		204.815	
0.02569		299.150		0.02569		204.815	
0.02616		300.507		0.02616		204.815	
0.02663		301.864		0.02663		204.815	
0.02710		303.221		0.02710		204.815	
0.02757		304.578		0.02757		204.815	
0.02804		305.935		0.02804		204.815	
0.02851		307.292		0.02851		204.815	
0.02898		308.649		0.02898		204.815	
0.02945		310.006		0.02945		204.815	
0.02992		311.363		0.02992		204.815	
0.03039		312.720		0.03039		204.815	
0.03086		314.077		0.03086		204.815	
0.03133		315.434		0.03133		204.815	
0.03180		316.791		0.03180		204.815	
0.03227		318.148		0.03227		204.815	
0.03274		319.505		0.03274		204.815	
0.03321		320.862		0.03321		204.815	
0.03368		322.219		0.03368		204.815	
0.03415		323.576		0.03415		204.815	
0.03462		324.933		0.03462		204.815	
0.03509		326.290		0.03509		204.815	
0.03556		327.647		0.03556		204.815	
0.03603		329.004		0.03603		204.815	
0.03650		330.361		0.03650		204.815	
0.03697		331.718		0.03697		204.815	
0.03744		333.075		0.03744		204.815	
0.03791		334.432		0.03791		204.815	
0.03838		335.789		0.03838		204.815	
0.03885		337.146		0.03885		204.815	
0.03932		338.503		0.03932		204.815	
0.03979		339.860		0.03979		204.815	
0.04026		341.217		0.04026		204.815	
0.04073		342.574		0.04073		204.815	
0.04120		343.931		0.04120		204.815	
0.04167		345.288		0.04167		204.815	
0.04214		346.645		0.04214		204.815	
0.04261		348.002		0.04261		204.815	
0.04308		349.359		0.04308		204.815	
0.04355		350.716		0.04355		204.815	
0.04402		352.073		0.04402		204.815	
0.04449		353.430		0.04449		204.815	
0.04496		354.787		0.04496		204.815	
0.04543		356.144		0.04543		204.815	
0.04590		357.501		0.04590		204.815	
0.04637		358.858		0.04637		204.815	
0.04684		360.215		0.04684		204.815	
0.04731		361.572		0.04731		204.815	
0.04778		362.929		0.04778		204.815	
0.04825		364.286		0.04825		204.815	
0.04872		365.643		0.04872		204.815	
0.04919		367.000		0.04919		204.815	
0.04966		368.357		0.04966		204.815	
0.05013		369.714		0.05013		204.815	
0.05060		371.071		0.05060		204.815	
0.05107		372.428		0.05107		204.815	
0.05154		373.785		0.05154		204.815	
0.05201		375.142		0.05201		204.815	
0.05248		376.499		0.05248		204.815	
0.05295		377.856		0.05295		204.815	
0.05342		379.213		0.05342		204.815	
0.05389		380.570		0.05389		204.815	
0.05436		381.927		0.05436		204.815	
0.05483		383.284		0.05483		204.815	
0.05530		384.641		0.05530		204.815	
0.05577		386.000		0.05577		204.815	
0.05624		387.357		0.05624		204.815	
0.05671		388.714		0.05671		204.815	
0.05718		390.071		0.05718		204.815	
0.05765		391.428		0.05765		204.815	
0.05812		392.785		0.05812		204.815	
0.05859		394.142		0.05859		204.815	
0.05906		395.500		0.05906		204.815	
0.05953		396.857		0.05953		204.815	
0.06000		398.214		0.06000		204.815	
0.06047		399.571		0.06047		204.815	
0.06094		400.928		0.06094		204.815	
0.06141		402.285		0.06141		204.815	
0.06188		403.642		0.06188		204.815	
0.06235		405.000		0.06235		204.815	
0.06282		406.357		0.06282		204.815	
0.06329		407.714		0.06329		204.815	
0.06376		409.071		0.06376		204.815	
0.06423		410.428		0.06423		204.815	
0.06470		411.785		0.06470		204.815	
0.06517		413.142		0.06517		204.815	
0.06564		414.500		0.06564		204.815	
0.06611		415.857		0.06611		204.815	
0.06658		417.214		0.06658		204.815	
0.06705		418.571		0.06705		204.815	
0.06752		419.928		0.06752		204.815	
0.06799		421.285		0.06799		204.815	
0.06846		422.642		0.06846		204.815	
0.06893		424.000		0.06893		204.815	
0.06940		425.357		0.06940		204.815	
0.06987		426.714		0.06987		204.815	
0.07034		428.071		0.07034		204.815	
0.07081		429.428		0.07081		204.815	
0.07128		430.785		0.07128		204.815	
0.07175		432.142		0.07175		204.815	
0.07222		433.500		0.07222		204.815	
0.07269		434.857		0.07269		204.815	
0.07316		436.214		0.07316		204.815	
0.07363		437.571		0.07363		204.815	
0.07410		438.928		0.07410		204.815	
0.07457		440.285		0.07457		204.815	
0.07504		441.642		0.07504		204.815	
0.07551		443.000		0.07551		204.815	
0.07598		444.357		0.07598		204.815	
0.07645		445.714		0.07645		204.815	
0.07692		447.071		0.07692		204.815	
0.07739		448.428		0.07739		204.815	
0.07786		449.785		0.07786		204.815	
0.07833		451.142		0.07833		204.815	
0.07880		452.5					

TEST NUMBER AA-4-2
EXPERIMENTAL DATA
TUBE CHARACTERISTICS
OD (CM) ID (CM) EMISSIVITY
1.42875 1.37795 0.300
PARTICLE SIZE RANGE (MICRONS)
177-250

EXPERIMENTAL VARIABLES
POWER VELOCITY DENSITY VOID
(W) (CM/S) (G/CM**3) FRACTION
601.4C 11.01 1.455 0.405

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
GAS PARTICLE PARTICLE HEAT HEAT TRANSFER
CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
0.02612 1.0395 0.7569 25440.98 390.35

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0	45.56	30.00	32.119	23100.84	2.055	1485.568
3.177	70.56	31.75	91.188	23854.54	2.350	614.750
7.944	88.33	34.45	139.416	24377.17	2.587	452.376
12.713	104.44	37.19	193.717	24848.17	2.821	369.383
17.483	111.11	39.56	249.205	25038.90	2.941	331.870
22.253	119.44	42.74	293.806	25275.84	3.088	329.513
27.023	131.67	45.54	293.929	25619.10	3.297	297.460
31.797	140.00	48.36	316.721	25852.11	3.456	282.120
36.569	140.56	51.19	312.807	25873.68	3.501	289.325
41.342	151.87	54.02	362.414	26170.10	3.711	268.091
46.115	162.22	56.86	358.426	26190.76	3.759	274.730
50.889	161.11	59.70	399.320	26141.19	3.942	260.720
54.072	161.11	61.59	394.962	26446.03	3.969	265.732

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
KUNII SMITH KUNII (1967) BALDI
(1957) (1960) SMITH (1980) SICARDI
(1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
0.2569 0.1509 0.1889 0.1565 0.3047 0.3052
PSEUDOHOMOGENEOUS PECELET NUMBER
6847.5 11000.7 9465.7 11243.9 5773.9 5764.6
AVERAGE EXPERIMENTAL NUSSELT NUMBER
20.936 33.635 28.941 34.378 17.654 17.625

TEST NUMBER AA-4-2				LOCAL MISSILE NUMBER PROFILES			
YAGI AND KUNII (1957)				YAGI AND KUNII (1957)			
N.D.	POSITION	EXPERIMENTAL	THEORETICAL	N.D.	POSITION	EXPERIMENTAL	THEORETICAL
0	0.00034	79.7099	72.0115	0	0.00034	79.7099	72.0115
0	0.00064	224.2990	200.7939	0	0.00064	224.2990	200.7939
0	0.00119	19.6540	22.6777	0	0.00119	19.6540	22.6777
0	0.00229	117.7003	123.0000	0	0.00229	117.7003	123.0000
0	0.00265	115.0044	119.0066	0	0.00265	115.0044	119.0066
0	0.00326	115.1620	119.0066	0	0.00326	115.1620	119.0066
0	0.00396	115.1620	119.0066	0	0.00396	115.1620	119.0066
0	0.00437	117.7669	119.0066	0	0.00437	117.7669	119.0066
0	0.00537	114.0267	114.0267	0	0.00537	114.0267	114.0267
0	0.00570	114.0267	114.0267	0	0.00570	114.0267	114.0267
KUNII AND SMITH (1967)				KUNII AND SMITH (1967)			
N.D.	POSITION	EXPERIMENTAL	THEORETICAL	N.D.	POSITION	EXPERIMENTAL	THEORETICAL
0	0.00024	110.197	120.815	0	0.00024	110.197	120.815
0	0.00097	152.576	159.250	0	0.00097	152.576	159.250
0	0.00134	227.426	220.7939	0	0.00134	227.426	220.7939
0	0.00170	224.472	224.0000	0	0.00170	224.472	224.0000
0	0.00206	224.0000	224.0000	0	0.00206	224.0000	224.0000
0	0.00279	221.510	221.510	0	0.00279	221.510	221.510
0	0.00315	221.510	221.510	0	0.00315	221.510	221.510
0	0.00382	220.7939	220.7939	0	0.00382	220.7939	220.7939
0	0.00419	117.7669	117.7669	0	0.00419	117.7669	117.7669
BALDI AND SICARDI (1980)				BALDI AND SICARDI (1980)			
N.D.	POSITION	EXPERIMENTAL	THEORETICAL	N.D.	POSITION	EXPERIMENTAL	THEORETICAL
0	0.00040	57.325	57.325	0	0.00040	57.325	57.325
0	0.00100	220.7939	220.7939	0	0.00100	220.7939	220.7939
0	0.00159	115.0066	115.0066	0	0.00159	115.0066	115.0066
0	0.00238	115.0066	115.0066	0	0.00238	115.0066	115.0066
0	0.00308	115.0066	115.0066	0	0.00308	115.0066	115.0066
0	0.00369	115.0066	115.0066	0	0.00369	115.0066	115.0066
0	0.00439	115.0066	115.0066	0	0.00439	115.0066	115.0066
0	0.00509	115.0066	115.0066	0	0.00509	115.0066	115.0066
0	0.00579	115.0066	115.0066	0	0.00579	115.0066	115.0066
0	0.00649	115.0066	115.0066	0	0.00649	115.0066	115.0066
KUNII AND SMITH (1967)				KUNII AND SMITH (1967)			
N.D.	POSITION	EXPERIMENTAL	THEORETICAL	N.D.	POSITION	EXPERIMENTAL	THEORETICAL
0	0.00024	110.197	120.815	0	0.00024	110.197	120.815
0	0.00097	152.576	159.250	0	0.00097	152.576	159.250
0	0.00134	227.426	220.7939	0	0.00134	227.426	220.7939
0	0.00170	224.472	224.0000	0	0.00170	224.472	224.0000
0	0.00206	224.0000	224.0000	0	0.00206	224.0000	224.0000
0	0.00279	221.510	221.510	0	0.00279	221.510	221.510
0	0.00315	221.510	221.510	0	0.00315	221.510	221.510
0	0.00382	220.7939	220.7939	0	0.00382	220.7939	220.7939
0	0.00419	117.7669	117.7669	0	0.00419	117.7669	117.7669
BALDI AND SICARDI (1980)				BALDI AND SICARDI (1980)			
N.D.	POSITION	EXPERIMENTAL	THEORETICAL	N.D.	POSITION	EXPERIMENTAL	THEORETICAL
0	0.00040	57.325	57.325	0	0.00040	57.325	57.325
0	0.00100	220.7939	220.7939	0	0.00100	220.7939	220.7939
0	0.00159	115.0066	115.0066	0	0.00159	115.0066	115.0066
0	0.00238	115.0066	115.0066	0	0.00238	115.0066	115.0066
0	0.00308	115.0066	115.0066	0	0.00308	115.0066	115.0066
0	0.00369	115.0066	115.0066	0	0.00369	115.0066	115.0066
0	0.00439	115.0066	115.0066	0	0.00439	115.0066	115.0066
0	0.00509	115.0066	115.0066	0	0.00509	115.0066	115.0066
0	0.00579	115.0066	115.0066	0	0.00579	115.0066	115.0066
0	0.00649	115.0066	115.0066	0	0.00649	115.0066	115.0066

TEST NUMBER AA-4-3
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 1.42875 1.37795 0.300
 PARTICLE SIZE RANGE (MICRONS)
 177-250

EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID
 (W) (CM/S) (G/CM**3) FRACTION
 807.60 9.08 1.455 0.405

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS PARTICLE PARTICLE HEAT HEAT
 CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
 (W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
 0.02634 1.0458 0.8015 25691.31 391.09

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES
 AXIAL POSITION (CM) WALL TEMPERATURE (C) PARTICLE TEMPERATURE (C) RADIATIVE HEAT FLUX (W/M**2) CONVECTIVE HEAT FLUX (W/M**2) RADIATIVE H T COEFF (W/M**2K) CONVECTIVE H T COEFF (W/M**2K)

0	37.78	31.11	34.973	23307.90	2.098	1398.294
0.177	71.67	35.07	91.711	24021.29	2.376	622.435
7.945	90.00	38.09	141.546	24563.22	2.626	455.646
12.714	106.67	39.16	193.917	25047.76	2.873	371.051
17.484	113.89	42.26	215.295	25290.71	3.006	352.642
22.254	122.78	45.38	245.114	25514.87	3.167	329.630
27.026	136.11	48.52	297.000	25699.02	3.400	295.562
31.790	144.44	51.68	330.913	26129.84	3.567	281.615
36.571	145.56	54.04	320.938	26181.41	3.626	288.403
41.344	156.67	58.01	379.428	26450.61	3.646	260.281
46.116	167.22	61.19	374.434	26459.98	3.890	275.834
50.892	167.22	64.37	422.847	26750.05	4.111	260.175
54.076	166.67	66.49	419.944	26751.01	4.132	267.036

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 VASIL KUNII WILLHITE KRUPICZKA SPENCIA
 (1957) SMITH KUNII (1957) RABDI SPICARDI
 (1960) SMITH (1962) SIGARDI (1960)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2589 0.1612 0.1873 0.1576 0.3071 0.3075

PSEUDO-HOMOGENEOUS PECLET NUMBER
 6132.4 9849.6 8476.9 10069.2 5169.6 5161.3

AVERAGE EXPERIMENTAL NUSSELT NUMBER
 20.862 33.509 28.839 34.256 17.507 17.559

TEST NUMBER AA-4-3				TEST NUMBER AA-4-3			
LOCAL NUSSELT (1957)				LOCAL NUSSELT (1957)			
FLAT AND EXPERIMENTAL				FLAT AND EXPERIMENTAL			
POSITION	THEORETICAL	EXPERIMENTAL	THEORETICAL	POSITION	THEORETICAL	EXPERIMENTAL	THEORETICAL
0.00034	74.474	74.474	204.815	0.00034	74.474	74.474	204.815
0.00036	93.165	93.165	204.815	0.00036	93.165	93.165	204.815
0.00038	111.856	111.856	204.815	0.00038	111.856	111.856	204.815
0.00040	130.547	130.547	204.815	0.00040	130.547	130.547	204.815
0.00042	149.238	149.238	204.815	0.00042	149.238	149.238	204.815
0.00044	167.929	167.929	204.815	0.00044	167.929	167.929	204.815
0.00046	186.620	186.620	204.815	0.00046	186.620	186.620	204.815
0.00048	205.311	205.311	204.815	0.00048	205.311	205.311	204.815
0.00050	224.002	224.002	204.815	0.00050	224.002	224.002	204.815
0.00052	242.693	242.693	204.815	0.00052	242.693	242.693	204.815
0.00054	261.384	261.384	204.815	0.00054	261.384	261.384	204.815
0.00056	280.075	280.075	204.815	0.00056	280.075	280.075	204.815
0.00058	298.766	298.766	204.815	0.00058	298.766	298.766	204.815
0.00060	317.457	317.457	204.815	0.00060	317.457	317.457	204.815
0.00062	336.148	336.148	204.815	0.00062	336.148	336.148	204.815
0.00064	354.839	354.839	204.815	0.00064	354.839	354.839	204.815
0.00066	373.530	373.530	204.815	0.00066	373.530	373.530	204.815
0.00068	392.221	392.221	204.815	0.00068	392.221	392.221	204.815
0.00070	410.912	410.912	204.815	0.00070	410.912	410.912	204.815
0.00072	429.603	429.603	204.815	0.00072	429.603	429.603	204.815
0.00074	448.294	448.294	204.815	0.00074	448.294	448.294	204.815
0.00076	466.985	466.985	204.815	0.00076	466.985	466.985	204.815
0.00078	485.676	485.676	204.815	0.00078	485.676	485.676	204.815
0.00080	504.367	504.367	204.815	0.00080	504.367	504.367	204.815
0.00082	523.058	523.058	204.815	0.00082	523.058	523.058	204.815
0.00084	541.749	541.749	204.815	0.00084	541.749	541.749	204.815
0.00086	560.440	560.440	204.815	0.00086	560.440	560.440	204.815
0.00088	579.131	579.131	204.815	0.00088	579.131	579.131	204.815
0.00090	597.822	597.822	204.815	0.00090	597.822	597.822	204.815
0.00092	616.513	616.513	204.815	0.00092	616.513	616.513	204.815
0.00094	635.204	635.204	204.815	0.00094	635.204	635.204	204.815
0.00096	653.895	653.895	204.815	0.00096	653.895	653.895	204.815
0.00098	672.586	672.586	204.815	0.00098	672.586	672.586	204.815
0.00100	691.277	691.277	204.815	0.00100	691.277	691.277	204.815
0.00102	709.968	709.968	204.815	0.00102	709.968	709.968	204.815
0.00104	728.659	728.659	204.815	0.00104	728.659	728.659	204.815
0.00106	747.350	747.350	204.815	0.00106	747.350	747.350	204.815
0.00108	766.041	766.041	204.815	0.00108	766.041	766.041	204.815
0.00110	784.732	784.732	204.815	0.00110	784.732	784.732	204.815
0.00112	803.423	803.423	204.815	0.00112	803.423	803.423	204.815
0.00114	822.114	822.114	204.815	0.00114	822.114	822.114	204.815
0.00116	840.805	840.805	204.815	0.00116	840.805	840.805	204.815
0.00118	859.496	859.496	204.815	0.00118	859.496	859.496	204.815
0.00120	878.187	878.187	204.815	0.00120	878.187	878.187	204.815
0.00122	896.878	896.878	204.815	0.00122	896.878	896.878	204.815
0.00124	915.569	915.569	204.815	0.00124	915.569	915.569	204.815
0.00126	934.260	934.260	204.815	0.00126	934.260	934.260	204.815
0.00128	952.951	952.951	204.815	0.00128	952.951	952.951	204.815
0.00130	971.642	971.642	204.815	0.00130	971.642	971.642	204.815
0.00132	990.333	990.333	204.815	0.00132	990.333	990.333	204.815
0.00134	1009.024	1009.024	204.815	0.00134	1009.024	1009.024	204.815
0.00136	1027.715	1027.715	204.815	0.00136	1027.715	1027.715	204.815
0.00138	1046.406	1046.406	204.815	0.00138	1046.406	1046.406	204.815
0.00140	1065.097	1065.097	204.815	0.00140	1065.097	1065.097	204.815
0.00142	1083.788	1083.788	204.815	0.00142	1083.788	1083.788	204.815
0.00144	1102.479	1102.479	204.815	0.00144	1102.479	1102.479	204.815
0.00146	1121.170	1121.170	204.815	0.00146	1121.170	1121.170	204.815
0.00148	1139.861	1139.861	204.815	0.00148	1139.861	1139.861	204.815
0.00150	1158.552	1158.552	204.815	0.00150	1158.552	1158.552	204.815
0.00152	1177.243	1177.243	204.815	0.00152	1177.243	1177.243	204.815
0.00154	1195.934	1195.934	204.815	0.00154	1195.934	1195.934	204.815
0.00156	1214.625	1214.625	204.815	0.00156	1214.625	1214.625	204.815
0.00158	1233.316	1233.316	204.815	0.00158	1233.316	1233.316	204.815
0.00160	1252.007	1252.007	204.815	0.00160	1252.007	1252.007	204.815
0.00162	1270.698	1270.698	204.815	0.00162	1270.698	1270.698	204.815
0.00164	1289.389	1289.389	204.815	0.00164	1289.389	1289.389	204.815
0.00166	1308.080	1308.080	204.815	0.00166	1308.080	1308.080	204.815
0.00168	1326.771	1326.771	204.815	0.00168	1326.771	1326.771	204.815
0.00170	1345.462	1345.462	204.815	0.00170	1345.462	1345.462	204.815
0.00172	1364.153	1364.153	204.815	0.00172	1364.153	1364.153	204.815
0.00174	1382.844	1382.844	204.815	0.00174	1382.844	1382.844	204.815
0.00176	1401.535	1401.535	204.815	0.00176	1401.535	1401.535	204.815
0.00178	1420.226	1420.226	204.815	0.00178	1420.226	1420.226	204.815
0.00180	1438.917	1438.917	204.815	0.00180	1438.917	1438.917	204.815
0.00182	1457.608	1457.608	204.815	0.00182	1457.608	1457.608	204.815
0.00184	1476.299	1476.299	204.815	0.00184	1476.299	1476.299	204.815
0.00186	1494.990	1494.990	204.815	0.00186	1494.990	1494.990	204.815
0.00188	1513.681	1513.681	204.815	0.00188	1513.681	1513.681	204.815
0.00190	1532.372	1532.372	204.815	0.00190	1532.372	1532.372	204.815
0.00192	1551.063	1551.063	204.815	0.00192	1551.063	1551.063	204.815
0.00194	1569.754	1569.754	204.815	0.00194	1569.754	1569.754	204.815
0.00196	1588.445	1588.445	204.815	0.00196	1588.445	1588.445	204.815
0.00198	1607.136	1607.136	204.815	0.00198	1607.136	1607.136	204.815
0.00200	1625.827	1625.827	204.815	0.00200	1625.827	1625.827	204.815
0.00202	1644.518	1644.518	204.815	0.00202	1644.518	1644.518	204.815
0.00204	1663.209	1663.209	204.815	0.00204	1663.209	1663.209	204.815
0.00206	1681.900	1681.900	204.815	0.00206	1681.900	1681.900	204.815
0.00208	1700.591	1700.591	204.815	0.00208	1700.591	1700.591	204.815
0.00210	1719.282	1719.282	204.815	0.00210	1719.282	1719.282	204.815
0.00212	1737.973	1737.973	204.815	0.00212	1737.973	1737.973	204.815
0.00214	1756.664	1756.664	204.815	0.00214	1756.664	1756.664	204.815
0.00216	1775.355	1775.355	204.815	0.00216	1775.355	1775.355	204.815
0.00218	1794.046	1794.046	204.815	0.00218	1794.046	1794.046	204.815
0.00220	1812.737	1812.737	204.815	0.00220	1812.737	1812.737	204.815
0.00222	1831.428	1831.428	204.815	0.00222	1831.428	1831.428	204.815
0.00224	1850.119	1850.119	204.815	0.00224	1850.119	1850.119	204.815
0.00226	1868.810	1868.810	204.815	0.00226	1868.810	1868.810	204.815
0.00228	1887.501	1887.501	204.815	0.00228	1887.501	1887.501	204.815
0.00230	1906.192	1906.192	204.815	0.00230	1906.192	1906.192	204.815
0.00232	1924.883	1924.883	204.815	0.00232	1924.883	1924.883	204.815
0.00234	1943.574	1943.574	204.815	0.00234	1943.574	1943.574	204.815
0.00236	1962.265	1962.265	204.815	0.00236	1962.265	1962.265	204.815
0.00238	1980.956	1980.956	204.815	0.00238	1980.956	1980.956	204.815
0.00240	2000.647	2000.647	204.815	0.00240	2000.647	2000.647	204.815
0.00242	2019.338	2019.338	204.815	0.00242	2019.338	2019.338	204.815
0.00244	2038.029	2038.029	204.815	0.00244	2038.029	2038.029	204.815
0.00246	2056.720	2056.720	204.815	0.00246	2056.720	2056.720	204.815
0.00248	2075.411	2075.411	204.815	0.00248	2075.411	2075.411	204.815
0.00250	2094.102	2094.102	204.815	0.00250	2094.102	2094.102	204.815
0.00252	2112.793	2112.793	204.815	0.00252	2112.793	2112.793	204.815
0.00254	2131.484	2131.484	204.815	0.00254	2131.484	2131.484	204.815
0.00256	2150.175	2150.175	204.815	0.00256	2150.175	2150.175	204.815
0.00258	2168.866	2168.866	204.815	0.00258	2168.866	2168.866	204.815
0.00260	2187.557	2187.557	204.815	0.00260	2187.557	2187.557	204.815
0.00262	2206.248	2206.248	204.815	0.00262	2206.2		

TEST NUMBER AA-4-4
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 1.42875 1.37795 0.300
 PARTICLE SIZE RANGE (MICRONS)
 177-250
 EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID
 (W) (CM/S) (G/CM³) FRACTION
 601.40 8.94 1.485 0.405
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS CONDUCTIVITY PARTICLE CONDUCTIVITY PARTICLE SPECIFIC HEAT HEAT FLUX HEAT TRANSFER
 (W/MK) (W/MK) (WS/GK) (W/M²) COEFFICIENT
 0.02646 1.0491 0.8039 25415.90 381.81
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M ²)	CONVECTIVE HEAT FLUX (W/M ²)	RADIATIVE H T COEFF (W/M ² K)	CONVECTIVE H T COEFF (W/M ² K)
0	46.11	31.11	21.221	22931.02	2.081	1528.735
3.177	72.22	33.25	92.936	23702.89	2.305	608.159
7.945	92.22	36.54	118.011	24284.07	2.658	436.111
12.714	108.89	39.39	200.824	24760.57	28.911	358.854
17.484	115.36	43.27	219.781	24953.03	3.041	345.201
22.255	125.58	46.66	251.201	25235.46	3.222	319.879
27.027	138.89	50.09	307.198	25604.12	3.462	285.333
31.799	147.78	53.54	343.375	25849.01	3.644	274.290
36.572	148.89	56.99	340.700	25896.77	3.707	281.679
41.346	161.11	60.44	397.021	26215.19	3.933	260.412
46.120	162.22	63.91	395.230	26252.91	4.020	267.023
50.893	172.22	67.37	444.638	26510.56	4.241	252.914
54.078	171.11	69.68	431.534	26496.62	4.253	261.231

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KUNICZKA SPECCHIA
 KUNII SMITH KUNII BALDI
 (1957) (1960) SMITH (1967) SIGARDI
 (1962) (1960)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2559 0.1618 0.1880 0.1583 0.3088
 PSEUDOHOMOGENEOUS PECLET NUMBER
 5345.3 8905.9 7685.5 9105.3 4674.2 4666.8
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 20.246 32.515 27.906 33.243 17.065 17.038

TEST NUMBER AA-4-5

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42875 1.37795 0.300

PARTICLE SIZE RANGE (MICRONS)

177-250

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM³)

802.70 7.68 1.455

VOID FRACTION

0.405

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT HEAT TRANSFER

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (WS/GR) (W/M²) (W/M²K)

0.02677 1.0580 0.8101 25444.44 365.95

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL WALL PARTICLE RADIATIVE CONVECTIVE RADIATIVE CONVECTIVE

POSITION TEMPERATURE TEMPERATURE HEAT FLUX HEAT FLUX H T COEFF H T COEFF

(CM) (C) (C) (W/M²) (W/M²) (W/M²K) (W/M²K)

0. 48.89 32.22 35.348 22802.80 2.121

3.177 75.67 34.71 102.847 23606.31 2.451

7.945 95.56 38.54 185.216 24241.30 2.722

12.715 112.22 42.42 208.352 24714.30 2.985

17.485 120.56 46.35 233.556 24951.74 3.147

22.256 131.11 50.29 270.611 25249.00 3.348

27.029 145.56 54.27 300.306 25641.30 3.610

31.802 154.44 58.27 365.766 25883.09 3.814

36.576 156.67 62.27 368.604 25951.76 3.905

41.350 159.44 66.28 400.876 26289.95 4.177

46.125 171.67 70.30 434.223 26357.18 4.274

50.901 181.67 74.32 484.366 26615.93 4.512

54.084 178.89 77.00 458.770 26557.65 4.503

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICKA SUGLICHIA

(1957) (1960) (1952) (1967) BALDI SUGLICHIA

(1957) SMITH (1952) SMITH (1900)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2625 0.1635 0.1899 0.1599 0.3116 0.3121

PSEUDOHOMOGENEOUS PECLET NUMBER 7779.6 3992.5 3006.3

AVERAGE EXPERIMENTAL NUSSELT NUMBER 19.166 30.802 26.519 31.499 16.165 16.140

TEST NUMBER AA-4-5				TEST NUMBER AA-4-5			
YAGI AND KUNITA				YAGI AND KUNITA			
EXPERIMENTAL				EXPERIMENTAL			
POSITION	THEORETICAL	FLAT	PARABOLIC	POSITION	THEORETICAL	FLAT	PARABOLIC
0.00049	72.085	204.815	21.360	0.00030	115.746	204.815	21.360
0.00121	72.085	222.732	19.175	0.00030	45.5834	204.815	21.360
0.00124	16.4124	222.732	10.101	0.00030	37.745	204.815	21.360
0.00267	16.4124	17.919	10.103	0.00165	226.932	204.815	21.360
0.00340	16.4124	16.4124	9.438	0.00212	226.932	204.815	21.360
0.00465	14.4640	16.4124	7.947	0.00257	226.932	204.815	21.360
0.00558	14.4640	16.4124	7.947	0.00347	226.932	204.815	21.360
0.00630	13.663	14.4640	6.961	0.00352	226.932	204.815	21.360
0.00703	13.663	14.4640	6.961	0.00438	226.932	204.815	21.360
0.00793	13.663	14.4640	6.961	0.00483	226.932	204.815	21.360
0.00824	13.663	14.4640	6.961	0.00558	226.932	204.815	21.360
KUNITA AND SMITH (1960)				KUNITA AND SMITH (1960)			
POSITION	THEORETICAL	FLAT	PARABOLIC	POSITION	THEORETICAL	FLAT	PARABOLIC
0.00035	91.552	204.815	21.360	0.00030	115.746	204.815	21.360
0.00058	41.0812	204.815	16.530	0.00030	37.745	204.815	21.360
0.00140	30.8228	222.732	11.175	0.00030	37.745	204.815	21.360
0.00236	22.7703	222.732	10.081	0.00165	226.932	204.815	21.360
0.00290	22.7703	17.919	9.733	0.00207	226.932	204.815	21.360
0.00351	19.5226	17.919	8.333	0.00295	226.932	204.815	21.360
0.00403	19.5226	16.700	7.906	0.00340	226.932	204.815	21.360
0.00488	18.095	16.700	7.706	0.00384	226.932	204.815	21.360
0.00561	18.095	16.700	7.706	0.00429	226.932	204.815	21.360
0.00596	18.095	16.700	7.706	0.00502	226.932	204.815	21.360
DALY AND SICARDI (1960)				DALY AND SICARDI (1960)			
POSITION	THEORETICAL	FLAT	PARABOLIC	POSITION	THEORETICAL	FLAT	PARABOLIC
0.00039	60.746	204.815	21.360	0.00030	115.746	204.815	21.360
0.00059	24.930	204.815	14.538	0.00030	37.745	204.815	21.360
0.00230	18.095	222.732	10.081	0.00030	37.745	204.815	21.360
0.00317	14.4640	222.732	9.621	0.00165	226.932	204.815	21.360
0.00403	13.663	17.919	9.032	0.00207	226.932	204.815	21.360
0.00490	13.663	16.4124	8.543	0.00295	226.932	204.815	21.360
0.00576	13.663	16.4124	8.543	0.00340	226.932	204.815	21.360
0.00662	13.663	16.4124	8.543	0.00384	226.932	204.815	21.360
0.00748	13.663	16.4124	8.543	0.00429	226.932	204.815	21.360
0.00834	13.663	16.4124	8.543	0.00502	226.932	204.815	21.360
0.00920	13.663	16.4124	8.543	0.00558	226.932	204.815	21.360

TEST NUMBER AA-4-6

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42875 1.37795 0.300

PARTICLE SIZE RANGE (MICRONS)

177-250

EXPERIMENTAL VARIABLES

POWER (W) VELOCITY (CM/S) DENSITY (G/CM³)

602.70 6.58 1.455

VOID FRACTION

0.405

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT

(W/MK) (W/MK) (J/GK)

0.02706 1.0664 0.8161

HEAT FLUX

(W/M²)

25411.18

HEAT TRANSFER

COEFFICIENT

(W/M²°K)

357.63

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM) WALL TEMPERATURE (°C) PARTICLE TEMPERATURE (°C) RADIATIVE HEAT FLUX (W/M²) CONVECTIVE HEAT FLUX (W/M²) RADIATIVE H.T. COEFF (W/M²°K) CONVECTIVE H.T. COEFF (W/M²°K)

0. 42.78 32.78 20.641 22475.50 2.064 2247.559

3.177 76.67 35.63 101.000 23459.68 2.461 571.626

7.945 98.69 40.04 163.704 24002.65 2.782 409.372

12.715 117.78 44.53 226.076 24620.19 3.006 336.117

17.486 127.78 49.07 259.459 24850.54 3.284 316.342

22.258 138.89 53.63 299.056 25204.95 3.508 295.620

27.031 156.67 58.23 379.033 25677.72 3.649 260.862

31.805 163.89 62.47 407.410 26073.52 4.053 256.124

36.580 166.67 67.50 411.212 26555.71 4.147 261.732

41.355 180.56 72.13 483.119 26313.04 4.459 242.690

46.131 183.33 76.78 488.042 26398.24 4.580 247.710

50.907 194.44 81.43 519.364 26677.56 4.861 236.651

54.092 195.00 84.53 515.657 26700.43 4.921 241.695

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA

KUNII SMITH KUNII BALDI

(1957) (1960) (1962) (1967) (1960) SICARDI

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITY (W/MK)

0.2651 0.1652 0.1918 0.1615 0.3147 0.3152

PSEUDOHOMOGENEOUS PECLET NUMBER

4060.6 5612.4 6666.3 3420.3 3475.0

AVERAGE EXPERIMENTAL NUSSELT NUMBER

18.508 29.834 25.692 30.516 15.657 15.639

TEST NUMBER AA-4-6 LOCAL NUSSELL NUMBER PROFILES YAGI AND KUNITI (1957)			
N.D. POSITION	THEORETICAL FLAT	EXPERIMENTAL	THEORETICAL PARABOLIC
0.00037	116.864		204.815
0.00041	129.740		21.360
0.00142	21.006		12.306
0.00226	17.499		11.145
0.00336	15.097		9.808
0.00481	13.091		8.670
0.00566	11.034		7.503
0.00650	9.939		6.333
0.00730	8.812		5.201
0.00820	7.666		4.061
0.00904	6.506		3.015
0.00961	5.341		2.215
0.01011	4.176		1.424
0.01056	3.011		0.636
0.01096	1.846		0.209
0.01141	0.681		0.000
0.01181			0.000
0.01221			0.000
0.01261			0.000
0.01301			0.000
0.01341			0.000
0.01381			0.000
0.01421			0.000
0.01461			0.000
0.01501			0.000
0.01541			0.000
0.01581			0.000
0.01621			0.000
0.01661			0.000
0.01701			0.000
0.01741			0.000
0.01781			0.000
0.01821			0.000
0.01861			0.000
0.01901			0.000
0.01941			0.000
0.01981			0.000
0.02021			0.000
0.02061			0.000
0.02101			0.000
0.02141			0.000
0.02181			0.000
0.02221			0.000
0.02261			0.000
0.02301			0.000
0.02341			0.000
0.02381			0.000
0.02421			0.000
0.02461			0.000
0.02501			0.000
0.02541			0.000
0.02581			0.000
0.02621			0.000
0.02661			0.000
0.02701			0.000
0.02741			0.000
0.02781			0.000
0.02821			0.000
0.02861			0.000
0.02901			0.000
0.02941			0.000
0.02981			0.000
0.03021			0.000
0.03061			0.000
0.03101			0.000
0.03141			0.000
0.03181			0.000
0.03221			0.000
0.03261			0.000
0.03301			0.000
0.03341			0.000
0.03381			0.000
0.03421			0.000
0.03461			0.000
0.03501			0.000
0.03541			0.000
0.03581			0.000
0.03621			0.000
0.03661			0.000
0.03701			0.000
0.03741			0.000
0.03781			0.000
0.03821			0.000
0.03861			0.000
0.03901			0.000
0.03941			0.000
0.03981			0.000
0.04021			0.000
0.04061			0.000
0.04101			0.000
0.04141			0.000
0.04181			0.000
0.04221			0.000
0.04261			0.000
0.04301			0.000
0.04341			0.000
0.04381			0.000
0.04421			0.000
0.04461			0.000
0.04501			0.000
0.04541			0.000
0.04581			0.000
0.04621			0.000
0.04661			0.000
0.04701			0.000
0.04741			0.000
0.04781			0.000
0.04821			0.000
0.04861			0.000
0.04901			0.000
0.04941			0.000
0.04981			0.000
0.05021			0.000
0.05061			0.000
0.05101			0.000
0.05141			0.000
0.05181			0.000
0.05221			0.000
0.05261			0.000
0.05301			0.000
0.05341			0.000
0.05381			0.000
0.05421			0.000
0.05461			0.000
0.05501			0.000
0.05541			0.000
0.05581			0.000
0.05621			0.000
0.05661			0.000
0.05701			0.000
0.05741			0.000
0.05781			0.000
0.05821			0.000
0.05861			0.000
0.05901			0.000
0.05941			0.000
0.05981			0.000
0.06021			0.000
0.06061			0.000
0.06101			0.000
0.06141			0.000
0.06181			0.000
0.06221			0.000
0.06261			0.000
0.06301			0.000
0.06341			0.000
0.06381			0.000
0.06421			0.000
0.06461			0.000
0.06501			0.000
0.06541			0.000
0.06581			0.000
0.06621			0.000
0.06661			0.000
0.06701			0.000
0.06741			0.000
0.06781			0.000
0.06821			0.000
0.06861			0.000
0.06901			0.000
0.06941			0.000
0.06981			0.000
0.07021			0.000
0.07061			0.000
0.07101			0.000
0.07141			0.000
0.07181			0.000
0.07221			0.000
0.07261			0.000
0.07301			0.000
0.07341			0.000
0.07381			0.000
0.07421			0.000
0.07461			0.000
0.07501			0.000
0.07541			0.000
0.07581			0.000
0.07621			0.000
0.07661			0.000
0.07701			0.000
0.07741			0.000
0.07781			0.000
0.07821			0.000
0.07861			0.000
0.07901			0.000
0.07941			0.000
0.07981			0.000
0.08021			0.000
0.08061			0.000
0.08101			0.000
0.08141			0.000
0.08181			0.000
0.08221			0.000
0.08261			0.000
0.08301			0.000
0.08341			0.000
0.08381			0.000
0.08421			0.000
0.08461			0.000
0.08501			0.000
0.08541			0.000
0.08581			0.000
0.08621			0.000
0.08661			0.000
0.08701			0.000
0.08741			0.000
0.08781			0.000
0.08821			0.000
0.08861			0.000
0.08901			0.000
0.08941			0.000
0.08981			0.000
0.09021			0.000
0.09061			0.000
0.09101			0.000
0.09141			0.000
0.09181			0.000
0.09221			0.000
0.09261			0.000
0.09301			0.000
0.09341			0.000
0.09381			0.000
0.09421			0.000
0.09461			0.000
0.09501			0.000
0.09541			0.000
0.09581			0.000
0.09621			0.000
0.09661			0.000
0.09701			0.000
0.09741			0.000
0.09781			0.000
0.09821			0.000
0.09861			0.000
0.09901			0.000
0.09941			0.000
0.09981			0.000
0.10021			0.000
0.10061			0.000
0.10101			0.000
0.10141			0.000
0.10181			0.000
0.10221			0.000
0.10261			0.000
0.10301			0.000
0.10341			0.000
0.10381			0.000
0.10421			0.000
0.10461			0.000
0.10501			0.000
0.10541			0.000
0.10581			0.000
0.10621			0.000
0.10661			0.000
0.10701			0.000
0.10741			0.000
0.10781			0.000
0.10821			0.000
0.10861			0.000
0.10901			0.000
0.10941			0.000
0.10981			0.000
0.11021			0.000
0.11061			0.000
0.11101			0.000
0.11141			0.000
0.11181			0.000
0.11221			0.000
0.11261			0.000
0.11301			0.000
0.11341			0.000
0.11381			0.000
0.11421			0.000
0.11461			0.000
0.11501			0.000
0.11541			0.000
0.11581			0.000
0.11621			0.000
0.11661			0.000
0.11701			0.000
0.11741			0.000
0.11781			0.000
0.11821			0.000
0.11861			0.000
0.11901			0.000
0.11941			0.000
0.11981			0.000
0.12021			0.000
0.12061			0.000
0.12101			0.000
0.12141			0.000
0.12181			0.000
0.12221			0.000
0.12261			0.000
0.12301			0.000
0.12341			0.000
0.12381			0.000
0.12421			0.000
0.12461			0.000
0.12501			0.000
0.12541			0.000
0.12581			0.000
0.12621			0.000
0.12661			0.000
0.12701			0.000
0.12741			0.000
0.12781			0.000
0.12821			0.000
0.12861			0.000
0.12901			0.000
0.12941			0.000
0.12981			0.000
0.13021			0.000
0.13061			0.000
0.13101			0.000
0.13141			0.000
0.13181			0.000
0.13221			0.000
0.13261			0.000
0.13301			0.000
0.13341			0.000
0.13381			0.000
0.13421			0.000
0.13461			0.000
0.13501			0.000
0.13541			0.000
0.13581			0.000
0.13621			0.000
0.13661			0.000
0.13701			0.000
0.13741			0.000
0.13781			0.000
0.13821			0.000
0.13861			0.000
0.13901			0.000
0.13941		</	

TEST NUMBER AA-4-7

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42875 1.37795 0.300

PARTICLE SIZE RANGE (MICRONS)

177-250

EXPERIMENTAL VARIABLES

POWER (W) VELOCITY (CM/S) DENSITY (G/CM**3) VOID FRACTION

608.85 5.80 1.455 0.405

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT HEAT TRANSFER

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M**2) (W/HS**2K)

0.02736 1.0750 0.8221 28634.06 339.26

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

POSITION WALL TEMPERATURE PARTICLE TEMPERATURE RADIATIVE CONVECTIVE RADIATIVE CONVECTIVE

(CM) (C) (C) (W/M**2) (W/HS**2K) (W/M**2) (W/HS**2K)

0. 43.33 32.22 22.939 22494.19 2.064 2024.477

3.177 80.58 35.58 112.706 23573.42 2.506 224.195

7.946 103.89 40.80 180.133 24206.21 2.855 384.143

12.716 124.44 46.11 250.632 24807.32 3.199 316.678

17.488 134.44 51.47 283.166 25086.36 3.413 302.338

22.260 145.56 56.05 324.035 25351.24 3.653 286.240

27.034 163.89 62.28 408.985 25875.76 4.025 254.640

31.808 179.33 67.74 450.401 26127.22 4.265 247.439

36.584 176.67 73.20 495.809 26225.09 4.405 235.453

41.360 191.67 78.66 538.410 26606.76 4.764 235.442

46.137 194.44 84.13 540.998 26690.05 4.904 241.946

50.915 207.22 89.60 516.953 27000.80 5.245 229.629

54.100 205.56 93.25 552.179 26902.11 5.273 240.253

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA

KUNII SMITH KUNII BALDI

(1957) (1960) (1962) (1967) (1960)

SICARDI

(1960)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2877 0.1658 0.1937 0.1631 0.3179 0.3184

PSEUDOHOMOGENEOUS PECLET NUMBER

3445.3 5528.3 4762.0 5656.1 2401.2 2896.8

AVERAGE EXPERIMENTAL NUSSELT NUMBER

17.462 28.019 24.135 28.666 14.704 14.602

TEST NUMBER AA-4-B

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42875 1.37795 0.300

PARTICLE SIZE RANGE (MICRONS)

177-250

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM³)

615.00 4.45 1.455

VOID FRACTION

0.405

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY PARTICLE CONDUCTIVITY PARTICLE SPECIFIC HEAT

(W/MK) (W/MK) (WS/GK)

0.02796 1.0923 0.8340

HEAT FLUX

(W/M²)

25824.75

HEAT TRANSFER COEFFICIENT

(W/M²K)

320.60

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M ²)	CONVECTIVE HEAT FLUX (W/M ²)	RADIATIVE H.T. COEFF (W/M ² K)	CONVECTIVE H.T. COEFF (W/M ² K)
0.	45.00	32.78	23.302	22377.17	2.057	1830.860
3.177	86.11	36.99	127.133	23556.59	2.588	479.547
7.946	112.22	43.53	205.955	24280.20	2.998	353.579
12.718	135.00	50.20	268.725	24910.36	3.405	293.746
17.490	146.11	56.93	325.653	25215.60	3.653	262.732
22.263	158.33	63.67	374.104	25411.11	3.852	259.850
27.038	180.00	70.47	404.536	26101.52	4.424	238.308
31.815	190.55	77.33	534.737	26375.59	4.723	232.938
36.592	194.44	84.16	540.906	26488.77	4.903	224.185
41.369	210.56	91.00	607.904	26885.95	5.336	224.872
46.148	213.69	97.84	610.040	26884.75	5.522	232.521
50.927	227.78	104.67	731.220	27319.14	5.940	221.914
54.114	226.67	109.22	704.499	27311.91	5.999	232.551

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI	KUNII	WILLHITE	KRUPICZKA	SPECCHIA	SPECCHIA
(1957)	SMITH	KUNII	(1967)	BAI DI	SICARDI
	(1960)	SMITH		(1960)	(1960)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2729 0.1702 0.1975 0.1663 0.3244 0.3213

PSEUDOHOMOGENEOUS PECLET NUMBER

2725.9 4371.2 3767.2

AVERAGE EXPERIMENTAL NUSSELT NUMBER

16.190 25.962 22.374

4474.3

2293.9

2290.5

13.624

13.604

TEST NUMBER AA-4-9

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42875 1.37795 0.300

PARTICLE SIZE RANGE (MICRONS)

177-250

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM**3)

621.15 3.49 1.455

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT

(W/MK) (W/MK) (WS/GK)

0.02866 1.1125 0.8476

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION WALL TEMPERATURE PARTICLE TEMPERATURE

(CM) (C) (C)

0. 48.89 32.22

3.178 93.89 37.56

7.948 122.78 45.86

12.720 148.89 54.32

17.489 161.11 52.85

22.268 175.36 71.39

27.045 201.67 80.02

31.823 212.22 88.70

36.602 217.78 97.35

41.382 236.67 105.89

46.162 241.67 114.65

50.944 257.76 123.29

54.132 254.44 129.04

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNITI WILLHITE KRUPICZKA SPECCHIA

KUNITI SMITH KUNITI SMITH BALDI

(1957) (1960) SMITH SICCARDI

(1962) (1960)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2790 0.1741 0.2019 0.1700 0.3318

PSEUDOHOMOGENEOUS PECLET NUMBER

2127.6 3409.6 2940.0 3491.6 1739.1

AVERAGE EXPERIMENTAL NUSSELT NUMBER

14.279 22.883 19.731 23.433 12.007

HEAT FLUX

(W/M**2)

28967.01

HEAT TRANSFER COEFFICIENT

(W/M**2K)

289.13

CONVECTIVE

HEAT FLUX

(W/M**2)

22183.72

23460.44

24251.80

24945.05

25272.44

25648.97

26204.65

26554.81

26707.30

27145.73

27283.62

27645.72

27603.63

7.026

CONVECTIVE

H T COEFF

(W/M**2K)

1331.620

416.477

315.205

253.774

257.200

246.240

216.101

214.982

221.763

207.738

214.797

205.567

220.123

TEST NUMBER AA-5-1
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 1.42875 1.37795 0.300
 PARTICLE SIZE RANGE (MICRONS)
 177-250
 EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID
 (W) (CM/S) (G/CM**3) FRACTION
 802.30 13.85 1.455 0.405
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS PARTICLE PARTICLE HEAT HEAT TRANSFER
 CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
 (W/MK) (W/MK) (WS/CK) (W/M**2) (W/M**2K)
 0.02615 1.0403 0.7975 33963.60 457.66
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES
 AXIAL POSITION WALL TEMPERATURE PARTICLE TEMPERATURE RADIATIVE HEAT FLUX CONVECTIVE HEAT FLUX RADIATIVE H T COEFF CONVECTIVE H T COEFF
 (CM) (C) (C) (W/M**2) (W/M**2K)
 0. 45.56 29.14 33.179 30369.55 2.059 1804.622
 3.177 73.33 31.28 99.044 31470.94 2.377 748.342
 7.945 95.00 34.11 162.308 32321.94 2.866 530.854
 12.714 112.22 37.01 219.745 32983.04 2.921 438.584
 17.483 121.11 39.93 249.050 33332.03 3.077 410.591
 22.256 131.11 42.87 267.253 33714.07 3.255 382.087
 27.028 144.44 45.85 344.277 34215.54 3.492 347.017
 31.801 153.33 48.84 303.401 34548.25 3.569 330.829
 36.575 155.56 51.84 388.362 34636.19 3.744 333.953
 41.349 168.89 54.85 456.754 35124.65 4.003 308.007
 46.124 171.87 57.87 465.061 35231.34 4.095 309.609
 50.900 180.56 60.90 513.677 35584.23 4.293 297.143
 54.084 178.89 62.92 497.802 35500.62 4.293 306.124
 DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA SPECCHIA
 KUNII SMITH KUNII SMITH BALDI SICARDI
 (1957) (1960) (1962) (1967) (1960) (1980)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2972 0.1601 0.1860 0.1566 0.3050 0.3055
 PSEUDOHOMOGENEOUS PECLET NUMBER
 8612.2 13835.4 11905.1 14141.6 7261.7 7250.0
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 24.522 39.394 33.897 40.265 20.676 20.643

[illegible]

TEST NUMBER AA-5-2

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42875 1.37795 0.300

PARTICLE SIZE RANGE (MICRONS)

177-250

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY VOID

(W) (CM/S) (G/CM³*3) FRACTION

796.65 12.54 1.455 0.405

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (W/GK) (W/M²*2) (W/M²*2K)

0.02642 1.0481 0.8031 33712.67 462.68

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M ² *2)	CONVECTIVE HEAT FLUX (W/M ² *2)	RADIATIVE H T COEFF (W/M ² *2K)	CONVECTIVE H T COEFF (W/M ² *2K)
0	46.67	31.67	31.388	30041.49	2.095	2002.766
3.177	75.56	33.66	101.670	31177.42	2.427	744.244
7.945	97.78	36.75	166.611	32037.59	2.730	524.985
12.713	115.56	39.80	226.997	32718.64	3.001	432.448
17.486	124.44	43.09	257.270	33053.84	3.162	406.297
22.257	136.11	46.30	302.813	33491.47	3.372	372.910
27.030	148.33	49.54	355.026	33944.11	3.600	343.581
31.803	158.89	52.80	404.332	34531.33	3.811	323.617
36.578	161.67	56.07	411.060	34458.32	3.901	326.143
41.352	175.00	59.36	482.617	34917.34	4.173	301.942
46.128	177.22	62.65	489.015	35003.46	4.260	305.521
50.904	182.22	65.94	511.251	35106.89	4.397	302.599
54.086	183.33	68.13	512.541	35230.50	4.449	305.821

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAOI KUNITI WILLHITE KRUPICZKA SPECCHIA

(1957) (1950) SMITH (1967) BALDI SICCARDI

(1962) (1960)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2595 0.1618 0.1878 0.1581 0.3079 0.3084

PSEUDOHOMOGENEOUS FILLET NUMBER 12772.2 6556.8 5546.4

7778.7 12492.9 10752.5

AVERAGE EXPERIMENTAL NUSSELT NUMBER 40.333 20.705 20.673

24.564 39.451 33.955

TEST NUMBER AA-5-3

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42875 1.37795 0.300

PARTICLE SIZE RANGE (MICRONS)

177-250

EXPERIMENTAL VARIABLES

POWER (W) VELOCITY (CM/S) DENSITY (G/CM³) VOID FRACTION

791.00 10.95 1.455 0.405

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY (W/MK) PARTICLE CONDUCTIVITY (W/MK) PARTICLE SPECIFIC HEAT (WS/GK) HEAT FLUX (W/M²) HEAT TRANSFER COEFFICIENT (W/M²°K)

0.02660 1.0531 0.8067 33431.27 425.84

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M ²)	CONVECTIVE HEAT FLUX (W/M ²)	RADIATIVE H.T. COEFF (W/M ² °K)	CONVECTIVE H.T. COEFF (W/M ² °K)
0.	41.11	31.67	19.233	29357.68	2.036	3105.460
3.177	77.78	33.91	107.717	30776.69	2.456	701.612
7.945	100.56	37.40	175.125	31648.50	2.773	501.032
12.715	120.00	40.96	242.986	32360.31	3.074	409.551
17.486	128.89	44.67	273.536	32701.40	3.244	307.810
22.258	142.22	48.20	327.953	33150.28	3.408	352.994
27.032	157.78	51.67	400.415	33750.53	3.781	318.672
31.806	166.67	55.57	441.923	34070.04	3.978	306.666
36.581	169.44	59.27	440.128	34175.58	4.077	310.197
41.356	183.33	62.98	525.270	34601.55	4.373	288.010
46.133	186.11	66.71	554.712	34785.62	4.478	291.170
50.909	197.78	70.45	605.107	35167.35	4.752	276.186
54.094	197.22	72.94	591.112	35155.80	4.700	232.067

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI	KUNITA	WILLHITE	KUNITA	SPECCHIA
KUNITA	SMITH	KUNITA	KUNITA	SICARDI
(1957)	(1960)	SMITH	(1967)	(1960)
		(1962)		

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2611 0.1626 0.1889 0.1590 0.3090 0.5103

PSEUDOHOMOGENEOUS PECELET NUMBER

6784.9 10034.8 9378.5 11140.0 5718.0 5709.0

AVERAGE EXPERIMENTAL NUSSELT NUMBER

22.528 36.170 31.140 36.939 18.986 18.956

[illegible]

TEST NUMBER AA-5-4
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) 1.42875 ID (CM) 1.37795 EMISSIVITY 0.300
 PARTICLE SIZE RANGE (MICRONS) 177-250
 EXPERIMENTAL VARIABLES
 POWER (W) 791.00 VELOCITY (CM/S) 9.54 DENSITY (G/CM**3) 1.435 VOID FRACTION 0.405
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS CONDUCTIVITY (W/MK) 0.02609 PARTICLE CONDUCTIVITY (W/MK) 1.0615 PARTICLE SPECIFIC HEAT (WS/OK) 0.8126 HEAT FLUX (W/M**2) 33093.73 HEAT TRANSFER COEFFICIENT (W/M**2K) 319.91
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	48.33	32.78	32.908	20400.99	2.121	1890.064
3.177	78.80	35.34	109.165	30571.28	2.484	702.056
7.945	103.33	39.31	181.220	31491.39	2.831	491.907
12.716	124.44	43.37	256.661	32271.37	3.166	398.068
17.487	133.89	47.48	329.781	32620.26	3.354	377.521
22.260	147.22	51.62	345.091	33103.49	3.610	346.255
27.034	163.69	55.80	423.286	33693.26	3.933	311.733
31.809	175.00	60.02	480.544	34088.63	4.183	296.455
36.584	177.78	64.24	487.347	34102.14	4.292	301.156
41.360	193.89	68.40	582.982	34713.60	4.649	277.044
46.137	195.56	72.73	592.010	34910.69	4.745	283.420
50.915	208.33	76.09	664.657	35241.15	5.060	260.311
54.101	204.44	79.82	626.742	35129.24	5.029	261.844

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNITA WILLHITE KUNITA KUNITA SPECCHIA
 (1957) (1960) SMITH (1967) BALDI SICARDI
 (1962) (1960)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2636 0.1642 0.1907 0.1608 0.3129 0.3134
 PSEUDOHOMOGENEOUS PECLET NUMBER 5894.9 9462.9 8148.0 9678.1 4966.3 4958.6
 AVERAGE EXPERIMENTAL NUSSELT NUMBER 21.949 35.233 30.337 36.035 18.491 18.462

TEST NUMBER AA-5-5

EXPERIMENTAL DATA
TUBE CHARACTERISTICS

OD (CM) 1.42875 ID (CM) 1.37795 EMISSIVITY 0.300

PARTICLE SIZE RANGE (MICRONS)
177-250

EXPERIMENTAL VARIABLES

POWER 810.75 VELOCITY 8.05 DENSITY 1.455 VOID FRACTION 0.405
(W) (CM/S) (G/CM³)

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY 0.02728 PARTICLE CONDUCTIVITY 1.0727 PARTICLE SPECIFIC HEAT 0.8205 HEAT FLUX 34179.47 HEAT TRANSFER COEFFICIENT 405.02
(W/MK) (W/MK) (WS/GK) (W/M²) (W/M²K)

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M ²)	CONVECTIVE HEAT FLUX (W/M ²)	RADIATIVE H T COEFF (W/M ² K)	CONVECTIVE H T COEFF (W/M ² K)
0.	46.11	33.33	26.077	29660.25	2.103	2321.237
3.177	82.78	36.41	117.853	31091.20	2.542	670.289
7.946	108.89	41.18	198.082	32073.69	2.926	473.726
12.717	131.67	46.07	282.782	32922.09	3.303	384.614
17.489	142.78	51.01	324.190	33334.08	3.593	363.270
22.262	156.67	55.99	384.426	33741.53	3.813	336.146
27.037	175.56	61.02	481.821	34513.69	4.207	301.345
31.813	187.22	66.10	543.780	34920.14	4.490	288.361
36.590	191.11	71.18	556.232	35071.66	4.638	292.440
41.367	206.33	76.28	608.733	35659.83	5.049	270.047
46.145	211.11	81.40	672.001	35766.20	5.188	275.730
50.924	225.56	86.52	774.698	36249.17	5.572	260.715
54.111	220.86	89.93	721.688	36090.91	5.523	276.356

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAOI (1957)	KUNII (1960)	WILLHITE (1962)	KRUPICZKA (1967)	SPECCHIA (1980)	SPECCHIA (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2670 0.1664 0.1932 0.1626 0.3171 0.3175

PSEUDOHOMOGENEOUS PECLET NUMBER

4960.0 7939.0 6855.3 8142.4 4176.8 4170.5

AVERAGE EXPERIMENTAL NUSSELT NUMBER

20.902 33.540 28.889 34.313 17.602 17.575

TEST NUMBER AA-5-6

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42675 1.37795 0.300

PARTICLE SIZE RANGE (MICRONS)

177-250

EXPERIMENTAL VARIABLES

POWER (W)

805.00

VELOCITY (CM/S)

5.71

DENSITY (G/CM³)

1.455

VOID FRACTION

0.405

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY (W/MK)

0.02773

PARTICLE CONDUCTIVITY (W/MK)

1.0857

PARTICLE SPECIFIC HEAT (WS/GK)

0.3294

HEAT FLUX (W/M²)

33871.76

HEAT TRANSFER COEFFICIENT (W/M²°K)

353.06

AXIAL TEMPERATURE (°C)

0.02773

WALL TEMPERATURE (°C)

44.44

PARTICLE TEMPERATURE (°C)

34.44

RADIATIVE HEAT FLUX (W/M²)

20.574

CONVECTIVE HEAT FLUX (W/M²)

30606.71

RADIATIVE H T COEFF (W/M²°K)

2.097

CONVECTIVE H T COEFF (W/M²°K)

2900.671

POSITION (CM)

0.

WALL TEMPERATURE (°C)

44.44

PARTICLE TEMPERATURE (°C)

34.44

RADIATIVE HEAT FLUX (W/M²)

121.483

CONVECTIVE HEAT FLUX (W/M²)

30627.66

RADIATIVE H T COEFF (W/M²°K)

2.613

CONVECTIVE H T COEFF (W/M²°K)

447.162

0.178

47.22

38.06

214.407

31637.15

3.030

339.650

7.947

114.44

43.69

314.208

32562.48

3.470

342.283

12.718

140.00

49.45

359.316

33515.14

3.729

317.704

17.491

151.67

55.30

427.899

34240.02

4.515

263.768

22.265

166.67

61.18

541.769

34657.47

4.836

273.135

27.041

187.78

67.12

613.647

34818.88

5.018

277.798

31.818

200.00

73.11

620.307

35402.48

5.478

255.212

36.595

204.44

79.11

751.094

35543.27

5.663

263.342

41.374

222.22

85.12

883.157

35936.82

6.112

249.430

46.154

226.11

91.14

832.840

6.098

263.110

50.934

241.67

97.18

54.121

237.78

101.19

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI

KUNII

WILLHITE

KRUPICZKA

SPECCHIA

SPECCHIA

KUNII

SMITH

KUNII

BALDI

SICARDI

SICARDI

(1957)

(1960)

(1962)

(1967)

(1980)

(1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2709

0.1689

0.1960

0.1651

0.3219

0.3224

PSEUDOHOMOGENEOUS PECLET NUMBER

4115.9

6601.5

5688.2

6756.0

3464.3

3459.2

AVERAGE EXPERIMENTAL NUSSELT NUMBER

19.482

31.248

26.925

31.979

16.390

16.374

TEST NUMBER AA-5-6			
LOCAL NUSSELL NUMBER			
YAGI AND KUNII (1957)			
EXPERIMENTAL			
POSITION	THEORETICAL	THEORETICAL	THEORETICAL
POSITION	PARABOLIC	PARABOLIC	PARABOLIC
0	147.5922	204.815	204.815
0.00056	126.760	199.487	199.487
0.00140	126.760	199.487	199.487
0.00223	126.760	199.487	199.487
0.00307	126.760	199.487	199.487
0.00391	126.760	199.487	199.487
0.00474	126.760	199.487	199.487
0.00557	126.760	199.487	199.487
0.00641	126.760	199.487	199.487
0.00724	126.760	199.487	199.487
0.00808	126.760	199.487	199.487
0.00891	126.760	199.487	199.487
0.00975	126.760	199.487	199.487
0.01058	126.760	199.487	199.487
0.01142	126.760	199.487	199.487
0.01225	126.760	199.487	199.487
0.01309	126.760	199.487	199.487
0.01392	126.760	199.487	199.487
0.01476	126.760	199.487	199.487
0.01559	126.760	199.487	199.487
0.01643	126.760	199.487	199.487
0.01726	126.760	199.487	199.487
0.01810	126.760	199.487	199.487
0.01893	126.760	199.487	199.487
0.01977	126.760	199.487	199.487
0.02060	126.760	199.487	199.487
0.02144	126.760	199.487	199.487
0.02227	126.760	199.487	199.487
0.02311	126.760	199.487	199.487
0.02394	126.760	199.487	199.487
0.02478	126.760	199.487	199.487
0.02561	126.760	199.487	199.487
0.02645	126.760	199.487	199.487
0.02728	126.760	199.487	199.487
0.02812	126.760	199.487	199.487
0.02895	126.760	199.487	199.487
0.02979	126.760	199.487	199.487
0.03062	126.760	199.487	199.487
0.03146	126.760	199.487	199.487
0.03229	126.760	199.487	199.487
0.03313	126.760	199.487	199.487
0.03396	126.760	199.487	199.487
0.03480	126.760	199.487	199.487
0.03563	126.760	199.487	199.487
0.03647	126.760	199.487	199.487
0.03730	126.760	199.487	199.487
0.03814	126.760	199.487	199.487
0.03897	126.760	199.487	199.487
0.03981	126.760	199.487	199.487
0.04064	126.760	199.487	199.487
0.04148	126.760	199.487	199.487
0.04231	126.760	199.487	199.487
0.04315	126.760	199.487	199.487
0.04398	126.760	199.487	199.487
0.04482	126.760	199.487	199.487
0.04565	126.760	199.487	199.487
0.04649	126.760	199.487	199.487
0.04732	126.760	199.487	199.487
0.04816	126.760	199.487	199.487
0.04899	126.760	199.487	199.487
0.04983	126.760	199.487	199.487
0.05066	126.760	199.487	199.487
0.05150	126.760	199.487	199.487
0.05233	126.760	199.487	199.487
0.05317	126.760	199.487	199.487
0.05400	126.760	199.487	199.487
0.0548	126.760	199.487	199.487

BALDI AND SICARDI (1980)			
EXPERIMENTAL			
POSITION	THEORETICAL	THEORETICAL	THEORETICAL
POSITION	PARABOLIC	PARABOLIC	PARABOLIC
0	126.760	204.815	204.815
0.00056	105.429	199.487	199.487
0.00140	105.429	199.487	199.487
0.00223	105.429	199.487	199.487
0.00307	105.429	199.487	199.487
0.00391	105.429	199.487	199.487
0.00474	105.429	199.487	199.487
0.00557	105.429	199.487	199.487
0.00641	105.429	199.487	199.487
0.00724	105.429	199.487	199.487
0.00808	105.429	199.487	199.487
0.00891	105.429	199.487	199.487
0.00975	105.429	199.487	199.487
0.01058	105.429	199.487	199.487
0.01142	105.429	199.487	199.487
0.01225	105.429	199.487	199.487
0.01309	105.429	199.487	199.487
0.01392	105.429	199.487	199.487
0.01476	105.429	199.487	199.487
0.01559	105.429	199.487	199.487
0.01643	105.429	199.487	199.487
0.01726	105.429	199.487	199.487
0.01810	105.429	199.487	199.487
0.01893	105.429	199.487	199.487
0.01977	105.429	199.487	199.487
0.02060	105.429	199.487	199.487
0.02144	105.429	199.487	199.487
0.02227	105.429	199.487	199.487
0.02311	105.429	199.487	199.487
0.02394	105.429	199.487	199.487
0.02478	105.429	199.487	199.487
0.02561	105.429	199.487	199.487
0.02645	105.429	199.487	199.487
0.02728	105.429	199.487	199.487
0.02812	105.429	199.487	199.487
0.02895	105.429	199.487	199.487
0.02979	105.429	199.487	199.487
0.03062	105.429	199.487	199.487
0.03146	105.429	199.487	199.487
0.03229	105.429	199.487	199.487
0.03313	105.429	199.487	199.487
0.03396	105.429	199.487	199.487
0.03480	105.429	199.487	199.487
0.03563	105.429	199.487	199.487
0.03647	105.429	199.487	199.487
0.03730	105.429	199.487	199.487
0.03814	105.429	199.487	199.487
0.03897	105.429	199.487	199.487
0.03981	105.429	199.487	199.487
0.04064	105.429	199.487	199.487
0.04148	105.429	199.487	199.487
0.04231	105.429	199.487	199.487
0.04315	105.429	199.487	199.487
0.04398	105.429	199.487	199.487
0.04482	105.429	199.487	199.487
0.04565	105.429	199.487	199.487
0.04649	105.429	199.487	199.487
0.04732	105.429	199.487	199.487
0.04816	105.429	199.487	199.487
0.04899	105.429	199.487	199.487
0.04983	105.429	199.487	199.487
0.05066	105.429	199.487	199.487
0.05150	105.429	199.487	199.487
0.05233	105.429	199.487	199.487
0.05317	105.429	199.487	199.487
0.05400	105.429	199.487	199.487
0.0548	105.429	199.487	199.487

KUNII AND SMITH (1960)			
EXPERIMENTAL			
POSITION	THEORETICAL	THEORETICAL	THEORETICAL
POSITION	PARABOLIC	PARABOLIC	PARABOLIC
0	206.724	204.815	204.815
0.00056	199.487	204.815	204.815
0.00140	199.487	204.815	204.815
0.00223	199.487	204.815	204.815
0.00307	199.487	204.815	204.815
0.00391	199.487	204.815	204.815
0.00474	199.487	204.815	204.815
0.00557	199.487	204.815	204.815
0.00641	199.487	204.815	204.815
0.00724	199.487	204.815	204.815
0.00808	199.487	204.815	204.815
0.00891	199.487	204.815	204.815
0.00975	199.487	204.815	204.815
0.01058	199.487	204.815	204.815
0.01142	199.487	204.815	204.815
0.01225	199.487	204.815	204.815
0.01309	199.487	204.815	204.815
0.01392	199.487	204.815	204.815
0.01476	199.487	204.815	204.815
0.01559	199.487	204.815	204.815
0.01643	199.487	204.815	204.815
0.01726	199.487	204.815	204.815
0.01810	199.487	204.815	204.815
0.01893	199.487	204.815	204.815
0.01977	199.487	204.815	204.815
0.02060	199.487	204.815	204.815
0.02144	199.487	204.815	204.815
0.02227	199.487	204.815	204.815
0.02311	199.487	204.815	204.815
0.02394	199.487	204.815	204.815
0.02478	199.487	204.815	204.815
0.02561	199.487	204.815	204.815
0.02645	199.487	204.815	204.815
0.02728	199.487	204.815	204.815
0.02812	199.487	204.815	204.815
0.02895	199.487	204.815	204.815
0.02979	199.487	204.815	204.815
0.03062	199.487	204.815	204.815
0.03146	199.487	204.815	204.815
0.03229	199.487	204.815	204.815
0.03313	199.487	204.815	204.815
0.03396	199.487	204.815	204.815
0.03480	199.487	204.815	204.815
0.03563	199.487	204.815	204.815
0.03647	199.487	204.815	204.815
0.03730	199.487	204.815	204.815
0.03814	199.487	204.815	204.815
0.03897	199.487	204.815	204.815
0.03981	199.487	204.815	204.815
0.04064	199.487	204.815	204.815
0.04148	199.487	204.815	204.815
0.04231	199.487	204.815	204.815
0.04315	199.487	204.815	204.815
0.04398	199.487	204.815	204.815
0.04482	199.487	204.815	204.815
0.04565	199.487	204.815	204.815
0.04649	199.487	204.815	204.815
0.04732	199.487	204.815	204.815
0.04816	199.487	204.815	204.815
0.04899	199.487	204.815	204.815
0.04983	199.487	204.815	204.815
0.05066	199.487	204.815	204.815
0.05150	199.487	204.815	204.815
0.05233	199.487	204.815	204.815
0.05317	199.487	204.815	204.815
0.05400	199.487	204.815	204.815
0.0548	199.487	204.815	204.815

SPECCHIA AND SICARDI (1980)			
EXPERIMENTAL			
POSITION	THEORETICAL	THEORETICAL	THEORETICAL
POSITION	PARABOLIC	PARABOLIC	PARABOLIC
0	191.032	204.815	204.815
0.00056	186.659	204.815	204.815
0.00140	186.659	204.815	204.815
0.00223	186.659	204.815	204.815
0.00307	186.659	204.815	204.815
0.00391	186.659	204.815	204.815
0.00474	186.659	204.815	204.815
0.00557	186.659	204.815	204.815
0.00641	186.659	204.815	204.815
0.00724	186.659	204.815	204.815
0.00808	186.659	204.815	204.815
0.00891	186.659	204.815	204.815
0.00975	186.659	204.815	204.815
0.01058	186.659	204.815	204.815
0.01142	186.659	204.815	204.815
0.01225	186.659	204.815	204.815
0.01309	186.659	204.815	204.815
0.01392	186.659	204.815	204.815
0.01476	186.659	204.815	204.815
0.01559	186.659	204.815	204.815
0.01643	186.659	204.815	204.815
0.01726	186.659	204.815	204.815
0.01810	186.659	204.815	204.815
0.01893	186.659	204.815	204.815
0.01977	186.659	204.815	204.815
0.02060	186.659	204.815	204.815
0.02144	186.659	204.815	204.815
0.02227	186.659	204.815	204.815

TEST NUMBER AA-5-7

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42875 1.37795 0.300

PARTICLE SIZE RANGE (MICRONS)

177-250

EXPERIMENTAL VARIABLES

POWER (W) VELOCITY (CM/S) DENSITY (G/CM**3) VOID FRACTION

812.00 5.32 1.455 0.405

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT HEAT TRANSFER

CONDUCTIVITY (W/MK) CONDUCTIVITY (W/MK) SPECIFIC HEAT (WS/GK) FLUX (W/M**2) COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.02835 1.1035 0.8415 3402.37 353.48

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM) WALL TEMPERATURE (C) PARTICLE TEMPERATURE (C) RADIATIVE HEAT FLUX (W/M**2) CONVECTIVE HEAT FLUX (W/M**2) RADIATIVE H T COEFF (W/M**2K) CONVECTIVE H T COEFF (W/M**2K)

0.	41.11	34.44	18.758	28523.44	2.064	4278.516
3.178	93.33	38.95	148.770	30474.20	2.899	560.384
7.947	125.00	46.03	253.218	31625.09	3.206	400.451
12.720	152.78	53.28	370.071	32807.26	3.719	327.704
17.494	185.56	60.61	422.676	33050.78	4.029	315.010
22.269	192.78	67.90	509.332	33650.31	4.437	293.137
27.048	207.78	75.44	604.025	34177.58	5.025	260.535
31.825	220.56	82.97	719.889	34390.85	5.497	253.866
36.604	225.00	90.49	757.081	35060.41	5.628	260.646
41.385	246.67	98.02	927.753	35736.06	6.241	240.413
46.167	252.22	105.56	954.062	35926.50	6.511	244.089
50.950	258.99	113.14	1099.872	36491.19	7.062	233.911
54.139	266.11	118.18	1040.385	36373.49	7.094	245.874

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI	KUNII	WILLHITE	KRUPICZKA	SPECCHIA	SPECCHIA
KUNII	SMITH	KUNII	BALDI	SICARDI	SICARDI
(1967)	(1960)	(1962)	(1967)	(1960)	(1960)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2763 0.1724 0.1999 0.1683 0.3205 0.3209

PSEUDOHOMOGENEOUS PEGLET NUMBER

3246.5 5204.2 5328.3 2730.8 2726.9

AVERAGE EXPERIMENTAL NUSSELT NUMBER

17.629 28.258 24.351 28.932 14.028 14.607

TEST NUMBER AA-5-8

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42875 1.37795 0.300

PARTICLE SIZE RANGE (MICRONS)

177-250

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM³) VOID FRACTION

826.00 4.40 1.455 0.405

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY PARTICLE CONDUCTIVITY PARTICLE SPECIFIC HEAT HEAT FLUX HEAT TRANSFER COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M²) (W/M²·K)

0.02899 1.1219 0.8538 34525.54 333.31

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION WALL TEMPERATURE PARTICLE TEMPERATURE RADIATIVE HEAT FLUX CONVECTIVE HEAT FLUX RADIATIVE H.T. COEFF CONVECTIVE H.T. COEFF

(CM) (C) (C) (W/M²) (W/M²) (W/M²·K) (W/M²·K)

0. 36.67 34.44 4.468 28292.06 2.020 12731.426

3.178 99.44 39.88 166.013 30629.70 2.787 514.186

7.948 133.33 48.45 289.019 31852.14 3.358 375.237

12.721 163.89 57.23 421.787 32920.25 3.954 308.660

17.496 179.44 66.13 492.089 33460.78 4.350 295.282

22.273 197.78 75.06 591.993 34001.07 4.824 277.720

27.051 226.67 84.10 791.825 35011.55 5.554 245.588

31.832 240.00 93.23 881.126 35442.54 6.004 241.487

36.613 245.67 102.33 912.351 35671.16 6.321 247.138

41.396 268.88 111.45 1106.534 36341.91 7.028 230.824

46.179 275.56 120.58 1148.840 36563.09 7.381 235.331

50.964 295.00 129.73 1336.816 37123.95 8.089 224.624

54.155 293.89 135.82 1204.860 37122.87 8.192 234.655

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA

KUNII SMITH KUNII (1967) BALDI

(1957) (1960) SMITH (1962) SICARDI

(1957) (1960) (1962) (1960)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2819 0.1759 0.2040 0.1718 0.3353 0.3358

PSEUDOHOMOGENEOUS PECLET NUMBER 2675.1 4205.7 3695.4 4369.8 2248.8 2245.7

AVERAGE EXPERIMENTAL NUSSELT NUMBER 16.295 26.106 22.516 26.740 13.690 13.679

TEST NUMBER AA-6-1

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42875 1.37795 0.300

PARTICLE SIZE RANGE (MICRONS)

177-250

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM**3)

928.00 15.25 1.455

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY PARTICLE CONDUCTIVITY PARTICLE SPECIFIC HEAT HEAT FLUX HEAT TRANSFER COEFFICIENT

(W/MK) (W/MK) (W/GK) (W/M**2) (W/M**2K)

0.02625 1.0432 0.7996 39307.24 484.47

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION WALL TEMPERATURE PARTICLE TEMPERATURE RADIATIVE HEAT FLUX CONVECTIVE HEAT FLUX RADIATIVE H T COEFF CONVECTIVE H T COEFF

(CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K) (W/M**2K)

0. 38.33 30.00 18.607 34341.35 1.993 4120.962

3.177 73.89 31.89 100.345 35974.63 2.989 856.593

9.945 97.78 34.83 170.494 37054.11 2.709 548.682

12.715 119.44 37.85 247.204 38017.28 3.030 465.919

17.486 128.33 40.90 279.006 38411.32 3.191 439.344

22.258 140.00 43.98 320.517 38922.05 3.401 405.366

27.031 157.78 47.10 411.408 39686.29 3.717 358.575

31.805 167.78 50.25 461.095 40113.44 3.923 341.316

36.580 169.44 53.41 463.527 40100.42 3.995 346.360

41.356 188.67 56.59 564.521 40900.12 4.340 314.478

46.132 188.33 59.77 567.744 40985.13 4.416 318.796

50.909 202.22 62.97 607.536 41584.34 4.722 298.420

54.094 198.89 65.11 627.623 41426.69 4.691 309.665

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAOI KUNII WILLHITE KRUPICZKA SPECCHIA

(1957) SMITH KUNII BALOI SPECCHIA

(1960) SMITH (1967) SPECCHIA

(1962) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2980 0.1606 0.1867 0.1572 0.3061 0.3066

PSEUDOHOMOGENEOUS PECLET NUMBER

9474.2 15218.6 13096.5 15556.7 7987.5 7974.8

AVERAGE EXPERIMENTAL NUSSELT NUMBER

25.870 41.556 35.761 42.479 21.811 21.776

TEST NUMBER AA-6-2

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) 1.42875 ID (CM) 1.37795 EMISSIVITY 0.300

PARTICLE SIZE RANGE (MICRONS)

177-250

EXPERIMENTAL VARIABLES

POWER (W) 982.80 VELOCITY (CM/S) 13.73 DENSITY (G/CM³) 1.455 VOID FRACTION 0.405

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY (W/MK) 0.02658 PARTICLE CONDUCTIVITY (W/MK) 1.0528 PARTICLE SPECIFIC HEAT (WS/GK) 0.8064 HEAT FLUX (W/M²) 41806.72 HEAT TRANSFER COEFFICIENT (W/M²K) 515.45

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M ²)	CONVECTIVE HEAT FLUX (W/M ²)	RADIATIVE H T COEFF (W/M ² K)	CONVECTIVE H T COEFF (W/M ² K)
0	39.44	31.67	15.710	35137.08	2.030	4646.196
3.177	75.00	33.87	99.656	37856.80	2.423	920.414
7.945	100.00	37.30	173.353	39046.02	2.765	622.721
12.715	122.78	40.81	255.030	40113.29	3.111	489.373
17.486	132.22	44.37	299.050	40554.41	3.290	481.625
22.259	146.11	47.96	347.901	41193.33	3.545	419.697
27.033	164.44	51.60	438.545	42021.95	3.886	372.885
31.807	175.00	55.28	492.729	42400.11	4.116	354.952
36.583	177.78	58.96	500.953	42626.02	4.215	356.754
41.359	194.44	62.66	602.409	43357.03	4.571	329.004
46.136	197.22	66.38	612.261	43486.67	4.679	332.352
50.914	210.00	70.10	697.200	44098.06	4.984	314.757
54.100	208.89	72.59	681.637	43998.08	5.001	322.020

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNITA WILLIAMS KRUPICZKA SPECCHIA
KUNITA SMITH KUNITA BAI DI SICARDI
(1957) (1960) SMITH (1962) SICARDI (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2610 0.1625 0.1568 0.1589 0.3097 0.3101

PSEUDOHOMOGENEOUS PECLET NUMBER

8504.6 13656.3 11755.6 13963.5 7167.3 7156.0

AVERAGE EXPERIMENTAL NUSSELT NUMBER

27.217 43.704 37.621 44.687 22.937 22.901

TEST NUMBER AA-6-3
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 1.42075 1.37795 0.300
 PARTICLE SIZE RANGE (MICRONS)
 177-250
 EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID
 (W) (CM/S) (G/CM**3) FRACTION
 982.80 12.24 1.455 0.405
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS PARTICLE PARTICLE SPECIFIC HEAT HEAT HEAT TRANSFER
 CONDUCTIVITY CONDUCTIVITY FLUX COEFFICIENT
 (W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
 0.02680 1.0589 0.8108 41553.57 505.13
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	38.89	32.22	13.465	35808.33	2.020	5380.253
3.177	76.11	34.67	101.206	37655.99	2.444	908.766
7.945	101.67	38.49	176.870	38093.32	2.800	615.160
12.715	125.56	42.41	208.577	39072.36	3.170	460.725
17.487	136.67	46.38	305.265	40405.67	3.361	448.402
22.260	151.67	50.39	371.008	41168.00	3.663	406.473
26.034	172.78	54.45	481.050	42108.47	4.068	355.872
31.810	180.56	58.56	519.606	42456.32	4.259	348.018
36.566	184.44	62.67	534.951	42634.56	4.388	350.103
41.363	201.67	66.79	643.387	43379.42	4.770	321.634
46.140	205.56	70.94	660.907	43554.42	4.910	323.554
50.919	218.89	75.10	783.797	44120.96	5.242	306.852
54.105	219.44	77.88	780.193	44152.04	5.295	311.891

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII (1967) BALDI
 (1957) (1960) SMITH (1962) SICARDI
 (1960)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2628 0.1637 0.1901 0.1601 0.3119 0.3124
 PSEUDOHOMOGENEOUS FECTLET NUMBER
 7569.7 12152.5 10463.0 12427.9 6377.9 6368.0
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 26.483 42.516 36.605 43.400 22.313 22.279

TEST NUMBER AA-6-4

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) 1.42875 ID (CM) 1.37795 EMISSIVITY 0.300

PARTICLE SIZE RANGE (MICRONS) 177-250

EXPERIMENTAL VARIABLES

POWER (W) 998.40 VELOCITY (CM/S) 10.65 DENSITY (G/CM³) 1.455 VOID FRACTION 0.405

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY (W/MK) 0.02710 PARTICLE CONDUCTIVITY (W/MK) 1.0677 PARTICLE SPECIFIC HEAT (WS/GK) 0.8169 HEAT FLUX (W/M²) 42167.91 HEAT TRANSFER COEFFICIENT (W/M²K) 487.26

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M ²)	CONVECTIVE HEAT FLUX (W/M ²)	RADIATIVE H T COEFF (W/M ² K)	CONVECTIVE H T COEFF (W/M ² K)
0.	37.78	32.78	10.071	35992.30	2.014	7198.477
3.177	78.69	35.61	107.630	37976.25	2.487	877.456
7.946	106.67	40.03	105.096	39232.49	2.883	589.643
12.716	131.11	44.56	283.565	40422.83	3.276	467.138
17.408	143.33	49.16	331.230	40995.23	3.517	433.337
22.262	158.89	53.81	401.936	41703.48	3.825	396.862
27.037	180.00	58.51	516.173	42644.05	4.249	351.013
31.813	191.67	63.27	561.485	43160.49	4.529	336.149
36.590	197.22	60.04	607.769	43410.94	4.705	336.034
41.368	214.44	72.83	724.460	44150.93	5.116	311.760
46.147	219.44	77.64	750.917	44372.84	5.295	312.911
50.927	234.44	82.47	850.201	45002.74	5.693	296.112
54.114	230.56	85.68	820.905	44054.54	5.664	309.614

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI	KUNII	WILLHITE	KRUPICZKA	SPECCHIA	SPECCHIA
KUNII	SMITH	KUNII	(1967)	BALDI	SICARDI
(1957)	(1960)	(1962)		(1980)	(1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2855 0.1654 0.1921 0.1617 0.3157

PSEUDOHOMOGENEOUS PECLET NUMBER

6571.1 10546.0 9082.2 10787.6 5534.6 5520.1

AVERAGE EXPERIMENTAL NUSSELT NUMBER

25.291 40.590 34.956 41.520 21.302 21.260

TEST NUMBER AA-6-5

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42875 1.37795 0.300

PARTICLE SIZE RANGE (MICRONS)

177-250

EXPERIMENTAL VARIABLES

POWER (W) VELOCITY (CM/S) DENSITY (G/CM**3) VOID FRACTION

998.40 9.08 1.455 0.405

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY (W/MK) PARTICLE CONDUCTIVITY (W/MK) SPECIFIC HEAT (WS/GK) HEAT FLUX (W/M**2) HEAT TRANSFER COEFFICIENT (W/M**2K)

0.02754 1.0801 0.8256 42095.86 461.30

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM) WALL TEMPERATURE (C) PARTICLE TEMPERATURE (C) RADIATIVE HEAT FLUX (W/M**2) CONVECTIVE HEAT FLUX (W/M**2) RADIATIVE H.T. COEFF (W/M**2K) CONVECTIVE H.T. COEFF (W/M**2K)

0.177	35.56	34.44	2.332	35370.20	2.009	31833.181
0.946	83.89	37.71	110.636	37605.21	2.569	815.678
12.718	120.00	42.86	238.914	39337.67	3.097	508.957
17.481	139.44	48.14	314.539	40224.18	3.445	440.572
22.255	153.33	53.49	372.520	40852.06	3.731	409.148
27.041	169.44	58.87	450.124	41368.62	4.071	378.950
31.819	193.33	64.34	550.229	42803.20	4.576	330.277
36.597	205.66	69.67	663.894	43129.20	4.893	317.663
41.376	210.00	75.40	682.150	43028.78	5.060	321.910
46.156	230.00	80.36	830.427	44159.30	5.572	296.285
50.938	235.00	86.84	937.400	44976.64	5.775	298.913
54.125	251.11	92.14	991.349	45020.00	6.236	283.249
	249.44	95.67	952.239	44976.75	6.266	292.671

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLIAMS KRUPICZKA SPECCHIA

KUNII SMITH KUNII BALDI

(1957) (1960) (1962) (1967) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2692 0.1678 0.1640 0.3193 0.3203

PSEUDOHOMOGENEOUS PECLET NUMBER

5581.0 8953.3 7713.4 9161.4 4698.5 4691.5

AVERAGE EXPERIMENTAL NUSSELT NUMBER

20.613 37.800 32.634 38.761 19.879 19.819

TEST NUMBER AA-G-5			
AL NUMBERS			
YAGI AND KUNII (1957)			
POSITION	EXPERIMENTAL	THEORETICAL	THEORETICAL
0.00041	1629.521	204.813	21.360
0.00013	225.144	204.813	17.320
0.00165	225.595	204.813	14.123
0.00226	220.988	204.813	11.157
0.00286	19.3281	204.813	11.0332
0.00411	19.1822	204.813	9.711
0.00473	16.5233	204.813	8.223
0.00534	14.941	204.813	6.406
0.00597	13.827	204.813	5.206
0.00698	13.090	204.813	4.962
KUNII AND SMITH (1962)			
POSITION	EXPERIMENTAL	THEORETICAL	THEORETICAL
0.00030	2257.756	204.813	17.320
0.00076	226.937	204.813	12.410
0.00164	226.937	204.813	10.782
0.00208	226.937	204.813	9.209
0.00252	226.937	204.813	8.206
0.00342	226.937	204.813	7.173
0.00431	226.937	204.813	6.265
0.00502	226.937	204.813	5.871
BALDI AND SICARDI (1960)			
POSITION	EXPERIMENTAL	THEORETICAL	THEORETICAL
0.00049	1371.925	204.813	21.360
0.00122	226.937	204.813	17.320
0.00166	226.937	204.813	14.123
0.00220	226.937	204.813	11.157
0.00274	226.937	204.813	9.711
0.00342	226.937	204.813	8.223
0.00415	226.937	204.813	6.406
0.00489	226.937	204.813	5.206
0.00544	226.937	204.813	4.962
0.00708	226.937	204.813	3.573
0.00789	226.937	204.813	2.463

KUNII AND SMITH (1960)			
POSITION	EXPERIMENTAL	THEORETICAL	THEORETICAL
0.00025	2614.209	204.813	21.360
0.00038	67.043	204.813	17.320
0.00043	37.247	204.813	14.123
0.00141	30.947	204.813	11.157
0.00180	30.947	204.813	9.711
0.00216	22.512	204.813	8.223
0.00253	22.512	204.813	6.406
0.00331	22.512	204.813	5.206
0.00371	22.512	204.813	4.962
0.00438	22.512	204.813	3.573
KRUPICZKA (1967)			
POSITION	EXPERIMENTAL	THEORETICAL	THEORETICAL
0.00023	2675.062	204.813	21.360
0.00033	67.043	204.813	17.320
0.00050	37.247	204.813	14.123
0.00077	30.947	204.813	11.157
0.00133	22.512	204.813	9.711
0.00200	22.512	204.813	8.223
0.00283	22.512	204.813	6.406
0.00366	22.512	204.813	5.206
0.00450	22.512	204.813	4.962
0.00545	22.512	204.813	3.573
SPECCHIA AND SICARDI (1960)			
POSITION	EXPERIMENTAL	THEORETICAL	THEORETICAL
0.00019	1369.975	204.813	21.360
0.00036	37.247	204.813	17.320
0.00069	30.947	204.813	14.123
0.00136	22.512	204.813	11.157
0.00204	22.512	204.813	9.711
0.00272	22.512	204.813	8.223
0.00340	22.512	204.813	6.406
0.00408	22.512	204.813	5.206
0.00476	22.512	204.813	4.962
0.00544	22.512	204.813	3.573

THEORETICAL PARABOLIC			
21.360	17.320	14.123	11.157
9.711	8.223	6.406	5.206
4.962	3.573	2.463	1.733

THEORETICAL PARABOLIC			
21.360	17.320	14.123	11.157
9.711	8.223	6.406	5.206
4.962	3.573	2.463	1.733

THEORETICAL PARABOLIC			
21.360	17.320	14.123	11.157
9.711	8.223	6.406	5.206
4.962	3.573	2.463	1.733

TEST NUMBER AA-6-6

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42075 1.37795 0.300

PARTICLE SIZE RANGE (MICRONS)

177-250

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM**3)

999.75 7.59 1.455

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY PARTICLE CONDUCTIVITY PARTICLE SPECIFIC HEAT HEAT FLUX HEAT TRANSFER COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.02795 1.0920 0.8330 42047.47 420.75

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

POSITION WALL TEMPERATURE PARTICLE TEMPERATURE RADIATIVE HEAT FLUX CONVECTIVE HEAT FLUX RADIATIVE H T COEFF

(CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K)

0. 35.56 34.44 2.232 34865.06 2.009

3.177 90.00 38.31 136.985 37406.86 2.650

7.947 121.67 44.40 242.855 30850.22 3.139

12.719 150.56 50.65 364.569 40136.18 3.649

17.493 163.89 56.99 422.352 40720.57 3.951

22.268 181.11 63.38 510.029 41473.70 4.339

27.045 206.33 69.87 688.013 42616.91 4.947

31.824 220.56 76.43 769.695 43120.31 5.290

36.603 226.11 82.98 790.560 43365.27 5.523

41.384 240.33 89.57 972.573 44256.08 6.126

46.166 255.00 96.19 1016.467 44939.42 6.401

50.949 274.44 102.84 1200.718 45201.91 6.997

54.138 270.00 107.27 1134.762 45134.89 6.973

CONVECTIVE

H T COEFF

(W/M**2K)

31378.558

723.670

502.775

401.734

380.992

352.282

307.780

299.239

303.013

278.763

200.427

263.678

277.367

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA

KUNII SMITH KUNII BALDI

(1957) (1960) (1962) (1967) (1960)

SICARDI

(1960)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2729 0.1702 0.1974 0.1662 0.3242 0.3247

PSEUDOHOMOGENEOUS PECLET NUMBER 7636.3 3915.0 3909.3

4652.4 7440.6 6429.5

AVERAGE EXPERIMENTAL NUSSELT NUMBER 21.249 34.074 29.365 34.877 17.881 17.854

TEST NUMBER AA-6-7
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) 1.42875 ID (CM) 1.37795 EMISSIVITY 0.300
 PARTICLE SIZE RANGE (MICRONS) 177-250
 EXPERIMENTAL VARIABLES
 POWER (W) 1015.25 VELOCITY (CM/S) 6.13 DENSITY (G/CM³) 1.455 VOID FRACTION 0.405
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS CONDUCTIVITY (W/MK) 0.02851 PARTICLE CONDUCTIVITY (W/MK) 1.1082 PARTICLE SPECIFIC HEAT (WS/GK) 0.8447 HEAT FLUX (W/M²) 42570.08 HEAT TRANSFER COEFFICIENT (W/M²K) 395.55
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M ²)	CONVECTIVE HEAT FLUX (W/M ²)	RADIATIVE H T COEFF (W/M ² K)	CONVECTIVE H T COEFF (W/M ² K)
0	34.44	33.33	2.208	34552.70	1.987	31187.502
3.177	94.44	38.12	152.278	37430.47	2.703	664.664
7.947	128.33	45.67	268.642	38971.14	3.250	471.444
12.720	150.56	53.43	412.111	40389.42	3.847	377.042
17.495	177.78	61.32	494.945	41138.02	4.250	353.258
22.272	197.22	69.27	604.380	41566.31	4.724	327.395
27.050	228.89	77.35	831.567	42861.74	5.467	285.482
31.831	241.11	85.32	916.731	43762.42	5.892	281.262
36.612	248.33	93.67	930.925	44065.90	6.200	284.900
41.395	272.78	101.65	1185.634	45007.21	6.937	263.315
46.179	280.56	110.08	1249.659	45320.05	7.295	265.841
50.965	301.67	118.33	1471.352	46047.12	8.025	251.432
54.155	295.56	123.82	1369.703	45508.12	7.976	267.317

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNITI WILLHITE KRUPICZKA SPECCHIA
 KUNITI SMITH (1960) SMITH (1962) BALDI SICARDI
 (1957) (1960)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2777 0.1733 0.2010 0.1692 0.3302 0.3307
 PSEUDOHOMOGENEOUS PECLET NUMB. 3737.5 5990.3 5164.7 6133.9 3143.3 3130.9
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 19.626 31.455 27.120 32.209 16.506 16.482

ST NUMBER AA-6-8
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) 1.42875 ID (CM) 1.37795 EMISSIVITY 0.300
 PARTICLE SIZE RANGE (MICRONS) 177-250
 EXPERIMENTAL VARIABLES
 POWER (W) 1023.00 VELOCITY (CM/S) 4.94 DENSITY (G/CM**3) 1.455 VOID FRACTION 0.405
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS CONDUCTIVITY (W/MK) 0.02927 PARTICLE CONDUCTIVITY (W/MK) 1.1300 SPECIFIC HEAT (WS/GK) 0.8591 HEAT FLUX (W/M**2) 42676.44 HEAT TRANSFER COEFFICIENT (W/M**2K) 353.64
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	43.33	33.33	20.751	34305.29	2.075	3438.529
3.178	107.22	39.24	195.033	37271.32	2.881	548.226
7.949	145.56	48.57	343.702	38049.08	3.544	401.605
12.724	180.56	58.17	520.500	40431.73	4.254	390.368
17.500	199.44	67.91	524.058	41220.39	4.745	313.395
22.279	218.89	77.71	46.153	42015.60	5.285	297.604
27.059	254.44	87.65	139.407	43392.99	6.232	260.156
31.842	268.33	97.70	1151.354	43931.62	6.747	257.461
36.626	276.67	107.71	1207.335	44264.94	7.149	261.996
41.411	303.33	117.77	1495.504	45221.84	8.059	243.695
46.196	310.56	127.85	1549.357	45504.33	8.400	249.059
50.986	333.33	137.95	1832.790	46279.61	9.381	236.867
54.179	328.89	144.67	1732.566	46173.51	9.405	250.646

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAOI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII BALDI
 (1957) (1960) SMITH (1967) SIGARDI
 (1962) (1960)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2843 0.1775 0.2057 0.1732 0.3383 0.3387
 PSEUDOHOMOGENEOUS PECLET NUMBER
 2991.9 4791.9 4133.8 4909.3 2514.4 2510.9
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 17.141 27.455 23.684 28.127 14.406 14.306

TEST NUMBER AB-1-1

EXPERIMENTAL DATA
TUBE CHARACTERISTICS

OD (CM) 1.42875 ID (CM) 1.37795 EMISSIVITY 0.300

PARTICLE SIZE RANGE (MICRONS)
420-590

EXPERIMENTAL VARIABLES

POWER (W) 590.40 VELOCITY (CM/S) 13.30 DENSITY (G/CM**3) 1.469 VOID FRACTION 0.390

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY (W/MK) 0.02574 PARTICLE CONDUCTIVITY (W/MK) 1.0286 PARTICLE SPECIFIC HEAT (WS/GK) 0.7891 HEAT FLUX (W/M**2) 24306.22 HEAT TRANSFER COEFFICIENT (W/M**2K) 376.15

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	52.22	27.78	51.610	23057.23	2.111	943.251
3.177	71.67	29.21	90.177	23628.70	2.336	556.592
7.945	87.78	31.41	143.588	24096.14	2.548	427.511
12.713	101.67	33.65	188.701	24493.50	2.745	350.103
17.483	105.11	35.90	198.545	24622.45	2.828	350.694
22.253	117.22	38.17	237.393	24935.27	3.003	315.408
27.024	123.89	40.45	260.556	25122.80	3.123	301.078
31.795	131.67	42.74	280.075	25335.07	3.262	284.936
36.567	137.67	45.03	285.059	25344.08	3.290	292.535
41.339	143.33	47.38	343.409	25661.05	3.494	267.304
46.111	137.22	49.63	300.503	25504.00	3.431	291.164
50.884	150.00	51.93	350.675	25540.71	3.657	263.566
54.066	148.89	53.46	349.264	25823.11	3.660	270.614

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI	KUNII	WILLHITE	KRUPICZKA	SPECCHIA
(1957)	SMITH (1960)	KUNII (1962)	(1967)	BAIDI SICARDI (1960)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2704 0.1693 0.1915 0.1617 0.3231 0.3155

PSEUDO-HOMOGENEOUS PECLET NUMBER

7853.5 12948.1 11089.8 13136.5 6572.4 6646.4

AVERAGE EXPERIMENTAL NUSSELT NUMBER

19.172 30.624 27.065 32.060 16.040 16.221

TEST NUMBER AB-1-2
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) 1.42875 ID (CM) 1.37795 EMISSIVITY 0.300
 PARTICLE SIZE RANGE (MICRONS) 420-590
 EXPERIMENTAL VARIABLES
 POWER (W) 607.60 VELOCITY (CM/S) 12.20 DENSITY (G/CM**3) 1.469 VOID FRACTION 0.390
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS CONDUCTIVITY (W/MK) 0.02593 PARTICLE CONDUCTIVITY (W/MK) 1.0341 PARTICLE SPECIFIC HEAT (WS/GK) 0.7931 HEAT FLUX (W/M**2) 25697.14 HEAT TRANSFER COEFFICIENT (W/FT**2K) 374.17
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/FT**2K)	CONVECTIVE H T COEFF (W/FT**2K)
0.	48.33	28.89	40.487	23422.85	2.082	1204.604
3.177	72.22	30.48	93.328	24141.91	2.356	578.346
7.945	89.44	32.92	146.054	24652.25	2.584	436.171
12.714	104.44	35.41	193.332	25000.16	2.801	363.454
17.483	110.56	37.92	211.356	25269.98	2.910	347.901
22.252	121.11	40.44	240.746	25579.18	3.084	317.024
27.025	131.67	42.93	285.530	25979.12	3.265	291.767
31.797	139.44	45.55	320.371	26092.86	3.412	277.901
36.569	140.00	48.12	317.281	26113.83	3.453	284.202
41.342	151.67	50.69	370.309	26436.21	3.667	261.795
46.116	151.67	53.26	364.223	26447.30	3.701	268.713
50.889	161.11	55.84	404.404	26700.63	3.809	253.644
54.072	160.00	57.57	399.935	26675.41	3.695	260.413

 DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 VAGI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII (1957) Paldi Sicaudi
 (1957) (1960) SMITH (1962) (1960)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2721 0.1704 0.1928 0.1627 0.3253 0.3217
 PSEUDOHOMOGENEOUS PECLET NUMBER 10157.0
 7195.1 11490.6 12031.4 6018.4 6006.2
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 18.947 30.259 26.747 31.683 15.849 16.027

TEST NUMBER AB-1-3

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42075 1.37795 0.390

PARTICLE SIZE RANGE (MICRONS)

420-590

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM³*)3)

607.60 11.18 1.469 0.390

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (J5/8K) (W/M²*)2) (W/M²*)2K)

0.02606 1.0379 0.7958 25697.56 380.25

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION WALL TEMPERATURE PARTICLE TEMPERATURE RADIATIVE CONVECTIVE RADIATIVE CONVECTIVE

(CM) (C) (C) (W/M²*)2) (W/M²*)2) (W/M²*)2K) (W/M²*)2K)

0 42.22 29.44 29.887 23187.30 2.026

3.17 70.56 31.17 52.326 24040.23 2.344

7.944 89.44 33.82 144.262 24699.38 2.594

12.713 105.00 36.52 193.133 25052.00 2.820

17.483 111.67 39.25 212.913 25240.21 2.940

22.254 124.44 42.00 259.630 25613.11 3.149

27.025 131.67 44.77 289.632 25818.49 3.287

31.797 142.78 47.56 352.145 26130.08 3.408

36.570 143.33 50.35 370.490 26151.58 3.533

41.343 155.00 53.15 382.259 26472.24 3.753

46.117 155.00 55.95 375.342 26479.02 3.791

50.891 165.56 58.76 427.515 26765.26 4.004

54.074 162.78 60.64 406.896 26698.07 3.903

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA

KUNII SMITH KUNII (1967) BALDI

(1957) (1960) (1962) SICARDI

(1957) (1960) (1962) (1960)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2733 0.1712 0.1936 0.1635 0.3268 0.3232

PSEUDOHOMOGENEOUS PECLET NUMBER

6385.5 10515.5 9286.2 11011.8 5507.7 5569.8

AVERAGE EXPERIMENTAL NUSSULT NUMBER

19.166 30.607 27.058 32.052 16.031 16.212

TEST NUMBER AB-1-4
EXPERIMENTAL DATA
TUBE CHARACTERISTICS
OD (CM) 1.42875 ID (CM) 1.37795 EMISSIVITY 0.300
PARTICLE SIZE RANGE (MICRONS)
420-590

EXPERIMENTAL VARIABLES

POWER (W) 513.80 VELOCITY (CM/S) 10.15 DENSITY (G/CM**3) 1.469 VOID FRACTION 0.390

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY (W/MK) 0.02619 PARTICLE CONDUCTIVITY (W/MK) 1.0414 PARTICLE SPECIFIC HEAT (WS/GK) 0.7983 HEAT FLUX (W/M**2) 25948.59 HEAT TRANSFER COEFFICIENT (W/M**2K) 375.41

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	42.78	29.44	27.086	23354.41	2.031	1751.530
3.177	71.67	31.35	95.077	24229.78	2.358	601.023
7.944	89.44	34.29	143.341	24760.47	2.599	448.963
12.713	105.67	37.29	197.800	25265.71	2.851	364.171
17.483	113.69	40.31	219.456	25470.43	2.983	346.285
22.254	126.67	43.36	266.360	25845.69	3.197	310.241
27.026	135.56	46.43	290.920	26099.89	3.365	292.840
31.798	145.56	49.52	341.930	26381.62	3.536	274.700
36.571	148.67	52.61	339.918	26410.14	3.614	260.886
41.345	159.44	55.71	400.466	26771.20	3.840	238.078
46.119	160.00	58.82	395.800	26793.73	3.912	264.814
50.893	171.11	61.93	402.309	27093.41	4.143	248.170
54.077	167.78	64.01	427.048	27013.26	4.115	260.326

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICKA SPENCER SPECTORIA
KUNII SMITH KUNII (1967) BALDI SICARDI
(1957) (1960) SMITH (1962) SICARDI (1960)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITY (W/MK)

0.2745 0.1719 0.1945 0.1842 0.3203 0.3246

PSEUDOHOMOGENEOUS PECLET NUMBER

5978.5 9514.9 3439.1 9996.4 4990.3 5055.7

AVERAGE EXPERIMENTAL NUSSELT NUMBER

18.846 30.080 26.602 31.511 15.759 16.937

TEST NUMBER AB-1-4 GENERAL NUMBER YAGI AND KUNII (1957)				KUNII AND SMITH (1960)				THEORETICAL PARABOLIC			
POSITION	FLAT	THEORETICAL	EXPERIMENTAL	POSITION	FLAT	THEORETICAL	EXPERIMENTAL	POSITION	FLAT	THEORETICAL	EXPERIMENTAL
0.00038	37.954	204.815	204.815	0.00024	140.736	204.815	204.815	0.00024	204.815	21.330	21.330
0.00096	22.5693	38.7397	38.7397	0.00066	38.7397	38.7397	38.7397	0.00066	38.7397	14.563	14.563
0.00154	17.4030	31.0894	31.0894	0.00122	31.0894	31.0894	31.0894	0.00122	31.0894	12.1322	12.1322
0.00212	14.7790	26.9171	26.9171	0.00180	26.9171	26.9171	26.9171	0.00180	26.9171	10.0427	10.0427
0.00327	10.9201	20.5352	20.5352	0.00277	20.5352	20.5352	20.5352	0.00277	20.5352	8.4067	8.4067
0.00442	14.1332	19.5359	19.5359	0.00373	19.5359	19.5359	19.5359	0.00373	19.5359	8.6377	8.6377
0.00557	13.1236	17.0300	17.0300	0.00469	17.0300	17.0300	17.0300	0.00469	17.0300	8.1118	8.1118
0.00673	12.4911	16.566	16.566	0.00565	16.566	16.566	16.566	0.00565	16.566	7.565	7.565
KUNII AND SMITH (1957)				KUNII AND SMITH (1960)				THEORETICAL PARABOLIC			
POSITION	FLAT	THEORETICAL	EXPERIMENTAL	POSITION	FLAT	THEORETICAL	EXPERIMENTAL	POSITION	FLAT	THEORETICAL	EXPERIMENTAL
0.00027	124.167	204.815	204.815	0.00023	147.080	204.815	204.815	0.00023	204.815	21.330	21.330
0.00109	42.627	37.430	37.430	0.00066	37.430	37.430	37.430	0.00066	37.430	14.563	14.563
0.00150	22.5693	31.0894	31.0894	0.00122	31.0894	31.0894	31.0894	0.00122	31.0894	12.1322	12.1322
0.00191	22.5693	26.9171	26.9171	0.00180	26.9171	26.9171	26.9171	0.00180	26.9171	10.0427	10.0427
0.00272	20.5352	20.5352	20.5352	0.00277	20.5352	20.5352	20.5352	0.00277	20.5352	8.4067	8.4067
0.00315	19.5359	19.5359	19.5359	0.00373	19.5359	19.5359	19.5359	0.00373	19.5359	8.6377	8.6377
0.00354	18.032	17.0300	17.0300	0.00469	17.0300	17.0300	17.0300	0.00469	17.0300	8.1118	8.1118
0.00395	17.4030	16.566	16.566	0.00565	16.566	16.566	16.566	0.00565	16.566	7.565	7.565
0.00436	16.566	16.566	16.566	0.00673	16.566	16.566	16.566	0.00673	16.566	7.565	7.565
BALDI AND SICARDI (1960)				SPECCHIA AND SICARDI (1960)				THEORETICAL PARABOLIC			
POSITION	FLAT	THEORETICAL	EXPERIMENTAL	POSITION	FLAT	THEORETICAL	EXPERIMENTAL	POSITION	FLAT	THEORETICAL	EXPERIMENTAL
0.00045	73.523	204.815	204.815	0.00045	73.523	204.815	204.815	0.00045	204.815	21.330	21.330
0.00184	18.032	37.430	37.430	0.00122	31.0894	31.0894	31.0894	0.00122	31.0894	12.1322	12.1322
0.00233	14.563	26.9171	26.9171	0.00180	26.9171	26.9171	26.9171	0.00180	26.9171	10.0427	10.0427
0.00301	11.817	20.5352	20.5352	0.00277	20.5352	20.5352	20.5352	0.00277	20.5352	8.4067	8.4067
0.00450	11.817	19.5359	19.5359	0.00373	19.5359	19.5359	19.5359	0.00373	19.5359	8.6377	8.6377
0.00529	10.0427	17.0300	17.0300	0.00469	17.0300	17.0300	17.0300	0.00469	17.0300	8.1118	8.1118
0.00626	10.0427	16.566	16.566	0.00565	16.566	16.566	16.566	0.00565	16.566	7.565	7.565
0.00781	10.0427	16.566	16.566	0.00673	16.566	16.566	16.566	0.00673	16.566	7.565	7.565

TEST NUMBER AB-1-5
EXPERIMENTAL DATA
TUBE CHARACTERISTICS

OD (CM) 1.42875 ID (CM) 1.37795 EMISSIVITY 0.300
PARTICLE SIZE RANGE (MICRONS) 420-590

EXPERIMENTAL VARIABLES

POWER (W) 591.70 VELOCITY (CM/S) 8.84 DENSITY (G/CM**3) 1.469 VOID FRACTION 0.390

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY (W/MK) 0.02636 PARTICLE CONDUCTIVITY (W/MK) 1.0463 PARTICLE SPECIFIC HEAT (VS/GK) 0.3019 HEAT FLUX (W/M**2) 25012.48 HEAT TRANSFER COEFFICIENT (W/M**2K) 381.63

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	42.22	30.00	24.827	22516.05	2.031	1842.222
3.177	69.44	32.11	87.412	23311.25	2.341	624.356
7.944	89.44	35.36	141.207	23385.93	2.611	441.624
12.718	106.11	38.67	192.863	24356.87	2.860	361.143
17.483	112.78	42.01	211.441	24547.05	2.988	346.848
22.234	125.56	45.37	257.101	24901.03	3.206	310.525
27.025	135.00	48.75	292.080	25161.07	3.386	291.727
31.799	144.44	52.16	329.792	25418.00	3.573	275.419
36.571	148.11	55.56	329.998	25469.76	3.644	261.263
41.344	150.69	58.98	365.226	25600.58	3.896	256.317
46.118	150.00	62.40	306.657	25545.73	3.962	264.819
50.893	171.11	65.63	442.066	26135.91	4.199	248.251
54.076	168.33	69.12	419.320	26072.30	4.184	260.161

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNITI WILLHITE KRUPICZKA SPECCHIA SPECCHIA
KUNITI SMITH KUNITI BALDI SICCARDI SICCARDI
(1957) (1960) SMITH (1962) (1960) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2761 0.1729 0.1956 0.1651 0.3302 0.3265

PSEUDOHOMOGENEOUS PECLET NUMBER

5196.7 8295.2 7393.2 8688.8 4344.7 4393.7

AVERAGE EXPERIMENTAL NUSSELT NUMBER

19.048 30.406 26.887 31.849 15.925 16.105

TEST NUMBER AB-1-6

EXPERIMENTAL DATA
TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42875 1.37795 0.300

PARTICLE SIZE RANGE (MICRONS)

420-530

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY VOID
(W) (CM/S) (G/CM³) FRACTION

591.70 7.35 1.469 0.390

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER
CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M²) (W/M²K)

0.02653 1.0541 0.8074 24974.31 364.24

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M ²)	CONVECTIVE HEAT FLUX (W/M ²)	RADIATIVE H T COEFF (W/M ² K)	CONVECTIVE H T COEFF (W/M ² K)
0	43.89	30.00	20.444	22321.96	2.048	1607.101
3	71.11	32.51	51.253	23107.34	2.364	398.683
7	92.22	36.39	140.318	23706.56	2.656	424.589
12	110.56	40.34	208.306	24217.00	2.938	344.873
17	119.44	44.32	233.410	24465.06	3.107	325.673
22	136.67	48.35	300.814	24928.94	3.406	282.270
27	146.11	52.41	337.579	25181.61	3.603	268.772
31	153.89	56.48	361.218	25393.73	3.700	260.700
36	156.67	60.55	373.023	25474.50	3.881	265.047
41	170.00	64.63	438.584	25819.29	4.162	245.044
46	172.78	68.73	444.319	25898.96	4.270	248.903
50	183.89	72.82	503.118	26101.50	4.530	235.728
54	181.11	75.55	477.216	26122.10	4.521	247.462

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA

KUNII SMITH SMITH GALDI SICARDI

(1957) (1960) (1962) (1967) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2766 0.1746 0.1668 0.3333 0.3296

PSEUDOHOMOGENEOUS PECLET NUMBER 4309.8 6877.4 7205.4 3602.1 3642.7

AVERAGE EXPERIMENTAL NUSSELT NUMBER 18.017 28.750 25.430 30.122 15.058 15.228

TEST NUMBER AB-1-6
LOCAL MUSEUM NUMBER, PROFILES
VAC AND DATE

N D AND POSITION		KUNZI AND EXPERIMENTAL		THEORETICAL FLAT		THEORETICAL PARABOLIC		KUNZI AND SMITH (1966)		THEORETICAL FLAT		THEORETICAL PARABOLIC	
0.00033	79.539	204.815	5.360	0.00033	126.910	204.815	5.360	0.00033	126.910	204.815	5.360	0.00033	126.910
0.00213	23.105	29.904	11.325	0.00184	32.565	29.904	11.325	0.00184	32.565	29.904	11.325	0.00184	32.565
0.00393	17.085	19.048	8.674	0.00184	32.565	19.048	8.674	0.00184	32.565	19.048	8.674	0.00184	32.565
0.00433	13.934	17.235	7.702	0.00234	32.565	17.235	7.702	0.00234	32.565	17.235	7.702	0.00234	32.565
0.00533	12.924	15.938	7.324	0.00334	32.565	15.938	7.324	0.00334	32.565	15.938	7.324	0.00334	32.565
0.00633	12.152	14.736	6.864	0.00434	32.565	14.736	6.864	0.00434	32.565	14.736	6.864	0.00434	32.565
0.00733	11.344	13.000	6.400	0.00534	32.565	13.000	6.400	0.00534	32.565	13.000	6.400	0.00534	32.565
0.00852	11.683	12.256	6.315	0.00634	32.565	12.256	6.315	0.00634	32.565	12.256	6.315	0.00634	32.565
0.00982	11.2	11.506	6.019	0.00734	32.565	11.506	6.019	0.00734	32.565	11.506	6.019	0.00734	32.565
0.01084	10.269	11.506	6.019	0.00834	32.565	11.506	6.019	0.00834	32.565	11.506	6.019	0.00834	32.565
0.00033	112.230	204.815	5.360	0.00033	132.562	204.815	5.360	0.00033	132.562	204.815	5.360	0.00033	132.562
0.00033	24.183	29.904	11.325	0.00033	32.565	29.904	11.325	0.00033	32.565	29.904	11.325	0.00033	32.565
0.00151	19.776	22.324	9.883	0.00151	32.565	22.324	9.883	0.00151	32.565	22.324	9.883	0.00151	32.565
0.00264	18.927	19.048	8.674	0.00264	32.565	19.048	8.674	0.00264	32.565	19.048	8.674	0.00264	32.565
0.00324	18.927	18.000	8.177	0.00324	32.565	18.000	8.177	0.00324	32.565	18.000	8.177	0.00324	32.565
0.00334	18.927	17.235	7.702	0.00334	32.565	17.235	7.702	0.00334	32.565	17.235	7.702	0.00334	32.565
0.00434	17.453	15.938	7.324	0.00434	32.565	15.938	7.324	0.00434	32.565	15.938	7.324	0.00434	32.565
0.00497	17.453	14.736	6.864	0.00497	32.565	14.736	6.864	0.00497	32.565	14.736	6.864	0.00497	32.565
0.00547	17.453	13.000	6.400	0.00547	32.565	13.000	6.400	0.00547	32.565	13.000	6.400	0.00547	32.565
0.00642	17.453	12.256	6.315	0.00642	32.565	12.256	6.315	0.00642	32.565	12.256	6.315	0.00642	32.565
0.00664	17.453	11.506	6.019	0.00664	32.565	11.506	6.019	0.00664	32.565	11.506	6.019	0.00664	32.565
0.00664	17.453	11.506	6.019	0.00664	32.565	11.506	6.019	0.00664	32.565	11.506	6.019	0.00664	32.565
0.00664	17.453	11.506	6.019	0.00664	32.565	11.506	6.019	0.00664	32.565	11.506	6.019	0.00664	32.565
0.00664	17.453	11.506	6.019	0.00664	32.565	11.506	6.019	0.00664	32.565	11.506	6.019	0.00664	32.565
0.00664													

[illegible]

TEST NUMBER CC-2-9

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) 1.0

EMISSIVITY

0.95250 0.77470 0.300

PARTICLE SIZE RANGE (MICRONS)

590-840

EXPERIMENTAL VARIABLES

POWER (W) 434.90

DENSITY

VOID FRACTION

VELOCITY (CM/S) 4.66

(G/CM**3) 1.485

0.397

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

PARTICLE

PARTICLE

HEAT FLUX

HEAT TRANSFER COEFFICIENT

CONDUCTIVITY (W/MK) 0.03023

CONDUCTIVITY (W/MK) 1.1577

SPECIFIC HEAT (WS/GK) 0.8770

HEAT FLUX (W/M**2) 33026.63

COEFFICIENT (W/M**2K) 349.27

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

POSITION (CM)

WALL TEMPERATURE (C)

PARTICLE TEMPERATURE (C)

HEAT FLUX (W/M**2)

CONVECTIVE HEAT FLUX (W/M**2)

RADIATIVE H T COEFF (W/M**2K)

CONVECTIVE H T COEFF (W/M**2K)

0. 78.89

26.11

125.953

28559.69

2.386

541.899

2.225 112.78

32.44

231.088

29772.59

2.876

370.572

4.770 132.22

39.82

299.842

30441.54

3.234

329.438

7.315 152.22

47.28

351.056

31115.26

3.631

288.498

10.180 162.22

55.70

416.018

31457.62

3.906

285.325

13.045 176.11

64.12

477.228

31919.66

4.251

285.021

15.707 179.33

72.08

469.456

32011.09

4.418

301.286

18.094 192.78

81.76

536.707

32486.94

4.834

292.627

22.698 211.11

91.97

639.051

33072.54

5.364

277.603

26.102 223.69

102.21

707.067

33403.08

5.811

275.171

30.248 228.33

114.22

743.910

33657.12

6.128

294.936

34.366 236.69

126.12

812.036

34007.03

6.587

301.563

38.532 251.67

137.98

851.676

34415.83

7.143

302.730

43.314 262.22

151.62

922.563

34769.57

7.700

314.353

48.098 270.56

165.19

951.94.82

35194.82

8.360

318.907

52.681 285.56

178.59

951.089

35014.27

8.406

402.600

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA

KUNII SMITH KUNII SMITH BALDI SIGARDI

(1957) (1960) (1962) (1967) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.3026 0.1897 0.2167 0.1827 0.3620

PSEUDOHOMOGENEOUS PECLET NUMBER

2479.5

2170.1

2574.7

1299.3

1306.3

AVERAGE EXPERIMENTAL NUSSELT NUMBER

8.941 14.285 12.485 14.613 7.475 7.516

TEST NUMBER CC-2-2

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

0.95250 0.77470 0.300

PARTICLE SIZE RANGE (MICRONS)

590-840

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM**3)

424.80 7.39 1.485

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE PARTICLE

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT

(W/MK) (W/MK) (WS/GK)

0.02809 1.0881 0.8365

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER

POSITION WALL TEMPERATURE PARTICLE TEMPERATURE

(CM) (C) (C)

0. 75.56 25.00

2.225 105.00 28.94

4.789 118.89 33.53

7.314 133.89 38.16

10.177 140.56 43.40

13.041 151.67 48.64

15.782 161.11 53.60

18.088 162.22 59.65

22.589 175.57 66.04

26.091 187.78 72.46

30.231 188.33 80.01

34.371 198.11 87.50

38.512 205.00 94.97

43.290 214.44 103.58

48.069 223.89 112.17

52.848 215.56 120.65

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA

KUNII SMITH KUNII BALDI

(1967) (1960) SMITH (1962) SICARDI

(1967) (1960) (1960) (1960)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2835 0.1774 0.2030 0.1710 0.3364

PSEUDOHOMOGENEOUS PECELET NUMBER

2577.8 4120.9 3601.1 4273.0 2159.8

AVERAGE EXPERIMENTAL NUSSELT NUMBER

9.580 15.285 13.355 15.847 8.009

HEAT FLUX (W/M**2)

32453.12 349.89

HEAT TRANSFER COEFFICIENT (W/M**2K)

32453.12 349.89

COEFFICIENT PROFILES

CONVECTIVE HEAT FLUX (W/M**2)

28551.33 30010.50

30500.83 30791.37

31022.36 31258.24

31640.69 31833.89

32014.63 32490.77

32889.51 32909.11

33475.13 33792.75

34107.68 33893.30

5.982 5.969

5.982 5.969

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5.982 5.969

5.982 5.969

CONVECTIVE

H T COEFF

(W/M**2K)

572.861

384.552

357.319

324.075

321.790

307.112

324.430

312.128

285.783

285.040

303.603

305.455

304.245

304.809

305.290

357.143

TEST NUMBER CC-2-1
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 0.95250 0.77470 0.300
 PARTICLE SIZE RANGE (MICRONS)
 590-840
 EXPERIMENTAL VARIABLES
 POWER (W) VELOCITY (CM/S) DENSITY (G/CM**3) VOID FRACTION
 419.00 12.40 1.485 0.397
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS CONDUCTIVITY (W/MK) PARTICLE CONDUCTIVITY (W/MK) PARTICLE SPECIFIC HEAT (WS/GK) HEAT FLUX (W/M**2) HEAT TRANSFER COEFFICIENT (W/H**2K)
 0.02714 1.0686 0.8176 32089.26 346.94
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	75.00	24.44	117.536	29091.45	2.325	575.435
2.225	102.78	27.34	202.868	30085.47	2.689	398.806
4.769	113.33	30.70	236.648	30462.30	2.864	368.864
7.313	126.67	34.10	265.649	30929.96	3.086	334.145
10.178	131.11	37.94	297.696	31089.96	3.195	333.689
13.040	140.00	41.78	331.285	31400.17	3.373	319.701
15.760	138.33	45.42	315.319	31351.70	3.394	337.441
19.085	147.78	49.86	352.028	31679.95	3.595	323.341
22.585	161.67	54.56	415.653	32152.28	3.881	300.189
26.087	171.11	59.28	459.073	32472.00	4.105	290.386
30.225	170.00	64.05	438.024	32451.05	4.186	308.805
34.364	176.67	70.37	463.766	32681.99	4.363	307.464
38.503	184.44	75.89	497.918	32947.03	4.587	303.514
43.279	192.22	82.26	531.323	33212.53	4.832	302.029
48.067	200.56	88.62	570.442	33453.35	5.096	299.211
52.834	191.11	94.91	482.535	33218.63	5.016	345.294

 DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII (1967) BALDI
 (1957) (1960) SMITH (1960) SICARDI
 (1980)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2749 0.1718 0.1968 0.1658 0.3279 0.3261
 PSEUDOHOMOGENEOUS PECLET NUMBER
 3567.4 569.3 4970.4
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 9.776 15.642 13.658 16.208 8.198 8.241

TEST NUMBER CC-1-4

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) 1D (CM) EMISSIVITY
0.95250 0.77470 0.300

PARTICLE SIZE RANGE (MICRONS)
590-840

EXPERIMENTAL VARIABLES

POWER (W) VELOCITY (CM/S) DENSITY (G/CM**3) VOID FRACTION
370.50 2.08 1.485 0.397

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT HEAT TRANSFER
CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
0.03443 1.2808 0.9492 27746.26 324.28

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	79.44	26.67	126.596	22906.31	2.399	435.530
2.226	120.56	38.06	251.401	24117.62	3.047	292.353
4.771	146.67	51.33	342.928	24820.72	3.587	260.360
7.317	171.67	64.70	440.421	25473.69	4.192	238.152
10.182	185.56	79.72	493.096	25846.60	4.667	244.234
13.048	204.44	94.66	579.055	26334.00	5.274	239.862
15.772	211.11	108.73	579.069	26535.03	5.656	259.183
19.102	236.57	129.87	724.651	27158.65	6.541	245.127
22.608	260.00	143.95	867.634	27715.83	7.477	238.839
26.118	279.44	162.04	985.241	28180.12	8.392	240.025
30.263	289.44	183.25	975.205	28108.86	9.183	268.272
34.411	308.67	204.28	1040.560	29928.94	10.242	282.541
38.560	324.44	225.25	1130.507	29376.01	11.397	296.143
43.349	341.67	249.39	1173.458	29844.28	12.716	323.414
48.140	352.22	273.52	1265.092	30361.32	14.262	342.274
52.931	345.56	297.30	897.993	30435.03	14.463	630.654

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
KUNII SMITH KUNII BALDI
(1957) (1960) (1962) (1967) (1980)
SICARDI
SICARDI (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.3404 0.2140 0.2439 0.2056 0.4084 0.4062

PSEUDOHOMOGENEOUS PECLET NUMBER

667.3 1061.3 931.2 1104.5 556.1 559.2

AVERAGE EXPERIMENTAL NUSSELT NUMBER

7.381 11.738 10.299 12.216 6.151 6.185

TEST NUMBER CC-1-3

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

0.95250 0.77470 0.300

PARTICLE SIZE RANGE (MICRONS)

590-840

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY VOID

(W) (CM/S) (G/CM**3) FRACTION

349.70 5.02 1.485 0.397

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (HS/GK) (W/M**2) (W/M**2K)

0.02898 1.1217 0.8537 26674.51 340.16

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL WALL PARTICLE RADIATIVE CONVECTIVE RADIATIVE CONVECTIVE

POSITION TEMPERATURE TEMPERATURE TEMPERATURE HEAT FLUX HEAT FLUX H T COEFF H T COEFF

(CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K) (W/M**2K)

0. 68.33 26.67 94.703 23668.86 2.273 565.053

2.225 96.11 31.51 171.254 24479.84 2.631 375.929

4.769 110.56 37.14 212.962 24398.51 2.901 335.145

7.313 127.22 42.82 260.871 25371.71 3.198 300.520

10.176 134.44 49.24 280.343 25582.77 3.384 300.262

13.039 146.11 55.66 329.760 25911.56 3.646 286.471

15.760 146.67 61.73 317.398 25941.59 3.736 305.436

19.086 159.44 69.13 365.573 26298.19 4.048 291.192

22.587 174.44 76.95 431.144 26707.06 4.422 273.926

26.089 185.11 84.78 481.975 27024.64 4.757 266.708

30.229 187.78 93.99 462.992 27096.22 4.937 288.918

34.369 196.11 103.12 488.376 27333.61 5.252 293.946

38.509 206.11 112.23 527.124 27609.83 5.615 294.078

43.288 216.11 122.70 562.258 27889.29 6.019 298.553

48.067 227.22 133.15 608.435 28192.19 6.468 299.677

52.847 219.44 143.47 493.664 28062.65 6.498 369.368

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA

KUNII SMITH KUNII SMITH BALDI

(1957) (1960) (1962) (1967) (1980)

SICARDI

(1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2915 0.1825 0.2087 0.1759 0.3482 0.3464

PSEUDOHOMOGENEOUS PECLET NUMBER

1691.4 2701.6 2362.5 2803.1 1415.8 1423.4

AVERAGE EXPERIMENTAL NUSSELT NUMBER

9.041 14.440 12.627 14.982 7.567 7.608

TEST NUMBER CC-1-2
EXPERIMENTAL DATA
TUBE CHARACTERISTICS

CO (CM) ID (CM) EMISSIVITY
0.95250 0.77470 0.300
PARTICLE SIZE RANGE (MICRONS)

590-840
EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY VOID
(W) (CM/S) (G/CM**3) FRACTION
339.30 8.07 1.485 0.397

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER
CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
0.02739 1.0759 0.8227 25987.20 337.21

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES
POSITION WALL TEMPERATURE PARTICLE TEMPERATURE RADIATIVE CONVECTIVE RADIATIVE CONVECTIVE
(CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K) (W/M**2K)

0.	86.11	26.67	88.687	23625.31	2.248	598.952
2.225	91.11	29.07	157.849	24356.00	2.569	396.422
4.768	101.67	33.17	187.656	24663.20	2.739	360.040
7.312	113.89	36.69	226.988	25013.56	2.940	324.004
10.174	118.33	40.66	236.713	25145.40	3.048	323.748
13.037	127.22	44.64	265.997	25389.02	3.221	307.574
15.756	126.67	48.42	255.091	25392.25	3.260	324.502
19.081	137.22	53.02	292.542	25690.69	3.474	305.115
22.581	149.44	57.90	341.316	26029.65	3.726	284.331
26.061	158.89	62.79	379.460	26290.97	3.949	273.595
30.219	158.33	68.56	360.952	26291.83	4.021	292.867
34.357	165.00	74.29	382.340	26481.47	4.217	291.931
38.495	172.22	80.61	408.415	26384.15	4.429	289.379
43.270	180.56	86.61	439.897	26916.23	4.682	286.499
48.046	188.33	93.20	459.431	27132.40	4.934	285.194
52.823	181.67	99.72	402.769	25908.47	4.915	329.353

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI	KUNII	WILLHITE	KRUPICZKA	SPECCHIA
KUNII	SMITH	KUNII	BALDI	SICARDI
(1957)	(1960)	SMITH	(1967)	(1980)
		(1962)	(1980)	

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
0.2772 0.1733 0.1984 0.1672 0.3290

PSEUDOHOMOGENEOUS PECLET NUMBER

2755.5 4408.0 3849.8 4568.4 2310.2 2322.4

AVERAGE EXPERIMENTAL NUSSELT NUMBER

9.423 15.073 13.165 15.622 7.900 7.942

TEST NUMBER CC-1-1				KUNII AND SMITH (1960)				THEORETICAL				THEORETICAL				THEORETICAL			
LCCAL NUSSELT (1957)				N POSITION				FLAT				FLAT				FLAT			
VAGI AND KUNII				EXPERIMENTAL				EXPERIMENTAL				EXPERIMENTAL				EXPERIMENTAL			
POSITION				POSITION				POSITION				POSITION				POSITION			
0.	0.0079	17.246	34.815	0.	0.0049	27.598	54.815	0.	0.0049	27.598	54.815	0.	0.0049	27.598	54.815	0.	0.0049	27.598	54.815
0.	0.0077	17.246	34.815	0.	0.0105	19.166	54.815	0.	0.0105	19.166	54.815	0.	0.0105	19.166	54.815	0.	0.0105	19.166	54.815
0.	0.0057	19.166	54.815	0.	0.0160	15.151	54.815	0.	0.0160	15.151	54.815	0.	0.0160	15.151	54.815	0.	0.0160	15.151	54.815
0.	0.0049	19.166	54.815	0.	0.0223	12.733	54.815	0.	0.0223	12.733	54.815	0.	0.0223	12.733	54.815	0.	0.0223	12.733	54.815
0.	0.0053	19.166	54.815	0.	0.0286	10.407	54.815	0.	0.0286	10.407	54.815	0.	0.0286	10.407	54.815	0.	0.0286	10.407	54.815
0.	0.0053	19.166	54.815	0.	0.0341	8.931	54.815	0.	0.0341	8.931	54.815	0.	0.0341	8.931	54.815	0.	0.0341	8.931	54.815
0.	0.0079	19.166	54.815	0.	0.0449	7.598	54.815	0.	0.0449	7.598	54.815	0.	0.0449	7.598	54.815	0.	0.0449	7.598	54.815
0.	0.0091	19.166	54.815	0.	0.0571	6.598	54.815	0.	0.0571	6.598	54.815	0.	0.0571	6.598	54.815	0.	0.0571	6.598	54.815
0.	0.0106	19.166	54.815	0.	0.0693	5.815	54.815	0.	0.0693	5.815	54.815	0.	0.0693	5.815	54.815	0.	0.0693	5.815	54.815
0.	0.0120	19.166	54.815	0.	0.0843	5.151	54.815	0.	0.0843	5.151	54.815	0.	0.0843	5.151	54.815	0.	0.0843	5.151	54.815
0.	0.0151	19.166	54.815	0.	0.1047	4.598	54.815	0.	0.1047	4.598	54.815	0.	0.1047	4.598	54.815	0.	0.1047	4.598	54.815
0.	0.0183	19.166	54.815	0.	0.1315	4.071	54.815	0.	0.1315	4.071	54.815	0.	0.1315	4.071	54.815	0.	0.1315	4.071	54.815
0.	0.0185	19.166	54.815	0.	0.1556	3.598	54.815	0.	0.1556	3.598	54.815	0.	0.1556	3.598	54.815	0.	0.1556	3.598	54.815
WILHITE, KUNII AND SMITH (1962)				KUNII AND SMITH (1960)				KUNII AND SMITH (1960)				KUNII AND SMITH (1960)				KUNII AND SMITH (1960)			
POSITION				POSITION				POSITION				POSITION				POSITION			
0.	0.0056	24.098	54.815	0.	0.0047	28.598	54.815	0.	0.0047	28.598	54.815	0.	0.0047	28.598	54.815	0.	0.0047	28.598	54.815
0.	0.0120	17.246	54.815	0.	0.0115	19.166	54.815	0.	0.0115	19.166	54.815	0.	0.0115	19.166	54.815	0.	0.0115	19.166	54.815
0.	0.0027	12.733	54.815	0.	0.0276	15.151	54.815	0.	0.0276	15.151	54.815	0.	0.0276	15.151	54.815	0.	0.0276	15.151	54.815
0.	0.0036	12.733	54.815	0.	0.0334	12.733	54.815	0.	0.0334	12.733	54.815	0.	0.0334	12.733	54.815	0.	0.0334	12.733	54.815
0.	0.0079	12.733	54.815	0.	0.0476	10.407	54.815	0.	0.0476	10.407	54.815	0.	0.0476	10.407	54.815	0.	0.0476	10.407	54.815
0.	0.0075	12.733	54.815	0.	0.0552	8.931	54.815	0.	0.0552	8.931	54.815	0.	0.0552	8.931	54.815	0.	0.0552	8.931	54.815
0.	0.0082	12.733	54.815	0.	0.0693	7.598	54.815	0.	0.0693	7.598	54.815	0.	0.0693	7.598	54.815	0.	0.0693	7.598	54.815
0.	0.0085	12.733	54.815	0.	0.0843	6.598	54.815	0.	0.0843	6.598	54.815	0.	0.0843	6.598	54.815	0.	0.0843	6.598	54.815
0.	0.0120	12.733	54.815	0.	0.1047	5.815	54.815	0.	0.1047	5.815	54.815	0.	0.1047	5.815	54.815	0.	0.1047	5.815	54.815
0.	0.0132	12.733	54.815	0.	0.1315	5.151	54.815	0.	0.1315	5.151	54.815	0.	0.1315	5.151	54.815	0.	0.1315	5.151	54.815
SPECCHIA, BALZANI AND SICARDI (1960)				SPECCHIA, BALZANI AND SICARDI (1960)				SPECCHIA, BALZANI AND SICARDI (1960)				SPECCHIA, BALZANI AND SICARDI (1960)				SPECCHIA, BALZANI AND SICARDI (1960)			
POSITION				POSITION				POSITION				POSITION				POSITION			
0.	0.0053	14.570	54.815	0.	0.0093	14.570	54.815	0.	0.0093	14.570	54.815	0.	0.0093	14.570	54.815	0.	0.0093	14.570	54.815
0.	0.0030	14.570	54.815	0.	0.0304	12.733	54.815	0.	0.0304	12.733	54.815	0.	0.0304	12.733	54.815	0.	0.0304	12.733	54.815
0.	0.0042	14.570	54.815	0.	0.0424	10.407	54.815	0.	0.0424	10.407	54.815	0.	0.0424	10.407	54.815	0.	0.0424	10.407	54.815
0.	0.0054	14.570	54.815	0.	0.0552	8.931	54.815	0.	0.0552	8.931	54.815	0.	0.0552	8.931	54.815	0.	0.0552	8.931	54.815
0.	0.0079	14.570	54.815	0.	0.0693	7.598	54.815	0.	0.0693	7.598	54.815	0.	0.0693	7.598	54.815	0.	0.0693	7.598	54.815
0.	0.0094	14.570	54.815	0.	0.0843	6.598	54.815	0.	0.0843	6.598	54.815	0.	0.0843	6.598	54.815	0.	0.0843	6.598	54.815
0.	0.0109	14.570	54.815	0.	0.1047	5.815	54.815	0.	0.1047	5.815	54.815	0.	0.1047	5.815	54.815	0.	0.1047	5.815	54.815
0.	0.0132	14.570	54.815	0.	0.1315	5.151	54.815	0.	0.1315	5.151	54.815	0.	0.1315	5.151	54.815	0.	0.1315	5.151	54.815
0.	0.0206	14.570	54.815	0.	0.1556	4.598	54.815	0.	0.1556	4.598	54.815	0.	0.1556	4.598	54.815	0.	0.1556	4.598	54.815

TEST NUMBER CC-1-1
EXPERIMENTAL DATA
TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY
0.95250 0.77470 0.300
PARTICLE SIZE RANGE (MICRONS)
590-840

EXPERIMENTAL VARIABLES
POWER VELOCITY
(W) (CM/S)

331.50 10.67
AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER
CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.02669 1.0657 0.8086 25445.61 339.14
AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	65.00	26.11	86.747	23436.79	2.231	602.660
2.225	88.89	28.37	153.011	24129.97	2.528	398.702
4.788	97.22	30.35	176.117	24371.28	2.659	367.966
7.312	106.33	33.63	211.409	24688.07	2.831	330.491
10.173	110.56	36.61	214.038	24755.90	2.895	334.804
13.036	117.22	39.60	214.409	24946.54	3.020	321.367
15.756	116.11	42.42	223.872	24921.92	3.038	338.207
19.078	125.56	45.88	255.965	25180.52	3.212	316.125
22.378	136.67	49.53	298.030	25497.37	3.421	292.629
26.077	144.44	53.21	327.236	25719.57	3.587	281.843
30.214	143.33	57.54	311.207	25694.61	3.628	299.502
34.350	148.89	61.85	328.416	25852.57	3.773	297.029
38.487	154.44	66.16	348.336	26009.70	3.923	294.605
43.261	161.11	71.12	369.362	26196.68	4.105	291.113
48.036	167.78	76.09	393.519	26382.16	4.292	287.731
52.810	160.00	81.01	334.233	26196.74	4.231	331.632

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
KUNII SMITH KUNII SMITH BALDI
(1957) (1960) (1962) (1967) (1980)
SICARDI
(1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
0.2709 0.1692 0.1939 0.1634 0.3229 0.3212
PSEUDOHOMOGENEOUS PECLET NUMBER
3654.9 5667.1 5121.0
AVERAGE EXPERIMENTAL NUSSELT NUMBER 6077.1 3075.0 3091.1
9.697 15.524 13.550 16.080 8.136 8.179

TEST NUMBER CB-3-3
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 0.95250 0.77470 0.300
 PARTICLE SIZE RANGE (MICRONS)
 420-590
 EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID
 (W) (CM/S) (G/CM**3) FRACTION
 560.30 5.85 1.469 0.397
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS PARTICLE PARTICLE HEAT HEAT TRANSFER
 CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
 (W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
 0.03048 1.1652 0.8817 42430.86 366.39
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	85.56	27.22	144.443	36035.87	2.476	617.758
2.226	125.00	33.65	279.278	37771.31	3.057	413.480
4.771	147.22	41.19	368.463	38731.93	3.475	365.276
7.317	169.44	48.82	474.257	39673.13	3.932	328.909
10.182	180.00	57.46	518.804	40124.92	4.234	327.433
13.046	196.11	66.09	605.114	40794.54	4.654	313.759
15.771	199.44	74.27	606.309	40950.04	4.844	327.132
19.100	216.67	84.23	703.215	41654.63	5.348	314.521
22.605	237.78	94.76	855.448	42493.87	5.982	297.130
26.112	253.89	105.34	972.406	43127.64	6.546	290.335
30.256	259.44	117.78	980.515	43376.12	6.922	306.210
34.402	271.11	130.12	1052.567	43848.51	7.465	310.998
38.548	285.56	142.42	1161.026	44410.55	8.111	310.269
43.344	298.99	156.58	1253.131	44836.25	8.806	315.765
48.121	315.00	170.71	1388.307	45546.21	9.622	315.685
52.908	305.56	184.67	1171.604	45326.30	9.692	374.949

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 VAGI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII (1967) BALDI
 (1957) (1960) SMITH SICARDI
 (1962) (1960)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.3049 0.1912 0.1841 0.3648 0.3628
 PSEUDOHOMOGENEOUS PECLET NUMBER
 1924.6 3069.9 2687.3 1608.7 1617.4
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 9.308 14.847 12.997 15.420 7.780 7.823

TEST NUMBER CB-3-2
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 0.95260 0.77470 0.300
 PARTICLE SIZE RANGE (MICRONS)
 420-590

EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID
 (W) (CM/S) (G/CM**3) FRACTION
 552.40 8.46 1.469 0.397

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS PARTICLE PARTICLE HEAT HEAT TRANSFER
 CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
 (W/MK) (W/MK) (WS/OK) (W/M**2) (W/M**2K)
 0.02674 1.1148 0.6491 42057.51 371.24

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES						
AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	82.22	26.11	136.081	36578.16	2.425	651.888
2.226	117.78	30.63	254.717	38178.08	2.923	438.092
4.770	135.56	35.92	322.323	38968.23	3.235	391.122
7.316	153.89	41.28	403.087	39769.29	3.580	353.172
10.180	162.22	47.34	435.662	40136.89	3.792	349.387
13.045	174.44	53.41	493.796	40664.97	4.080	335.985
15.767	175.56	59.16	486.553	40725.46	4.180	349.891
19.094	191.11	66.18	509.954	41386.77	4.562	331.276
22.598	208.89	73.62	678.720	42127.37	5.017	311.426
26.102	221.67	81.09	758.901	42656.52	5.399	303.441
30.245	224.44	89.88	754.359	42793.39	5.606	318.022
34.387	235.00	98.62	816.816	43233.39	5.989	317.005
38.531	247.22	107.35	899.107	43732.07	6.428	312.655
43.313	259.89	117.41	876.274	44206.83	6.301	312.482
48.096	271.67	127.47	1070.552	44719.88	7.424	310.125
52.880	262.78	137.41	923.656	44440.64	7.407	354.471

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 VARI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII BALDI
 (1957) (1960) SMITH (1967) SICARDI
 (1962) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2893 0.1811 0.2071 0.1746 0.3436 0.3438
 PSEUDOHOMOGENEOUS PECLET NUMBER
 2824.4 4512.3 3945.1 4681.0 2364.6 2377.3
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 9.940 15.880 13.884 16.474 8.322 8.366

TEST NUMBER CB-3-1

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

0.95250 0.77470 0.300

PARTICLE SIZE RANGE (MICRONS)

420-590

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM**3)

549.20 10.87 1.469

VOID FRACTION

0.397

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT HEAT TRANSFER

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.02777 1.0869 0.8303 41957.24 981.45

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION WALL TEMPERATURE PARTICLE TEMPERATURE RADIATIVE HEAT FLUX CONVECTIVE HEAT FLUX RADIATIVE H T COEFF

(CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K)

0. 80.56 24.44 134.022 37098.61 2.389

2.226 113.89 28.02 243.960 38627.46 2.841

4.770 128.89 32.20 299.235 39307.53 3.095

7.315 145.00 36.43 367.131 39027.93 3.382

10.179 151.11 41.21 386.525 40305.22 3.535

13.043 162.22 46.00 438.676 40797.47 3.775

15.765 161.67 50.54 425.185 40763.85 3.826

19.091 173.89 56.08 453.927 41320.94 4.108

22.593 190.86 61.95 577.287 42030.65 4.489

26.097 201.67 67.85 640.500 42515.23 4.786

30.237 202.78 74.80 629.195 42580.48 4.916

34.378 211.11 81.70 671.962 42942.02 5.193

38.520 221.67 88.60 735.227 43390.27 5.525

43.300 231.11 96.86 789.360 43735.25 5.867

48.081 242.78 104.52 867.225 44279.30 6.272

52.861 234.44 112.39 760.447 43983.36 6.231

CONVECTIVE

H T COEFF

(W/M**2K)

661.163

449.835

406.538

368.695

366.751

351.037

367.009

350.743

326.572

317.711

332.712

331.833

326.090

329.485

320.263

360.370

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

VAGI KUNII WILLHITE KRUPICZKA SPECCHIA

KUNII SMITH KUNII (1967) BALDI

(1957) (1960) SMITH SICCARDI

(1962) (1960)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2807 0.1755 0.2009 0.1693 0.3349 0.3331

PSEUDOHOMOGENEOUS PECLET NUMBER 3069.0 3068.1 3084.4

3861.0 5854.4 5114.6

AVERAGE EXPERIMENTAL NUSSELT NUMBER 10.529 16.837 14.710 17.455 8.824 8.871

TEST NUMBER CB-2-3
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 0.95250 0.77470 0.300
 PARTICLE SIZE RANGE (MICRONS)
 420-590
 EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID
 (W) (CM/S) (G/CM**3) FRACTION
 464.90 6.22 1.469 0.397
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS PARTICLE PARTICLE HEAT HEAT HEAT TRANSFER
 CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
 (W/MK) (W/MK) (HS/GK) (W/M**2) (W/M**2K)
 0.02938 1.1332 0.3612 35372.25 362.67
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES
 AXIAL WALL PARTICLE RADIATIVE CONVECTIVE RADIATIVE CONVECTIVE
 POSITION TEMPERATURE TEMPERATURE TEMPERATURE HEAT FLUX HEAT FLUX H T COEFF H T COEFF
 (CM) (C) (C) (C) (W/M**2) (W/M**2) (W/M**2K) (W/M**2K)
 0. 76.11 27.78 114.638 30776.09 2.372 636.747
 2.225 108.89 32.91 215.029 32021.35 2.630 421.475
 4.770 127.22 38.92 278.276 32708.48 3.151 370.405
 7.315 146.11 44.99 354.554 33403.60 3.506 330.343
 10.179 155.56 51.87 388.301 33754.90 3.745 325.537
 13.043 167.78 58.74 440.588 34200.25 4.041 313.663
 15.765 169.44 65.25 433.630 34275.01 4.162 328.960
 19.092 183.89 73.19 502.070 34793.62 4.535 314.306
 22.835 201.67 81.58 600.732 35415.99 5.003 294.826
 26.099 214.44 90.01 671.842 35862.25 5.399 288.198
 30.241 217.78 99.91 664.723 36004.18 5.640 305.472
 34.383 228.89 109.75 721.648 36396.24 6.057 305.497
 38.526 240.56 119.57 787.296 36801.36 6.507 304.185
 43.308 252.22 130.88 850.579 37208.16 7.010 306.642
 48.030 265.00 142.17 929.265 37643.53 7.565 306.467
 52.673 259.44 153.34 813.499 37535.89 7.667 353.759
 DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNITI WILLHITE KRUPICZKA SPECCHIA SPECCHIA
 KUNITI SMITH KUNITI BALDI SICARDI SICARDI
 (1957) (1960) (1962) (1967) (1980) (1980)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2950 0.1848 0.2113 0.1781 0.3526 0.3507
 PSEUDOHOMOGENEOUS PECLET NUMBER
 2067.2 3300.6 2887.0 3425.4 1729.6 1738.9
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 9.523 15.204 13.299 15.780 7.968 8.011

TEST NUMBER CB-2-2
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 0.95250 0.77470 0.300
 PARTICLE SIZE RANGE (MICRONS)
 420-590

EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID
 (W) (CM/S) (G/CM**3) FRACTION
 460.40 9.22 1.469 0.397

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS PARTICLE PARTICLE HEAT HEAT TRANSFER
 CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
 (W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
 0.02796 1.0924 0.8340 35176.71 369.43

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES						
AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	73.89	27.78	108.200.	31276.21	2.346	678.279
2.225	103.33	31.30	197.376	32419.37	2.740	450.039
4.769	117.78	35.40	245.310	32974.42	2.978	400.304
7.314	133.33	39.56	304.491	33563.44	3.247	357.915
10.177	140.56	44.26	328.607	33839.86	3.412	351.414
13.041	150.56	48.97	368.454	34215.72	3.627	336.812
15.762	150.00	53.43	355.104	34205.98	3.677	354.211
19.067	161.67	58.07	405.022	34640.45	3.940	336.992
22.599	176.67	64.64	479.332	35137.91	4.279	314.094
26.091	188.33	70.43	539.406	35610.65	4.575	302.042
30.231	189.44	77.26	527.341	35660.66	4.701	317.954
34.371	198.89	84.06	572.885	36013.41	4.989	313.616
38.512	208.89	90.85	625.574	36373.48	5.300	308.153
43.291	219.44	98.69	682.663	36751.52	5.654	304.360
48.070	229.44	106.53	738.729	37107.16	6.010	301.905
52.850	223.89	114.30	650.974	36956.26	6.032	337.236

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII BALDI
 (1957) (1960) SMITH (1967) SICARDI
 (1962) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2824 0.1766 0.2021 0.1703 0.3370 0.3352
 PSEUDOHOMOGENEOUS PECELET NUMBER
 3100.5 4957.0 4331.3 5139.5 2597.8 2611.6
 AVERAGE EXPERIMENTAL NUSSLET NUMBER
 10.135 16.204 14.159 16.801 8.492 8.537

TEST NUMBER CB-2-1

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

0.95250 0.7720 0.300

PARTICLE SIZE RANGE (MICRONS)

420-590

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM**3)

457.40 12.26 1.469

VOID FRACTION

0.397

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT HEAT TRANSFER

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.02721 1.0707 0.8191 35020.25 371.15

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

POSITION WALL TEMPERATURE PARTICLE TEMPERATURE RADIATIVE CONVECTIVE RADIATIVE

(CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K)

0. 75.00 27.78 111.404 31576.46 2.359

2. 225 102.22 30.45 194.959 32641.55 2.716

4. 769 114.44 33.56 235.490 33115.53 2.912

7. 313 128.33 36.71 287.750 33647.04 3.141

10. 176 133.33 40.27 302.991 33841.72 3.256

13. 040 143.33 43.84 343.169 34221.01 3.449

15. 760 141.67 47.23 327.425 34160.98 3.467

19. 085 152.22 51.56 371.661 34564.95 3.685

22. 586 165.56 55.74 435.037 35059.47 3.962

26. 088 175.56 60.15 484.056 35428.29 4.194

30. 227 178.33 65.34 470.537 35441.91 4.269

34. 366 183.33 70.82 505.972 35731.00 4.485

38. 505 191.67 75.69 547.169 36037.28 4.718

43. 283 200.56 81.67 592.388 36362.30 4.983

48. 060 208.89 87.65 636.049 36865.38 5.246

62. 839 203.89 93.64 579.570 36514.86 5.245

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAOI KUNII WILLHITE KRUPICZKA SPECCHIA

KUNII SMITH KUNII (1967) BALDI

(1957) (1960) (1962) SICCARDI

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2756 0.1723 0.1973 0.1662 0.3287 0.3269

PSEUDOHOMOGENEOUS PECLET NUMBER

4147.8 6636.4 5795.1 6876.8 3478.1 3496.4

AVERAGE EXPERIMENTAL NUSSELT NUMBER

10.433 16.692 14.576 17.297 8.748 8.794

TEST NUMBER CB-1-4
EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

0.95250 0.77470 0.300

PARTICLE SIZE RANGE (MICRONS)

420-590

EXPERIMENTAL VARIABLES

POWER (W) VELOCITY (CM/S) DENSITY (G/CM**3)

375.70 2.96 1.469

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT

(W/MK) (W/MK) (WS/GK)

0.03197 1.2086 0.9082

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER

POSITION (CM) WALL TEMPERATURE (C) PARTICLE TEMPERATURE (C)

0. 77.78 25.56

2.228 120.56 33.74

4.771 148.33 43.35

7.317 173.89 53.10

10.182 190.00 64.14

13.049 208.89 75.19

15.773 217.22 85.66

18.103 237.78 98.44

22.609 263.89 111.98

26.118 286.11 125.56

30.265 297.78 141.60

34.414 315.00 157.55

38.564 332.78 173.47

43.954 351.11 191.82

48.145 371.67 210.17

52.937 356.67 228.25

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNITI WILLHITE KRUPICZKA SPECCHIA

KUNITI SMITH KUNITI BALDI

(1957) (1960) SMITH (1962) SICARDI

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.3183 0.1938 0.2280 0.1922 0.3813 0.3792

PSEUDOHOMOGENEOUS PECLET NUMBER

962.3 1533.1 1343.4 1593.6 803.4 807.8

AVERAGE EXPERIMENTAL NUSSELT NUMBER

5.633 8.976 7.864 9.329 4.703 4.729

VOID FRACTION

0.397

HEAT TRANSFER DATA

HEAT FLUX

(W/M**2)

27847.21

HEAT TRANSFER COEFFICIENT

(W/M**2K)

231.44

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER

POSITION (CM) WALL TEMPERATURE (C) PARTICLE TEMPERATURE (C)

0. 77.78 25.56

2.228 120.56 33.74

4.771 148.33 43.35

7.317 173.89 53.10

10.182 190.00 64.14

13.049 208.89 75.19

15.773 217.22 85.66

18.103 237.78 98.44

22.609 263.89 111.98

26.118 286.11 125.56

30.265 297.78 141.60

34.414 315.00 157.55

38.564 332.78 173.47

43.954 351.11 191.82

48.145 371.67 210.17

52.937 356.67 228.25

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNITI WILLHITE KRUPICZKA SPECCHIA

KUNITI SMITH KUNITI BALDI

(1957) (1960) SMITH (1962) SICARDI

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.3183 0.1938 0.2280 0.1922 0.3813 0.3792

PSEUDOHOMOGENEOUS PECLET NUMBER

962.3 1533.1 1343.4 1593.6 803.4 807.8

AVERAGE EXPERIMENTAL NUSSELT NUMBER

5.633 8.976 7.864 9.329 4.703 4.729

HEAT TRANSFER

COEFFICIENT

(W/M**2K)

231.44

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER

POSITION (CM) WALL TEMPERATURE (C) PARTICLE TEMPERATURE (C)

0. 77.78 25.56

2.228 120.56 33.74

4.771 148.33 43.35

7.317 173.89 53.10

10.182 190.00 64.14

13.049 208.89 75.19

15.773 217.22 85.66

18.103 237.78 98.44

22.609 263.89 111.98

26.118 286.11 125.56

30.265 297.78 141.60

34.414 315.00 157.55

38.564 332.78 173.47

43.954 351.11 191.82

48.145 371.67 210.17

52.937 356.67 228.25

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNITI WILLHITE KRUPICZKA SPECCHIA

KUNITI SMITH KUNITI BALDI

(1957) (1960) SMITH (1962) SICARDI

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.3183 0.1938 0.2280 0.1922 0.3813 0.3792

PSEUDOHOMOGENEOUS PECLET NUMBER

962.3 1533.1 1343.4 1593.6 803.4 807.8

AVERAGE EXPERIMENTAL NUSSELT NUMBER

5.633 8.976 7.864 9.329 4.703 4.729

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNITI WILLHITE KRUPICZKA SPECCHIA

KUNITI SMITH KUNITI BALDI

(1957) (1960) SMITH (1962) SICARDI

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.3183 0.1938 0.2280 0.1922 0.3813 0.3792

PSEUDOHOMOGENEOUS PECLET NUMBER

962.3 1533.1 1343.4 1593.6 803.4 807.8

AVERAGE EXPERIMENTAL NUSSELT NUMBER

5.633 8.976 7.864 9.329 4.703 4.729

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNITI WILLHITE KRUPICZKA SPECCHIA

KUNITI SMITH KUNITI BALDI

(1957) (1960) SMITH (1962) SICARDI

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.3183 0.1938 0.2280 0.1922 0.3813 0.3792

PSEUDOHOMOGENEOUS PECLET NUMBER

962.3 1533.1 1343.4 1593.6 803.4 807.8

AVERAGE EXPERIMENTAL NUSSELT NUMBER

5.633 8.976 7.864 9.329 4.703 4.729

CONVECTIVE

H T COEFF

(W/M**2K)

442.554

279.793

238.451

212.715

207.432

198.772

203.666

195.806

183.402

176.512

183.248

184.109

184.256

186.624

186.466

234.254

TEST NUMBER CB-1-3
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 0.95250 0.77470 0.300
 PARTICLE SIZE RANGE (MICRONS)
 420-590
 EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID
 (W) (CM/S) (G/CM**3) FRACTION
 336.70 5.70 1.469 0.397
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS PARTICLE PARTICLE HEAT HEAT
 CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
 (W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
 0.02824 1.1002 0.8393 25721.10 340.33
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H.T. COEFF (W/M**2K)	CONVECTIVE H.T. COEFF (W/M**2K)
0.	61.11	23.89	80.643	22935.97	2.167	616.190
2.225	86.67	29.08	146.369	23669.66	2.499	404.044
4.768	101.11	32.97	186.045	24080.76	2.730	353.374
7.312	116.11	37.89	233.433	24500.68	2.984	313.241
10.174	123.33	43.46	251.694	24707.12	3.151	309.338
13.037	133.33	49.03	283.680	24905.94	3.365	296.391
15.757	138.00	54.31	278.997	25042.39	3.458	310.353
19.082	146.11	60.75	317.057	25349.16	3.714	296.948
22.582	160.56	67.54	376.117	25737.70	4.044	276.715
26.084	171.67	74.37	421.711	26035.88	4.334	267.587
30.222	173.99	82.40	411.294	26114.99	4.495	285.434
34.561	182.22	90.37	438.423	26345.32	4.773	286.826
38.501	192.22	98.33	478.313	26614.03	5.094	283.456
43.278	201.11	107.50	508.152	26858.18	5.428	286.902
48.056	211.22	116.54	536.552	27151.85	5.823	284.001
52.834	207.22	125.71	476.726	27074.80	5.885	332.141

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII BALDI
 (1957) (1960) (1962) (1967) (1980)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2848 0.782 0.2039 0.1718 0.3400 0.3382
 PSEUDOHOMOGENEOUS PECLET NUMBER
 1911.2 3054.8 2669.8 3167.9 1600.9 1609.5
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 9.257 14.796 12.931 15.344 7.754 7.796

TEST NUMBER CB-1-2

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

0.95250 0.77470 0.300

PARTICLE SIZE RANGE (MICRONS)

420-595

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM**3)

323.60 8.33 1.469

VOID FRACTION

0.397

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT HEAT

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.02700 1.0646 0.8148 24730.07 337.32

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL WALL PARTICLE RADIATIVE CONVECTIVE RADIATIVE CONVECTIVE

POSITION TEMPERATURE TEMPERATURE HEAT FLUX HEAT FLUX H T COEFF H T COEFF

(CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K) (W/M**2K)

0 58.89 23.33 75.999 22546.55 2.137

2.225 81.67 26.16 134.288 23193.07 2.419

4.767 92.78 29.44 163.862 23505.65 2.587

7.311 105.56 32.75 202.754 23859.68 2.783

10.173 110.56 36.49 214.281 24001.74 2.893

13.035 118.89 40.24 239.897 24231.91 3.050

15.754 118.89 43.80 232.256 24239.55 3.093

19.079 128.33 48.14 263.085 24498.30 3.281

22.577 141.11 52.73 311.954 24840.69 3.530

26.077 149.44 57.35 342.601 25064.81 3.721

30.214 150.00 62.78 331.758 25092.71 3.804

34.351 156.67 66.19 352.856 25275.29 3.988

38.489 164.44 73.60 381.323 25484.25 4.197

43.264 172.22 79.83 408.959 25693.00 4.426

48.039 181.11 86.06 445.203 25920.36 4.684

52.815 176.67 92.25 396.805 25841.40 4.700

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNITI WILLHITE KRUPICZKA SPECCHIA

KUNITI SMITH KUNITI (1967) BALDI

(1957) (1960) SMITH (1962) SICARDI

(1957) (1960) SMITH (1962) SICARDI (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2737 0.1710 0.1959 0.1651 0.3263

PSEUDOHOMOGENEOUS PECLET NUMBER

2821.6 4515.6 3942.4 4678.4 2366.6

AVERAGE EXPERIMENTAL NUSSELT NUMBER

9.547 15.279 13.340 15.830 8.008

TEST NUMBER CB-1-1
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 0.95250 0.77470 0.300
 PARTICLE SIZE RANGE (MICRONS)
 420-590
 EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID FRACTION
 (W) (CM/S) (G/CM**3) (CM**3)
 320.40 10.93 1.469 0.397
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS PARTICLE PARTICLE HEAT HEAT HEAT TRANSFER
 CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
 (W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
 0.02637 1.0466 0.8020 24607.79 345.99
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.224	55.56	22.78	68.738	22579.57	2.097	688.868
2.224	79.44	24.94	129.766	23260.02	2.381	426.741
4.767	88.89	27.45	154.726	23527.63	2.518	382.956
7.310	100.00	29.99	187.843	23838.30	2.683	340.467
10.172	103.33	32.85	194.341	23934.85	2.757	339.590
13.034	110.56	35.72	215.855	24136.47	2.884	322.525
15.753	108.89	38.44	203.858	24096.99	2.894	342.044
19.076	117.22	41.76	229.321	24328.30	3.045	322.383
22.574	120.33	45.27	269.525	24631.23	3.245	296.543
26.074	137.22	48.81	302.392	24872.14	3.420	281.312
30.210	136.67	52.98	290.019	24867.41	3.465	297.141
34.346	141.67	57.13	304.016	25007.30	3.596	295.808
38.482	143.33	61.28	327.033	25189.31	3.757	289.344
43.256	154.44	66.06	346.588	25357.56	3.922	286.913
48.030	161.67	70.85	373.258	25552.66	4.110	281.366
52.804	157.22	75.61	334.978	25454.49	4.104	311.879

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII BALDI
 (1957) (1960) SMITH SICARDI
 (1962) (1980)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2681 0.1674 0.1918 0.1616 0.3194 0.3177
 PSEUDOHOMOGENEOUS PECLET NUMBER
 9720.0 5957.3 5198.3 6169.0 3122.4 3138.7
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 9.999 16.013 13.973 16.582 8.393 8.437

TEST NUMBER CA-3-3				LOCAL NUSSELT NUMBER PROFILES				YAGI AND KUNITI (1957)				KUNITI AND SMITH (1960)				THEORETICAL PARABOLIC			
LOCAL NUSSELT NUMBER PROFILES				YAGI AND KUNITI (1957)				KUNITI AND SMITH (1960)				THEORETICAL PARABOLIC				THEORETICAL PARABOLIC			
POSITION	FLAT	EXPERIMENTAL	THEORETICAL	POSITION	FLAT	EXPERIMENTAL	THEORETICAL	POSITION	FLAT	EXPERIMENTAL	THEORETICAL	POSITION	FLAT	EXPERIMENTAL	THEORETICAL	POSITION	FLAT	EXPERIMENTAL	THEORETICAL
0.00115	23.588	14.778	204.815	0.00115	23.588	14.778	204.815	0.00072	37.662	19.257	204.815	0.00072	37.662	19.257	204.815	0.00072	37.662	19.257	204.815
0.00249	10.934	10.934	10.934	0.00249	10.934	10.934	10.934	0.00336	18.265	18.265	18.265	0.00336	18.265	18.265	18.265	0.00336	18.265	18.265	18.265
0.00524	9.934	9.934	9.934	0.00524	9.934	9.934	9.934	0.00480	15.064	15.064	15.064	0.00480	15.064	15.064	15.064	0.00480	15.064	15.064	15.064
0.00671	9.934	9.934	9.934	0.00671	9.934	9.934	9.934	0.00598	13.772	13.772	13.772	0.00598	13.772	13.772	13.772	0.00598	13.772	13.772	13.772
0.00811	8.812	8.812	8.812	0.00811	8.812	8.812	8.812	0.00727	13.431	13.431	13.431	0.00727	13.431	13.431	13.431	0.00727	13.431	13.431	13.431
0.01141	8.777	8.777	8.777	0.01141	8.777	8.777	8.777	0.00923	13.972	13.972	13.972	0.00923	13.972	13.972	13.972	0.00923	13.972	13.972	13.972
0.01553	8.777	8.777	8.777	0.01553	8.777	8.777	8.777	0.01166	14.019	14.019	14.019	0.01166	14.019	14.019	14.019	0.01166	14.019	14.019	14.019
0.01765	8.777	8.777	8.777	0.01765	8.777	8.777	8.777	0.01381	13.880	13.880	13.880	0.01381	13.880	13.880	13.880	0.01381	13.880	13.880	13.880
0.02222	8.523	8.523	8.523	0.02222	8.523	8.523	8.523	0.01544	13.609	13.609	13.609	0.01544	13.609	13.609	13.609	0.01544	13.609	13.609	13.609
0.02465	9.104	9.104	9.104	0.02465	9.104	9.104	9.104	0.01698	14.536	14.536	14.536	0.01698	14.536	14.536	14.536	0.01698	14.536	14.536	14.536
0.02710	32.943	20.080	204.815	0.02710	32.943	20.080	204.815	0.01698	14.536	14.536	14.536	0.01698	14.536	14.536	14.536	0.01698	14.536	14.536	14.536
0.00082	20.080	16.573	204.815	0.00082	20.080	16.573	204.815	0.00082	39.087	23.025	204.815	0.00082	39.087	23.025	204.815	0.00082	39.087	23.025	204.815
0.00176	13.176	13.176	13.176	0.00176	13.176	13.176	13.176	0.00148	19.664	19.664	19.664	0.00148	19.664	19.664	19.664	0.00148	19.664	19.664	19.664
0.00270	13.176	13.176	13.176	0.00270	13.176	13.176	13.176	0.00267	18.484	18.484	18.484	0.00267	18.484	18.484	18.484	0.00267	18.484	18.484	18.484
0.00481	13.176	13.176	13.176	0.00481	13.176	13.176	13.176	0.00405	19.634	19.634	19.634	0.00405	19.634	19.634	19.634	0.00405	19.634	19.634	19.634
0.00581	13.176	13.176	13.176	0.00581	13.176	13.176	13.176	0.00490	19.217	19.217	19.217	0.00490	19.217	19.217	19.217	0.00490	19.217	19.217	19.217
0.00703	13.176	13.176	13.176	0.00703	13.176	13.176	13.176	0.00593	19.458	19.458	19.458	0.00593	19.458	19.458	19.458	0.00593	19.458	19.458	19.458
0.00832	13.176	13.176	13.176	0.00832	13.176	13.176	13.176	0.00701	14.638	14.638	14.638	0.00701	14.638	14.638	14.638	0.00701	14.638	14.638	14.638
0.01124	13.176	13.176	13.176	0.01124	13.176	13.176	13.176	0.00937	14.500	14.500	14.500	0.00937	14.500	14.500	14.500	0.00937	14.500	14.500	14.500
0.01264	13.176	13.176	13.176	0.01264	13.176	13.176	13.176	0.01133	14.544	14.544	14.544	0.01133	14.544	14.544	14.544	0.01133	14.544	14.544	14.544
0.01416	13.176	13.176	13.176	0.01416	13.176	13.176	13.176	0.01381	14.226	14.226	14.226	0.01381	14.226	14.226	14.226	0.01381	14.226	14.226	14.226
0.01765	13.176	13.176	13.176	0.01765	13.176	13.176	13.176	0.01636	14.124	14.124	14.124	0.01636	14.124	14.124	14.124	0.01636	14.124	14.124	14.124
0.01941	13.176	13.176	13.176	0.01941	13.176	13.176	13.176	0.01636	15.066	15.066	15.066	0.01636	15.066	15.066	15.066	0.01636	15.066	15.066	15.066
SPECCHIA, BALDI AND SICARDI (1980)				SPECCHIA, BALDI AND SICARDI (1980)				SPECCHIA, BALDI AND SICARDI (1980)				SPECCHIA, BALDI AND SICARDI (1980)				SPECCHIA, BALDI AND SICARDI (1980)			
POSITION	FLAT	EXPERIMENTAL	THEORETICAL	POSITION	FLAT	EXPERIMENTAL	THEORETICAL	POSITION	FLAT	EXPERIMENTAL	THEORETICAL	POSITION	FLAT	EXPERIMENTAL	THEORETICAL	POSITION	FLAT	EXPERIMENTAL	THEORETICAL
0.00137	19.736	12.736	204.815	0.00137	19.736	12.736	204.815	0.00136	19.843	12.843	204.815	0.00136	19.843	12.843	204.815	0.00136	19.843	12.843	204.815
0.00294	9.934	9.934	9.934	0.00294	9.934	9.934	9.934	0.00228	19.292	19.292	19.292	0.00228	19.292	19.292	19.292	0.00228	19.292	19.292	19.292
0.00526	9.934	9.934	9.934	0.00526	9.934	9.934	9.934	0.00423	19.374	19.374	19.374	0.00423	19.374	19.374	19.374	0.00423	19.374	19.374	19.374
0.00802	9.934	9.934	9.934	0.00802	9.934	9.934	9.934	0.00684	19.346	19.346	19.346	0.00684	19.346	19.346	19.346	0.00684	19.346	19.346	19.346
0.00970	9.934	9.934	9.934	0.00970	9.934	9.934	9.934	0.00934	19.232	19.232	19.232	0.00934	19.232	19.232	19.232	0.00934	19.232	19.232	19.232
0.01344	7.736	7.736	7.736	0.01344	7.736	7.736	7.736	0.01177	19.347	19.347	19.347	0.01177	19.347	19.347	19.347	0.01177	19.347	19.347	19.347
0.01602	7.736	7.736	7.736	0.01602	7.736	7.736	7.736	0.01344	19.374	19.374	19.374	0.01344	19.374	19.374	19.374	0.01344	19.374	19.374	19.374
0.01856	7.736	7.736	7.736	0.01856	7.736	7.736	7.736	0.02098	19.361	19.361	19.361	0.02098	19.361	19.361	19.361	0.02098	19.361	19.361	19.361
0.02110	7.736	7.736	7.736	0.02110	7.736	7.736	7.736	0.02350	19.361	19.361	19.361	0.02350	19.361	19.361	19.361	0.02350	19.361	19.361	19.361
0.02357	7.736	7.736	7.736	0.02357	7.736	7.736	7.736	0.02632	19.361	19.361	19.361	0.02632	19.361	19.361	19.361	0.02632	19.361	19.361	19.361
0.03239	7.736	7.736	7.736	0.03239	7.736	7.736	7.736	0.03232	19.361	19.361	19.361	0.03232	19.361	19.361	19.361	0.03232	19.361	19.361	19.361

TEST NUMBER CA-3-3

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) 1.71 EMISSIVITY

0.95250 0.77470 0.300

PARTICLE SIZE RANGE (MICRONS)

177-250

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY VOID

(W) (CM/S) (G/CM**3) FRACTION

570.90 7.58 1.455 0.397

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.02938 1.1332 0.8612 43424.39 421.64

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL WALL PARTICLE RADIATIVE CONVECTIVE RADIATIVE

POSITION TEMPERATURE TEMPERATURE TEMPERATURE TEMPERATURE H T COEFF

(CM) (C) (C) (C) (W/M**2) (W/M**2) (W/M**2K)

0. 67.78 26.67 93.188 36901.07 2.267

2.225 102.22 31.78 192.380 38515.88 2.731

4.769 125.56 37.79 273.320 39592.08 3.114

7.314 148.89 43.90 371.149 40648.17 3.535

10.178 160.00 50.84 415.122 41132.54 3.803

13.043 174.44 57.81 483.080 41796.33 4.142

15.765 177.22 64.40 483.426 41932.72 4.285

19.093 192.73 72.46 504.154 42616.82 4.689

22.597 213.89 80.99 699.984 43520.65 5.237

26.101 227.78 89.58 783.844 44112.67 5.672

30.244 233.33 99.69 798.069 44370.07 5.972

34.388 244.44 109.74 853.303 44847.51 6.409

38.532 259.44 119.78 972.245 45469.99 6.961

43.315 271.11 131.36 1046.934 45963.23 7.492

48.100 287.22 142.93 1178.541 46614.52 8.168

52.885 290.00 154.45 1152.996 46774.89 8.506

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE SPECCHIA

KUNII SMITH KUNII (1967) BALDI

(1957) (1960) SMITH (1962) SICARDI

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2950 0.1848 0.2113 0.1780 0.3526 0.3507

PSEUDOHOMOGENEOUS PECLET NUMBER

2494.6 3983.1 3484.0 4133.8 2037.3 2098.5

AVERAGE EXPERIMENTAL NUSSELT NUMBER

11.071 17.677 15.462 18.346 9.263 9.313

TEST NUMBER CA-3-2
EXPERIMENTAL DATA
TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY
0.95250 0.77470 0.300
PARTICLE SIZE RANGE (MICRONS)
177-250

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY VOID
(W) (CM/S) (G/CM**3) FRACTION
555.96 10.13 1.455 0.397

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER
CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
0.02817 1.0984 0.8981 42444.86 440.98

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	63.89	26.11	83.812	36301.66	2.219	975.809
2.225	92.78	29.93	162.922	38268.46	2.592	608.923
4.768	113.33	34.41	229.385	39227.83	2.906	497.024
7.312	106.11	38.88	192.412	38904.66	2.862	578.703
10.174	115.56	43.88	218.461	39349.50	3.046	548.994
13.038	156.11	48.99	398.004	41186.01	3.715	384.477
15.759	156.67	53.92	389.444	41222.11	3.790	401.209
19.085	171.11	59.95	457.304	41869.78	4.115	376.653
22.587	190.00	66.35	561.890	42699.19	4.544	345.312
26.090	202.78	72.39	634.948	43256.68	4.885	332.776
30.231	205.56	80.39	633.344	43395.18	5.060	346.694
34.373	215.56	87.94	687.452	43833.72	5.387	343.491
38.515	228.33	95.51	768.753	44380.96	5.788	334.123
43.295	239.34	104.24	837.123	44858.36	6.191	331.776
48.077	252.78	112.97	931.988	45417.38	6.666	324.667
52.859	257.78	121.69	947.032	45647.27	6.959	335.424

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI	KUNII	WILLHITE	KRUPICZKA	SPECCHIA
KUNII	SMITH	KUNII	BALDI	SICARDI
(1957)	(1960)	SMITH	(1967)	(1980)
		(1962)		

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2842 0.1778 0.2035 0.1715 0.3393 0.3375

PSEUDOHOMOGENEOUS PECLET NUMBER

3368.0 5383.6 4704.8 5582.7 2821.3 2836.4

AVERAGE EXPERIMENTAL NUSSELT NUMBER

12.019 19.213 16.790 19.923 10.068 10.122

TEST NUMBER CA-3-1
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 0.95250 0.77470 0.300
 PARTICLE SIZE RANGE (MICRONS)
 177-250
 EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID
 (W) (CM/S) (G/CM**3) FRACTION
 542.84 11.75 1.455 0.397
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS PARTICLE PARTICLE HEAT HEAT TRANSFER
 CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
 (W/MK) (W/MK) (WS/OK) (W/M**2) (W/M**2K)
 0.02758 1.0814 0.8265 41544.88 454.80
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES
 AXIAL POSITION WALL TEMPERATURE PARTICLE TEMPERATURE RADIATIVE HEAT FLUX CONVECTIVE HEAT FLUX RADIATIVE H T COEFF CONVECTIVE H T COEFF
 (CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K) (W/M**2K)
 0. 60.56 25.00 77.212 36420.47 2.172 1024.326
 2.225 88.33 28.25 151.411 37725.10 2.520 627.959
 4.758 106.11 32.07 206.181 38550.44 2.784 520.874
 7.312 125.00 35.35 274.872 39414.99 3.084 442.605
 10.175 133.33 40.35 302.826 39797.81 3.257 428.005
 13.038 144.44 44.77 346.669 40301.30 3.478 404.315
 15.759 149.89 48.96 334.469 40286.15 3.523 424.368
 19.084 155.00 54.07 380.056 40707.20 3.765 404.109
 22.586 174.44 59.60 478.837 41643.26 4.166 362.281
 26.088 186.11 64.97 539.360 42154.56 4.452 347.990
 30.227 187.78 71.43 532.879 42242.67 4.500 363.069
 34.367 196.67 77.85 575.857 42634.73 4.847 358.838
 38.508 208.33 84.29 642.468 43138.38 5.179 347.758
 43.287 218.33 91.72 697.517 43571.48 5.509 344.124
 48.066 231.11 99.16 700.259 44111.59 5.913 334.299
 52.847 236.11 106.59 797.824 44337.49 6.160 342.317
 DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII BALDI
 (1957) (1960) SMITH SICARDI
 (1980)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2789 0.1744 0.1997 0.1683 0.3310
 PSEUDOHOMOGENEOUS PECLET NUMBER
 3923.9 6275.8 5482.0 6505.0 3269.0 3306.5
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 12.631 20.202 17.646 20.939 10.587 10.643

TEST NUMBER CA-2-3

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

0.95250 0.77470 0.300

PARTICLE SIZE RANGE (MICRONS)

177-250

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM**3) VOID FRACTION

488.70 7.69 1.455 0.997

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/N**2) (W/M**2K)

0.02890 1.1193 0.8521 37347.81 477.72

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL WALL PARTICLE RADIATIVE CONVECTIVE RADIATIVE CONVECTIVE

POSITION TEMPERATURE TEMPERATURE TEMPERATURE TEMPERATURE H T COEFF H T COEFF

(CM) (C) (C) (C) (W/M**2) (W/N**2) (W/M**2K) (W/M**2K)

0. 56.11 29.44 57.829 32348.30 2.169

2.225 84.44 33.82 128.253 33534.83 2.533

4.768 104.44 38.94 186.094 34361.74 2.841

7.312 123.89 44.14 252.594 35153.41 3.167

10.175 133.89 50.04 283.921 35562.65 3.386

13.038 147.22 55.96 334.664 36098.51 3.667

15.759 149.44 61.58 331.978 36198.87 3.778

18.085 165.89 68.45 392.531 36772.57 4.113

22.586 180.56 75.73 473.135 37422.42 4.513

26.089 192.78 83.04 532.766 37897.50 4.855

30.229 196.11 91.64 528.483 38047.48 5.059

34.370 206.11 100.20 572.212 38440.47 5.403

38.511 218.33 108.76 636.578 38909.15 5.809

43.291 230.00 118.63 695.905 39357.08 6.249

48.072 242.78 128.50 769.710 39839.67 6.735

52.853 249.44 138.34 788.392 40110.51 7.096

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA

KUNII SMITH KUNII SMITH BALDI

(1957) (1960) (1962) (1967) (1980) SICARDI

(1957) (1960) (1962) (1967) (1980) SICARDI

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2907 0.1820 0.2082 0.1754 0.3473 0.3455

PSEUDOHOMOGENEOUS PECLET NUMBER

2541.4 4059.5 3549.6 4211.7 2127.3 2138.8

AVERAGE EXPERIMENTAL NUSSELT NUMBER

12.730 20.334 17.780 21.096 10.656 10.713

TEST NUMBER CA-2-2
EXPERIMENTAL DATA

TUBE CHARACTERISTICS
OD (CM) ID (CM) EMISSIVITY
0.95250 0.77470 0.300
PARTICLE SIZE RANGE (MICRONS)
177-250

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY VOID
(W) (CM/S) (G/CM**3) FRACTION
448.40 10.74 1.455 0.397

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER
CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
0.02750 1.0791 0.8249 34367.90 466.89

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES
AXIAL POSITION (CM) WALL TEMPERATURE (C) PARTICLE TEMPERATURE (C) RADIATIVE HEAT FLUX (W/M**2) CONVECTIVE HEAT FLUX (W/M**2) RADIATIVE H T COEFF (W/M**2K) CONVECTIVE H T COEFF (W/M**2K)

0.	52.78	27.78	52.927	30454.26	2.117	1218.170
2.224	76.67	30.73	110.655	31389.45	2.409	683.594
4.767	93.33	34.19	156.494	32051.66	2.646	541.888
7.311	110.56	37.69	211.828	32716.21	2.907	449.002
10.173	118.33	41.67	234.563	33018.10	3.060	430.697
13.035	129.44	45.67	273.602	33442.29	3.266	399.190
15.755	130.00	49.47	267.495	33471.54	3.322	415.625
19.080	141.67	54.11	311.377	33913.35	3.556	387.302
22.580	156.11	60.03	373.852	34431.27	3.851	354.883
26.061	166.11	63.99	417.355	34822.81	4.087	340.983
30.219	166.67	69.82	404.841	34858.37	4.180	359.938
34.358	176.11	75.63	445.316	35209.39	4.432	350.418
38.497	185.56	81.45	488.628	35557.12	4.694	341.560
43.273	195.00	88.18	532.021	35904.32	4.980	336.106
48.051	205.56	94.90	586.548	36285.80	5.301	327.930
52.829	215.00	101.64	636.140	36625.84	5.612	329.095

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI	KUNII	WILLHITE	KRUPICZKA	SPECCHIA
(1957)	(1960)	(1962)	(1967)	(1980)
	SMITH	SMITH	BALDI	SICARDI
				(1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2762	0.1740	0.1992	0.1678	0.3319	0.3302
PSEUDOHOMOGENEOUS	PECLET NUMBER				
3588.7	5740.2	5013.8	5949.5	3008.3	3024.3
AVERAGE EXPERIMENTAL	NUSSELT NUMBER				
13.000	20.793	18.162	21.551	10.897	10.955

TEST NUMBER CA-2-1

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

0.95250 0.77470 0.300

PARTICLE SIZE RANGE (MICRONS)

177-250

EXPERIMENTAL VARIABLES

POWER (W) VELOCITY (CM/S) DENSITY (G/CM³) VOID FRACTION

426.30 13.34 1.455 0.397

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER

CONDUCTIVITY (W/MK) CONDUCTIVITY (W/MK) SPECIFIC HEAT (WS/GK) FLUX (W/M²) COEFFICIENT (W/M²K)

0.02686 1.0607 0.8121 32753.64 491.47

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM) WALL TEMPERATURE (C) PARTICLE TEMPERATURE (C) RADIATIVE HEAT FLUX (W/M²) CONVECTIVE HEAT FLUX (W/M²) RADIATIVE H T COEFF (W/M²K) CONVECTIVE H T COEFF (W/M²K)

0. 50.00 27.22 47.445 29498.95 2.083 1295.076

2.224 70.56 29.53 95.473 30290.36 2.327 738.247

4.767 84.44 32.21 131.431 30820.46 2.516 590.008

7.310 99.44 34.93 176.188 31388.00 2.731 486.476

10.171 105.56 38.01 192.144 31618.37 2.845 468.125

13.033 115.00 41.11 222.202 31971.74 3.007 432.703

15.752 114.44 44.06 213.616 31957.79 3.035 434.014

19.076 125.00 47.65 249.555 32349.91 3.227 418.252

22.575 138.33 51.47 301.502 32837.90 3.471 378.057

26.075 147.22 55.32 336.237 33162.64 3.659 360.843

30.212 146.67 59.85 322.149 33154.27 3.711 381.897

34.349 154.44 64.37 351.098 33439.57 3.888 371.237

38.486 162.78 68.89 384.077 33742.05 4.101 359.401

45.261 171.57 74.13 422.407 34063.04 4.331 349.219

48.036 180.56 79.37 462.349 34381.12 4.569 339.778

52.813 189.44 84.62 504.909 34696.20 4.817 330.996

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA

KUNII SMITH KUNII (1967) BALDI

(1957) (1960) SMITH SICARDI

(1962) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2725 0.1702 0.1950 0.1643 0.3231

PSEUDOHOMOGENEOUS PECLET NUMBER 4481.7 7173.3 6262.1 7431.2 3759.5

AVERAGE EXPERIMENTAL NUSSELT NUMBER 13.973 22.365 19.524 23.169 11.721

11.703

TEST NUMBER CA-1-4

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) 1D (CM) EMISSIVITY

0.95250 0.77470 0.300

PARTICLE SIZE RANGE (MICRONS)

177-250

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM**3)

349.70 4.37 1.455

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY PARTICLE CONDUCTIVITY PARTICLE SPECIFIC HEAT HEAT FLUX HEAT TRANSFER COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.02972 1.1430 0.8676 26606.46 367.05

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION WALL TEMPERATURE PARTICLE TEMPERATURE RADIATIVE HEAT FLUX CONVECTIVE HEAT FLUX RADIATIVE H T COEFF CONVECTIVE H T COEFF

(CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K) (W/M**2K)

0. 54.44 27.78 56.919 2287.91 2.134 862.047

2.224 55.00 33.28 131.067 23879.09 2.534 461.733

4.768 105.00 39.72 186.527 24455.10 2.857 374.590

7.312 124.44 46.23 250.352 25002.90 3.201 319.686

10.175 136.11 53.62 285.870 25333.67 3.465 307.099

13.038 148.89 61.02 330.563 25689.87 3.762 292.349

15.759 151.67 68.02 326.526 25760.61 3.904 308.214

18.085 166.11 76.66 382.364 26178.72 4.270 292.326

22.587 182.78 85.59 457.497 26622.07 4.707 273.922

26.090 196.11 94.64 518.355 26976.03 5.109 265.863

30.230 200.56 105.29 512.377 27121.21 5.378 284.687

34.371 211.57 115.86 555.366 27423.87 5.797 266.250

38.513 223.33 126.41 605.607 27736.05 6.249 286.177

43.293 236.11 138.57 661.517 28076.47 6.782 287.835

48.074 248.89 150.70 721.101 28412.59 7.344 289.368

52.856 251.67 162.75 682.886 28536.94 7.078 320.958

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA

KUNII SMITH KUNII (1967) BALDI

(1957) (1960) SMITH (1962) SICARDI

(1957) (1960) (1962) (1960) (1930)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2981 0.1867 0.2134 0.1799 0.3564 0.3545

PSEUDOHOMOGENEOUS PECLET NUMBER 2373.0 1197.9 1204.4

AVERAGE EXPERIMENTAL NUSSELT NUMBER 9.539 15.227 13.322 15.806 7.979 8.022

TEST NUMBER CA-1-3 LOCAL NUSSELT NUMBER PROFILES VAGT AND KUNII (1957)				KUNII AND SMITH (1960)				THEORETICAL PARABOLIC			
POSITION	FLAT	THEORETICAL	EXPERIMENTAL	POSITION	FLAT	THEORETICAL	EXPERIMENTAL	FLAT	THEORETICAL	PARABOLIC	THEORETICAL
0.00125	29.186	204.815		0.00028	45.685	204.815		204.815	204.815	21.360	21.360
0.00268	15.501	27.517		0.00058	11.2950	27.517		27.517	27.517	13.362	13.362
0.00571	11.2324	19.287		0.00087	7.0052	19.287		19.287	19.287	8.305	8.305
0.00732	10.0294	14.267		0.00098	6.2022	14.267		14.267	14.267	7.696	7.696
0.00884	9.3675	12.357		0.00083	5.3566	12.357		12.357	12.357	6.952	6.952
0.01267	8.079	10.033		0.00092	4.681	10.033		10.033	10.033	6.254	6.254
0.01462	7.307	11.053		0.00915	3.917	11.053		11.053	11.053	5.548	5.548
0.01694	6.541	10.032		0.01060	3.065	10.032		10.032	10.032	4.856	4.856
0.01926	5.174	9.751		0.01204	2.41	9.751		9.751	9.751	4.152	4.152
0.02427	4.272	8.227		0.01358	1.74	8.227		8.227	8.227	3.450	3.450
0.02690	3.107	9.020		0.0188	0.906	9.020		9.020	9.020	2.700	2.700
0.02957	8.510	8.854		0.01850	4.827	8.854		8.854	8.854	2.000	2.000
WILCHITE, KUNII AND SMITH (1962)				KUPIEKA (1967)				THEORETICAL PARABOLIC			
POSITION	FLAT	THEORETICAL	EXPERIMENTAL	POSITION	FLAT	THEORETICAL	EXPERIMENTAL	FLAT	THEORETICAL	PARABOLIC	THEORETICAL
0.00090	40.773	204.815		0.00075	48.381	204.815		204.815	204.815	21.360	21.360
0.00192	21.655	32.142		0.00122	19.451	32.142		32.142	32.142	13.360	13.360
0.00304	16.392	22.850		0.00228	12.115	22.850		22.850	22.850	9.320	9.320
0.00524	14.028	16.507		0.00411	7.925	16.507		16.507	16.507	6.861	6.861
0.00533	12.983	15.044		0.00534	6.406	15.044		15.044	15.044	5.724	5.724
0.00766	12.516	14.000		0.00564	5.049	14.000		14.000	14.000	4.947	4.947
0.01047	12.589	13.046		0.00694	4.156	13.046		13.046	13.046	4.321	4.321
0.01213	11.265	11.733		0.01032	3.308	11.733		11.733	11.733	3.811	3.811
0.01378	11.381	10.738		0.01162	2.550	10.738		10.738	10.738	3.299	3.299
0.01544	11.326	10.362		0.01301	1.842	10.362		10.362	10.362	2.743	2.743
0.01925	11.326	9.700		0.01482	1.251	9.700		9.700	9.700	2.351	2.351
0.02117	11.608	9.520		0.01784	0.775	9.520		9.520	9.520	2.050	2.050
BALOI AND SICARDI (1980)				SPECCIA AND SICARDI (1980)				THEORETICAL PARABOLIC			
POSITION	FLAT	THEORETICAL	EXPERIMENTAL	POSITION	FLAT	THEORETICAL	EXPERIMENTAL	FLAT	THEORETICAL	PARABOLIC	THEORETICAL
0.00149	24.458	204.815		0.00149	24.585	204.815		204.815	204.815	21.360	21.360
0.00320	9.932	25.517		0.00318	9.804	25.517		25.517	25.517	13.360	13.360
0.00490	8.599	18.270		0.00493	8.615	18.270		18.270	18.270	9.320	9.320
0.00675	7.787	15.451		0.00668	7.429	15.451		15.451	15.451	7.551	7.551
0.00856	6.107	13.220		0.00860	6.150	13.220		13.220	13.220	6.366	6.366
0.01278	6.007	11.046		0.01060	5.048	11.046		11.046	11.046	5.777	5.777
0.01742	7.070	10.911		0.01271	4.067	10.911		10.911	10.911	5.144	5.144
0.02026	7.156	9.900		0.01504	3.194	9.900		9.900	9.900	4.593	4.593
0.02293	6.946	9.103		0.02066	2.665	9.103		9.103	9.103	4.050	4.050
0.02674	6.793	8.391		0.02677	2.386	8.391		8.391	8.391	3.549	3.549
0.03353	6.563	7.693		0.03351	2.050	7.693		7.693	7.693	3.057	3.057

TEST NUMBER CA-1-3
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 0.95250 0.77470 0.300
 PARTICLE SIZE RANGE (MICRONS)
 177-250
 EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID FRACTION
 (W) (CM/S) (G/CM**3) (0.397)
 338.00 6.88 1.455
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS CONDUCTIVITY PARTICLE CONDUCTIVITY PARTICLE SPECIFIC HEAT HEAT FLUX HEAT TRANSFER COEFFICIENT
 (W/MK) (W/MK) (WS/GK) (W/M**2) (W/H**2K)
 0.02791 1.0308 0.8329 25874.21 403.60
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.224	48.89	27.22	44.884	22997.60	2.072	1061.428
4.767	72.78	30.71	99.460	23704.96	2.364	563.499
7.310	91.67	34.78	149.700	24255.69	2.632	426.422
10.172	105.00	38.91	188.203	24640.59	2.848	372.861
13.034	111.67	43.58	203.662	24836.58	2.991	364.790
15.754	122.78	48.26	238.626	25153.67	3.202	337.557
19.078	124.44	52.70	235.434	25209.63	3.282	351.401
22.578	135.56	58.13	272.221	25524.35	3.516	329.671
26.078	148.89	63.67	323.148	25894.62	3.801	304.589
29.578	158.89	69.64	361.087	26172.13	4.046	293.252
33.078	161.11	76.43	394.135	26248.13	4.182	309.693
36.578	172.78	83.21	401.989	26568.73	4.488	295.627
40.078	178.89	89.98	418.330	26744.63	4.705	300.809
43.578	188.89	97.78	457.430	27019.85	5.021	296.558
47.078	198.43	105.57	495.216	27278.83	5.339	294.363
50.578	204.44	113.34	510.170	27455.26	5.600	301.375

 DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPLICCHIA SPECCHIA
 KUNII SMITH KUNII BALDI SICARDI
 (1957) (1960) (1962) (1967) (1980) (1980)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2819763 0.1700 0.3364 0.3346
 PSEUDOHOMOGENEOUS PECLET NUMBER
 2290.8 3662.7 3200.3 1919.5 1929.7
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 11.092 17.735 15.496 18.387 9.294 9.344

TEST NUMBER CA-1-2 VAGI AND KUNITI (1957)				KUNITI AND SMITH (1960)				THEORETICAL FLAT				THEORETICAL PARABOLIC			
N D	EXPERIMENTAL	THEORETICAL FLAT	THEORETICAL PARABOLIC	N D	EXPERIMENTAL	THEORETICAL FLAT	THEORETICAL PARABOLIC	POSITION	EXPERIMENTAL	THEORETICAL FLAT	THEORETICAL PARABOLIC	POSITION	EXPERIMENTAL	THEORETICAL FLAT	THEORETICAL PARABOLIC
0.00093	32.641	204.815	21.360	0.00058	52.332	204.815	21.360	0.00058	52.332	204.815	21.360	0.00058	52.332	204.815	21.360
0.00199	19.639	22.479	19.994	0.00154	18.479	22.479	19.994	0.00154	18.479	22.479	19.994	0.00154	18.479	22.479	19.994
0.00305	11.243	16.357	7.724	0.00265	17.991	17.991	19.868	0.00265	17.991	17.991	19.868	0.00265	17.991	17.991	19.868
0.00444	10.800	14.335	7.307	0.00340	16.910	16.910	17.910	0.00340	16.910	16.910	17.910	0.00340	16.910	16.910	17.910
0.00596	10.832	12.874	6.545	0.00497	16.073	16.073	16.073	0.00497	16.073	16.073	16.073	0.00497	16.073	16.073	16.073
0.00941	9.122	12.131	6.249	0.00686	14.561	14.561	14.561	0.00686	14.561	14.561	14.561	0.00686	14.561	14.561	14.561
0.01087	9.655	11.557	6.014	0.00779	13.850	13.850	13.850	0.00779	13.850	13.850	13.850	0.00779	13.850	13.850	13.850
0.01259	9.158	11.021	5.750	0.00877	14.555	14.555	14.555	0.00877	14.555	14.555	14.555	0.00877	14.555	14.555	14.555
0.01404	8.787	10.550	5.500	0.00962	14.061	14.061	14.061	0.00962	14.061	14.061	14.061	0.00962	14.061	14.061	14.061
0.01570	8.570	9.924	5.317	0.01126	13.714	13.714	13.714	0.01126	13.714	13.714	13.714	0.01126	13.714	13.714	13.714
0.02000	8.461	9.656	5.098	0.01250	13.539	13.539	13.539	0.01250	13.539	13.539	13.539	0.01250	13.539	13.539	13.539
0.02199	8.466	9.433	5.098	0.01374	13.536	13.536	13.536	0.01374	13.536	13.536	13.536	0.01374	13.536	13.536	13.536
N D	EXPERIMENTAL	THEORETICAL FLAT	THEORETICAL PARABOLIC	KUNITI AND SMITH (1960) EXPERIMENTAL	THEORETICAL FLAT	THEORETICAL PARABOLIC	POSITION	EXPERIMENTAL	THEORETICAL FLAT	THEORETICAL PARABOLIC	POSITION	EXPERIMENTAL	THEORETICAL FLAT	THEORETICAL PARABOLIC	POSITION
0.00087	48.507	204.815	21.360	54.120	204.815	21.360	0.00056	54.120	204.815	21.360	0.00056	54.120	204.815	21.360	0.00056
0.00174	25.773	36.058	19.985	30.504	36.058	19.985	0.00154	30.504	36.058	19.985	0.00154	30.504	36.058	19.985	0.00154
0.00309	15.155	23.593	9.702	19.641	23.593	9.702	0.00256	19.641	23.593	9.702	0.00256	19.641	23.593	9.702	0.00256
0.00394	14.503	16.764	9.087	17.210	16.764	9.087	0.00329	17.210	16.764	9.087	0.00329	17.210	16.764	9.087	0.00329
0.00571	13.134	13.572	7.889	17.359	13.572	7.889	0.00397	17.359	13.572	7.889	0.00397	17.359	13.572	7.889	0.00397
0.00678	12.732	13.678	6.597	15.008	13.678	6.597	0.00558	15.008	13.678	6.597	0.00558	15.008	13.678	6.597	0.00558
0.00901	12.033	12.975	6.323	14.350	12.975	6.323	0.00660	14.350	12.975	6.323	0.00660	14.350	12.975	6.323	0.00660
0.00951	12.788	12.315	6.236	15.164	12.315	6.236	0.00760	15.164	12.315	6.236	0.00760	15.164	12.315	6.236	0.00760
0.01148	12.377	11.353	5.926	14.259	11.353	5.926	0.00867	14.259	11.353	5.926	0.00867	14.259	11.353	5.926	0.00867
0.01290	11.942	11.353	5.756	14.029	11.353	5.756	0.00967	14.029	11.353	5.756	0.00967	14.029	11.353	5.756	0.00967
0.01432	11.882	10.595	5.484	14.029	10.595	5.484	0.01026	14.029	10.595	5.484	0.01026	14.029	10.595	5.484	0.01026
0.0174	11.871	10.005	5.484	14.029	10.005	5.484	0.01326	14.029	10.005	5.484	0.01326	14.029	10.005	5.484	0.01326
SECTION A, BALDWIN SICARDI (1960)				SECTION A AND EXPERIMENTAL			POSITION	EXPERIMENTAL				POSITION	EXPERIMENTAL		
0.00111	27.375	204.815	21.360	27.519	204.815	21.360	0.00110	27.519	204.815	21.360	0.00110	27.519	204.815	21.360	0.00110
0.00237	19.639	22.479	19.994	19.639	22.479	19.994	0.00302	19.639	22.479	19.994	0.00302	19.639	22.479	19.994	0.00302
0.00564	9.493	17.525	7.465	9.493	17.525	7.465	0.00504	9.493	17.525	7.465	0.00504	9.493	17.525	7.465	0.00504
0.00506	9.705	13.673	6.935	9.705	13.673	6.935	0.00645	9.705	13.673	6.935	0.00645	9.705	13.673	6.935	0.00645
0.00649	9.477	12.030	6.236	9.477	12.030	6.236	0.00640	9.477	12.030	6.236	0.00640	9.477	12.030	6.236	0.00640
0.00649	9.705	11.439	5.756	9.705	11.439	5.756	0.01117	9.705	11.439	5.756	0.01117	9.705	11.439	5.756	0.01117
0.01233	7.728	11.046	5.484	7.728	11.046	5.484	0.01289	7.728	11.046	5.484	0.01289	7.728	11.046	5.484	0.01289
0.01502	7.681	10.476	5.317	7.681	10.476	5.317	0.01694	7.681	10.476	5.317	0.01694	7.681	10.476	5.317	0.01694
0.01707	7.137	9.761	5.098	7.137	9.761	5.098	0.01694	7.137	9.761	5.098	0.01694	7.137	9.761	5.098	0.01694
0.0149	7.137	9.486	5.098	7.137	9.486	5.098	0.02137	7.137	9.486	5.098	0.02137	7.137	9.486	5.098	0.02137
0.02622	7.137	9.068	5.098	7.137	9.068	5.098	0.02608	7.137	9.068	5.098	0.02608	7.137	9.068	5.098	0.02608

TEST NUMBER CA-1-2

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

0.99250 0.77470 0.300

PARTICLE SIZE RANGE (MICRONS)

177-250

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY VOID

(W) (CM/S) (G/CM**3) FRACTION

334.11 9.19 0.455 0.397

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.02710 1.0674 0.8168 25644.06 434.11

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION WALL TEMPERATURE PARTICLE TEMPERATURE RADIATIVE HEAT FLUX CONVECTIVE HEAT FLUX RADIATIVE H T COEFF

(CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K)

0. 46.67 26.67 40.872 23128.18 2.044

2.224 65.56 29.29 82.291 23694.75 2.269

4.766 81.67 32.34 122.559 24171.99 2.484

7.309 95.56 35.43 161.578 24578.33 2.687

10.171 101.11 38.93 173.948 24743.89 2.798

13.032 110.56 42.45 201.798 25018.27 2.963

15.751 111.11 45.78 196.640 25041.19 3.010

19.075 121.11 49.86 227.886 25329.56 3.199

22.574 133.89 54.19 274.127 25691.15 3.439

26.073 143.33 58.54 308.731 25957.59 3.641

30.210 143.89 63.66 298.345 25985.67 3.719

34.346 151.11 68.77 321.562 26192.42 3.905

38.484 158.89 73.80 349.149 26412.26 4.107

43.258 167.78 79.78 382.554 26661.35 4.347

48.033 175.56 85.68 411.304 26879.53 4.576

52.809 181.67 91.57 430.836 27053.85 4.782

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA

KUNII SMITH KUNII BALDI

(1957) (1960) SMITH SICARDI

(1962) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2746 0.1716 0.1965 D.1656 0.3274 0.3257

PSEUDOHOMOGENEOUS PECLET NUMBER

3082.9 4933.2 4307.4 5111.5 2585.4 2599.1

AVERAGE EXPERIMENTAL NUSSELT NUMBER

12.248 19.599 17.113 20.307 10.271 10.326

TEST NUMBER CA-1-1

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

0.95250 0.77470 0.300

PARTICLE SIZE RANGE (MICRONS)

177-250

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY VOID

(W) (CM/S) (G/CM**3) FRACTION

336.70 11.64 1.455 0.397

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.02651 1.0508 0.8051 25897.71 436.32

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL WALL PARTICLE RADIATIVE CONVECTIVE RADIATIVE CONVECTIVE

POSITION TEMPERATURE TEMPERATURE HEAT FLUX HEAT FLUX H T COEFF H T COEFF

(CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K) (W/M**2K)

0. 45.00 25.00 40.216 23632.43 2.011

2.224 66.67 27.13 89.327 24297.55 2.259

4.766 78.33 29.60 117.758 24652.05 2.416

7.309 88.33 32.10 144.048 24955.25 2.562

10.170 92.78 34.93 153.140 25092.07 2.647

13.031 100.56 37.76 174.392 25325.99 2.777

15.750 100.00 40.44 166.787 25315.38 2.801

19.072 109.44 43.73 194.715 25597.00 2.983

22.571 120.56 47.21 231.608 25923.84 3.158

26.069 128.33 50.72 257.145 26152.63 3.313

30.205 128.89 54.85 249.796 26178.13 3.374

34.340 135.56 58.97 270.125 26375.60 3.527

38.476 145.00 63.10 305.377 26648.50 3.729

43.249 149.44 67.87 315.331 26783.56 3.866

48.023 156.67 72.64 340.483 26993.76 4.052

52.797 162.78 77.40 360.715 27172.51 4.225

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA

KUNII SMITH KUNII BALDI SICARDI

(1957) (1960) SMITH (1967) SICARDI (1980)

(1962) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2694 0.1682 0.1928 0.1625 0.3210 0.3193

PSEUDOHOMOGENEOUS PECLET NUMBER 3921.5 6278.9 5479.7 6502.8 3290.8 3308.1

AVERAGE EXPERIMENTAL NUSSELT NUMBER 12.620 20.206 17.634 20.926 10.590 10.646

TEST NUMBER AB-3-9
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 1.42875 1.37795 0.300
 PARTICLE SIZE RANGE (MICRONS)
 420-590
 EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID FRACTION
 (W) (CM/S) (G/CM**3) (G/CM**3)
 1017.45 3.70 1.469 0.390
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS CONDUCTIVITY PARTICLE CONDUCTIVITY PARTICLE SPECIFIC HEAT HEAT FLUX HEAT TRANSFER COEFFICIENT
 (W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
 0.03037 1.1618 0.8796 42107.99 308.22
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	57.22	32.78	54.121	33634.47	2.214	1375.956
3.179	125.56	40.42	267.810	38559.64	3.146	429.451
7.952	167.78	52.51	455.797	38298.36	3.954	332.255
12.728	206.11	64.92	631.521	39813.39	4.827	281.975
17.507	227.22	77.48	816.770	40633.30	5.454	271.354
22.288	255.56	90.13	1042.576	41685.47	6.302	251.985
27.072	285.56	102.92	1329.650	42746.59	7.280	234.056
31.858	304.44	115.80	1518.177	43404.29	8.048	230.084
36.645	313.33	128.62	1584.143	43735.83	8.576	235.782
41.433	342.78	141.47	1963.917	44669.58	9.756	221.902
46.224	350.00	154.35	2015.899	44939.01	10.303	229.687
51.015	372.78	167.21	2343.658	45622.96	11.401	221.931
54.210	365.56	175.73	2160.875	45485.49	11.363	239.623

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII (1967) BALDI
 (1957) (1960) SMITH (1962) SICARDI
 (1980)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.3130 0.1969 0.2219 0.1874 0.3759 0.3716
 PSEUDOHOMOGENEOUS PECLET NUMBER
 2107.3 3350.4 3350.4
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 13.570 21.575 19.138 22.665 11.300 11.420

TEST NUMBER AB-3-8

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42875 1.37795 0.300

PARTICLE SIZE RANGE (MICRONS)

420-590

EXPERIMENTAL VARIABLES

POWER (W) VELOCITY (CM/S) DENSITY (G/CM**3)

1002.15 4.97 1.469

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY (W/MK) PARTICLE CONDUCTIVITY (W/MK) PARTICLE SPECIFIC HEAT (WS/GK) HEAT FLUX (W/M**2) HEAT TRANSFER COEFFICIENT (W/M**2K)

0.02906 1.1240 0.8552 41804.45 334.83

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM) WALL TEMPERATURE (C) PARTICLE TEMPERATURE (C) RADIATIVE HEAT FLUX (W/M**2) CONVECTIVE HEAT FLUX (W/M**2) RADIATIVE H T COEFF (W/M**2K) CONVECTIVE H T COEFF (W/M**2K)

0.	50.56	32.22	39.199	34046.85	2.138	1857.101
3.178	114.44	37.99	226.529	36859.35	2.963	482.105
7.950	150.56	47.09	372.720	38308.69	3.602	371.137
12.725	185.33	56.43	542.878	39752.13	4.278	313.146
17.502	200.00	65.88	633.618	40433.77	4.724	301.481
22.280	226.11	75.41	813.301	41460.95	5.397	275.127
27.061	250.56	85.05	1008.859	42391.88	6.096	256.154
31.844	259.56	94.77	1131.430	42958.54	6.625	251.535
36.627	271.67	104.44	1163.781	43206.69	6.959	250.374
41.412	296.67	114.13	1423.977	44091.73	7.801	241.552
46.198	303.33	123.85	1469.974	44350.52	8.190	247.096
50.986	323.89	133.57	1711.994	45046.59	8.955	236.686
54.178	320.00	140.03	1625.100	44956.20	9.030	249.802

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI	KUNII	WILLHITE	KRUPICZKA	SPECCHIA	SPECCHIA
KUNII	SMITH	KUNII	(1967)	BALDI	SICARDI
(1957)	(1960)	SMITH	(1962)	SICARDI	(1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.3009 0.1891 0.2133 0.1801 0.3610 0.3569

PSEUDOHOMOGENEOUS PECLET NUMBER 2383.3 2410.4

AVERAGE EXPERIMENTAL NUSSELT NUMBER 15.331 24.404 21.627 25.615 12.781 12.926

TEST NUMBER AB-3-7

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42875 1.37795 0.300

PARTICLE SIZE RANGE (MICRONS)

420-590

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY VOID

(W) (CM/S) (G/CM**3) FRACTION

1015.25 6.20 1.469 0.390

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.02841 1.1053 0.8428 42511.88 358.94

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL WALL PARTICLE RADIATIVE CONVECTIVE RADIATIVE CONVECTIVE

POSITION TEMPERATURE TEMPERATURE HEAT FLUX HEAT FLUX H T COEFF H T COEFF

(CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K) (W/M**2K)

0.	45.00	32.78	25.502	34850.06	2.087	2853.823
3.178	108.33	37.51	203.648	37772.83	2.876	333.367
7.949	141.67	45.00	332.408	39251.13	3.439	406.031
12.723	171.67	52.67	478.616	40545.70	4.022	340.731
17.499	186.11	60.44	551.148	41165.13	4.386	327.567
22.275	209.44	68.28	697.936	42133.40	4.944	298.467
27.056	233.89	76.22	878.991	43117.06	5.575	273.472
31.837	247.22	84.23	978.902	43650.95	6.006	267.811
36.618	251.11	92.21	991.109	43823.41	6.237	275.790
41.401	275.00	100.21	1216.532	44730.34	6.960	255.908
46.186	280.00	108.23	1244.260	44939.19	7.244	261.631
50.971	300.00	116.27	1458.112	45670.12	7.936	246.573
54.162	298.89	121.63	1421.598	45654.21	8.020	237.556

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA

KUNII SMITH KUNII BALDI SPECCHIA

(1957) (1960) (1962) (1967) (1980) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2950 0.1852 0.2091 0.1765 0.3536 0.3497

PSEUDOHOMOGENEOUS PECLET NUMBER

3583.3 5707.5 5055.6 5987.8 2989.2 3023.1

AVERAGE EXPERIMENTAL NUSSELT NUMBER

16.766 26.706 23.655 28.018 13.907 14.145

TEST NUMBER AB-3-6
EXPERIMENTAL DATA
TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42875 1.37795 0.300

PARTICLE SIZE RANGE (MICRONS)

420-590

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM**3)

1007.50 7.61 1.469

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY PARTICLE CONDUCTIVITY PARTICLE SPECIFIC HEAT HEAT FLUX HEAT TRANSFER COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.02779 1.0874 0.8306 42332.61 387.10

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION WALL TEMPERATURE PARTICLE TEMPERATURE RADIATIVE HEAT FLUX CONVECTIVE HEAT FLUX RADIATIVE H T COEFF

(CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K)

0.	51.67	32.22	41.300	35655.89	2.150
3.178	101.11	36.14	179.704	37947.16	2.766
7.949	131.11	42.27	288.569	39305.41	3.248
12.721	158.33	48.55	411.185	40509.51	3.745
17.496	172.78	54.91	479.376	41142.91	4.072
22.272	194.44	61.34	505.807	42068.07	4.552
27.050	210.00	67.84	703.421	42723.26	4.948
31.829	227.22	74.39	825.797	43432.71	5.403
36.609	230.00	80.94	830.487	43562.01	5.571
41.390	252.22	87.51	1017.592	44445.19	6.178
46.172	253.89	94.09	1012.473	44530.46	6.336
50.955	271.11	100.68	1171.331	45198.05	6.873
54.144	265.56	105.06	1004.748	45008.78	6.821

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA

(1957) SMITH KUNII BALDI SICARDI

(1960) SMITH (1962) SICARDI (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2993 0.1815 0.2050 0.1731 0.3465 0.3426

PSEUDOHOMOGENEOUS PECLET NUMBER 4422.2 7048.2 6240.1 7391.0 3691.4 3733.2

AVERAGE EXPERIMENTAL NUSSELT NUMBER 18.440 29.391 26.021 30.820 15.393 15.567

TEST NUMBER AB-3-5
EXPERIMENTAL DATA
TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY
1.42875 1.37795 0.300
PARTICLE SIZE RANGE (MICRONS)
420-590

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY VOID
(W) (CM/S) (G/CM**3) FRACTION
997.75 9.06 1.469 0.390

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER
CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
0.02737 1.0751 0.8222 41990.62 393.49

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.178	48.89	32.22	35.348	35651.94	2.121	2139.116
7.948	99.44	35.51	175.008	38005.74	2.737	594.473
12.720	126.11	40.67	269.721	39220.29	3.157	459.012
17.494	150.56	45.94	375.312	40311.20	3.587	385.316
22.269	161.67	51.27	423.478	40805.73	3.836	369.635
27.046	181.11	56.55	527.916	41640.26	4.242	334.645
31.824	201.11	62.11	651.661	42438.21	4.688	305.736
36.603	212.22	67.61	721.388	42967.84	4.988	297.123
41.382	214.44	73.10	723.681	43073.33	5.120	304.789
46.163	235.56	78.61	806.323	43932.54	5.651	279.925
50.945	238.33	84.15	885.310	44056.48	5.807	285.748
54.133	255.00	89.69	1038.377	44720.43	6.261	270.527
	254.44	93.39	1020.434	44711.56	6.336	277.624

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
KUNII SMITH KUNII BALDI
(1957) (1960) SMITH (1967) SICARDI
(1962) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
0.2853 0.1790 0.2022 0.1707 0.3417 0.3379

PSEUDOHOMOGENEOUS PECLET NUMBER
5284.9 8426.6 7458.1 8833.9 4413.5 4463.4

AVERAGE EXPERIMENTAL NUSSELT NUMBER
19.003 30.300 25.817 31.763 15.869 16.049

[illegible]

TEST NUMBER AB-3-4

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42875 1.37795 0.300

PARTICLE SIZE RANGE (MICRONS)

420-590

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM**3)

998.40 10.26 1.469

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY PARTICLE CONDUCTIVITY PARTICLE SPECIFIC HEAT HEAT FLUX HEAT TRANSFER COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.02708 1.0669 0.8164 42080.51 408.01

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION WALL TEMPERATURE PARTICLE TEMPERATURE RADIATIVE HEAT FLUX CONVECTIVE HEAT FLUX RADIATIVE H T COEFF CONVECTIVE H T COEFF

(CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K) (W/M**2K)

0.	32.22	31.67	44.193	36185.73	2.150	1760.387
3.178	97.78	34.61	170.942	36323.29	2.706	606.786
7.948	122.78	39.20	250.414	39482.53	3.092	472.427
12.720	146.11	43.90	356.959	40538.09	3.492	396.616
17.493	155.56	48.65	399.770	40966.34	3.702	383.200
22.266	175.00	53.44	497.155	41823.61	4.050	344.061
27.044	190.56	58.29	586.577	42499.49	4.435	321.323
31.821	202.78	63.18	661.154	43025.19	4.736	308.205
36.599	204.44	68.06	660.521	43107.61	4.843	316.080
41.378	223.89	72.96	801.478	43919.59	5.310	291.005
46.157	224.44	77.08	791.875	43956.39	5.403	289.914
50.938	240.00	82.00	914.832	44594.01	5.820	263.680
54.125	237.78	86.09	884.092	44516.23	5.628	293.463

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA

KUNII SMITH KUNII BALDI

(1957) (1960) (1967) (1980)

SICARDI

(1962) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2827 0.1772 0.2003 0.1691 0.3346

PSEUDOHOMOGENEOUS PECLET NUMBER

5999.5 9569.1 10029.0 5011.7 5060.4

AVERAGE EXPERIMENTAL NUSSELT NUMBER

19.888 31.721 20.068 33.246 16.614 16.002

TEST NUMBER AB-3-3 LOCAL NUSSELL NUMBER (1957)	FLIGHT NUMBER	THEORETICAL FLAT	THEORETICAL PARABOLIC	KUNII AND SMITH EXPERIMENTAL POSITION	KUNII AND SMITH EXPERIMENTAL POSITION	THEORETICAL FLAT	THEORETICAL PARABOLIC	THEORETICAL FLAT	THEORETICAL PARABOLIC
000000	85.740	204.815	136.787	0.00021	136.787	204.815	136.787	204.815	136.787
000001	31.216	50.769	15.469	0.00021	50.769	50.769	15.469	50.769	15.469
000002	24.591	33.094	13.094	0.00053	33.094	33.094	13.094	33.094	13.094
000003	19.797	25.922	10.236	0.00116	25.922	25.922	10.236	25.922	10.236
000004	16.799	20.921	9.477	0.00179	20.921	20.921	9.477	20.921	9.477
000005	16.634	19.265	8.911	0.00242	19.265	19.265	8.911	19.265	8.911
000006	16.397	18.089	8.108	0.00305	18.089	18.089	8.108	18.089	8.108
000007	14.988	16.182	7.610	0.00368	16.182	16.182	7.610	16.182	7.610
000008	14.495	15.495	7.555	0.00431	15.495	15.495	7.555	15.495	7.555
000009	14.246	14.917	7.337	0.00494	14.917	14.917	7.337	14.917	7.337
000010	12.517	13.517	7.205	0.00557	13.517	13.517	7.205	13.517	7.205
000011	12.101	12.815	7.085	0.00620	12.815	12.815	7.085	12.815	7.085
000012	34.706	38.903	14.408	0.00683	38.903	38.903	14.408	38.903	14.408
000013	36.360	31.235	12.604	0.00746	31.235	31.235	12.604	31.235	12.604
000014	27.857	27.055	11.424	0.00809	27.055	27.055	11.424	27.055	11.424
000015	25.477	23.326	10.882	0.00872	23.326	23.326	10.882	23.326	10.882
000016	22.990	20.818	9.442	0.00935	20.818	20.818	9.442	20.818	9.442
000017	22.973	19.614	9.031	0.00998	19.614	19.614	9.031	19.614	9.031
000018	22.153	19.633	8.630	0.01061	19.633	19.633	8.630	19.633	8.630
000019	20.456	17.908	8.136	0.01124	17.908	17.908	8.136	17.908	8.136
000020	21.271	16.608	7.955	0.01187	16.608	16.608	7.955	16.608	7.955
000021	71.643	204.815	136.787	0.01250	136.787	136.787	136.787	136.787	136.787
000022	26.547	46.630	15.893	0.01313	46.630	46.630	15.893	46.630	15.893
000023	21.527	30.475	12.399	0.01376	30.475	30.475	12.399	30.475	12.399
000024	18.972	24.675	10.693	0.01439	24.675	24.675	10.693	24.675	10.693
000025	18.899	22.974	9.954	0.01502	22.974	22.974	9.954	22.974	9.954
000026	13.895	17.674	8.422	0.01565	17.674	17.674	8.422	17.674	8.422
000027	13.855	16.727	8.009	0.01628	16.727	16.727	8.009	16.727	8.009
000028	13.601	15.815	7.674	0.01691	15.815	15.815	7.674	15.815	7.674
000029	12.823	14.074	7.337	0.01754	14.074	14.074	7.337	14.074	7.337
000030	12.113	13.625	7.099	0.01817	13.625	13.625	7.099	13.62	

TEST NUMBER AB-3-3
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) 1.42875 ID (CM) 1.37795 EMISSIVITY 0.300
 PARTICLE SIZE RANGE (MICRONS) 420-590
 EXPERIMENTAL VARIABLES
 POWER (W) 1004.80 VELOCITY (CM/S) 11.67 DENSITY (G/CM**3) 1.469 VOID FRACTION 0.390
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS CONDUCTIVITY (W/MK) 0.02686 PARTICLE CONDUCTIVITY (W/MK) 1.0606 PARTICLE SPECIFIC HEAT (WS/GK) 0.8120 HEAT FLUX (W/M**2) 42399.37 HEAT TRANSFER COEFFICIENT (W/M**2K) 423.26
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	32.78	31.67	45.510	36847.66	2.156	1745.415
3.179	95.56	34.30	163.849	38898.77	2.675	634.999
7.948	118.33	38.39	241.478	39971.06	3.021	500.024
12.718	118.89	42.52	235.036	40006.33	3.078	523.848
17.490	150.00	46.69	370.720	41437.21	3.589	401.115
22.254	167.78	50.97	459.433	42241.05	3.933	361.615
27.040	182.22	55.29	538.442	42885.81	4.242	337.852
31.816	194.44	59.64	610.152	43425.53	4.526	322.136
36.593	195.56	64.00	606.745	43484.48	4.612	330.528
41.371	213.89	68.37	732.184	44274.03	5.033	304.240
46.150	214.44	72.75	724.677	44309.54	5.114	312.711
50.929	230.00	77.14	841.070	44987.28	5.508	294.176
54.116	226.67	80.07	804.238	44830.98	5.486	305.871

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH (1967) BALDI
 (1957) (1960) SMITH (1962) SICARDI
 (1980)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2807 0.1759 0.1989 0.1679 0.3359 0.3321
 PSEUDOHOMOGENEOUS PECLET NUMBER
 6836.3 10906.4 9648.5 11428.6 5712.2 5776.7
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 20.780 33.152 29.328 34.739 17.363 17.559

TEST NUMBER AB-3-2
LOCAL NUSSELT NUMBER PROFILES
YAGI AND KUNITI (1957)

N D POSITION	EXPERIMENTAL	THEORETICAL FLAT
0.	64.831	204.815
0.00037	30.217	54.037
0.0007	24.323	35.147
0.00118	20.525	28.363
0.00162	19.691	24.602
0.00206	18.626	22.138
0.00250	16.930	20.367
0.00294	16.301	19.015
0.00339	16.730	17.938
0.00383	15.305	17.062
0.00427	15.679	16.324
0.00471	14.913	15.699
0.00500	15.439	15.327

N D POSITION	EXPERIMENTAL	THEORETICAL FLAT
0.	91.506	204.815
0.00021	42.650	63.672
0.00052	34.331	41.259
0.00084	28.971	33.183
0.00115	28.075	28.707
0.00146	26.250	25.761
0.00177	23.895	23.646
0.00209	23.008	22.023
0.00240	23.613	20.740
0.00271	21.602	19.690
0.00302	22.130	18.804
0.00334	21.057	18.052
0.00354	21.792	17.605

N D POSITION	EXPERIMENTAL	THEORETICAL FLAT
0.	54.189	204.815
0.00035	25.257	49.627
0.00080	20.330	32.364
0.00141	17.156	26.170
0.00194	16.626	22.739
0.00247	15.569	20.492
0.00300	14.151	18.879
0.00352	13.625	17.649
0.00405	13.983	16.670
0.00458	12.793	15.874
0.00511	13.105	14.205
0.00563	12.470	14.638
0.00599	12.905	14.301

THEORETICAL PARABOLIC
21.360
16.896
13.590
11.807
10.675
9.002
8.289
8.824
8.445
8.131
7.862
7.631
7.492

THEORETICAL PARABOLIC
21.360
17.903
14.904
13.109
11.904
11.034
10.372
9.846
9.415
9.058
8.750
8.455
8.326

THEORETICAL PARABOLIC
21.360
19.308
12.900
11.159
10.079
9.352
8.777
8.342
7.993
7.696
7.447
7.232
7.104

KUNITI AND SMITH (1960) N D POSITION	EXPERIMENTAL
0.	103.463
0.00018	48.223
0.00046	38.917
0.00074	32.756
0.00102	31.743
0.00129	29.725
0.00157	27.018
0.00185	26.014
0.00212	26.698
0.00240	24.425
0.00267	25.022
0.00295	23.608
0.00313	24.639

KRUPICZKA (1967) N D POSITION	EXPERIMENTAL
0.	100.391
0.00018	50.519
0.00044	40.665
0.00071	34.316
0.00097	33.255
0.00123	31.141
0.00150	28.304
0.00176	27.253
0.00203	27.970
0.00229	25.588
0.00255	26.214
0.00282	24.542
0.00299	25.813

SPECCHIA AND SICARDI (1980) N D POSITION	EXPERIMENTAL
0.	54.801
0.00035	25.543
0.00087	20.560
0.00139	17.350
0.00192	16.813
0.00244	15.744
0.00296	14.310
0.00348	13.779
0.00401	14.141
0.00453	12.937
0.00505	13.253
0.00557	12.611
0.00592	13.051

THEORETICAL FLAT	THEORETICAL PARABOLIC
204.815	21.360
67.498	18.221
45.706	15.359
35.114	13.582
30.345	12.363
27.215	11.472
24.963	10.768
23.240	10.242
21.867	9.793
20.747	9.418
19.803	9.097
19.000	8.819
18.523	8.652

THEORETICAL FLAT	THEORETICAL PARABOLIC
204.815	21.360
69.003	18.335
44.674	15.528
35.078	13.761
30.995	12.539
27.790	11.641
25.484	10.949
23.720	10.388
22.313	9.940
21.166	9.559
20.198	9.232
19.376	8.949
18.867	8.779

THEORETICAL FLAT	THEORETICAL PARABOLIC
204.815	21.360
48.832	16.346
22.531	12.843
26.301	11.198
22.851	10.115
20.591	9.365
19.969	8.808
17.731	8.371
16.746	8.016
15.945	7.722
15.272	7.472
14.701	7.256
14.962	7.127

TEST NUMBER AB-3-2
EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42875 1.37795 0.300

PARTICLE SIZE RANGE (MICRONS)

420-590

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM**3)

996.95 13.26 1.469 0.390

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.02656 1.0521 0.8060 42093.07 420.99

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

POSITION WALL TEMPERATURE PARTICLE TEMPERATURE RADIATIVE CONVECTIVE RADIATIVE CONVECTIVE

(CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K) (W/M**2K)

0.178	58.89	30.56	62.588	37025.33	2.209	1306.776
3.948	96.67	32.88	170.503	38826.54	2.673	608.671
7.948	117.78	36.48	243.130	39817.08	2.991	489.767
12.719	138.89	40.15	329.389	40791.31	3.336	418.144
17.492	146.67	43.87	359.839	41150.09	3.501	400.317
22.265	158.89	47.61	416.393	41706.51	3.742	374.781
27.040	176.11	51.38	508.324	42475.04	4.080	340.542
31.816	186.11	55.20	564.207	42918.90	4.310	327.836
36.592	186.67	59.00	598.400	42952.33	4.375	336.454
41.370	205.00	62.83	678.632	43745.53	4.773	307.700
46.149	205.56	66.67	672.635	43779.28	4.843	315.221
50.926	218.33	70.52	762.259	44324.93	5.157	299.864
54.112	215.56	73.08	732.613	44216.64	5.142	310.346

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA

(1957) (1960) SMITH (1967) BALDI SICARDI

(1962) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2779 0.1742 0.1969 0.1662 0.3325 0.3208

PSEUDOHOMOGENEOUS PECLET NUMBER

7796.1 12441.7 11003.9 13034.3 6516.4 6590.0

AVERAGE EXPERIMENTAL NUSSELT NUMBER

20.872 33.305 29.460 34.896 17.446 17.643

TEST NUMBER AB-9-1 GENERAL NUMBER PROFILES YAGI AND KUNII (1957)				KUNII AND SMITH (1960)				THEORETICAL PARABOLIC			
N D	POSITION	FLAT	EXPERIMENTAL	N D	POSITION	FLAT	EXPERIMENTAL	N D	POSITION	FLAT	EXPERIMENTAL
0.00025	56.394	57.815	57.292	0.00016	90.023	90.815	90.023	0.00016	90.023	90.815	90.023
0.00055	57.155	57.305	57.155	0.00041	40.155	40.443	40.155	0.00041	40.155	40.443	40.155
0.00104	221.393	30.064	30.064	0.00065	34.150	34.274	34.150	0.00065	34.150	34.274	34.150
0.00143	20.927	26.048	26.048	0.00093	32.147	32.835	32.147	0.00093	32.147	32.835	32.147
0.00220	17.927	22.075	22.075	0.00134	20.610	20.610	20.610	0.00134	20.610	20.610	20.610
0.00259	17.164	20.576	20.576	0.00167	20.393	20.393	20.393	0.00167	20.393	20.393	20.393
0.00298	17.572	18.924	18.924	0.00201	22.051	22.051	22.051	0.00201	22.051	22.051	22.051
0.00336	16.188	17.986	17.986	0.00235	22.412	22.412	22.412	0.00235	22.412	22.412	22.412
0.00412	16.568	16.568	16.568	0.00269	25.161	25.161	25.161	0.00269	25.161	25.161	25.161
0.00440	16.248	16.127	16.127	0.00276	25.938	25.938	25.938	0.00276	25.938	25.938	25.938
WILLHITE, KUNII AND SMITH (1962)				KRUPICZKA (1967)				THEORETICAL PARABOLIC			
N D	POSITION	FLAT	EXPERIMENTAL	N D	POSITION	FLAT	EXPERIMENTAL	N D	POSITION	FLAT	EXPERIMENTAL
0.00018	79.602	67.608	67.608	0.00016	94.291	94.291	94.291	0.00016	94.291	94.291	94.291
0.00045	35.507	43.927	43.927	0.00039	51.171	51.171	51.171	0.00039	51.171	51.171	51.171
0.00073	30.587	38.209	38.209	0.00065	42.059	42.059	42.059	0.00065	42.059	42.059	42.059
0.00124	27.602	32.266	32.266	0.00108	32.695	32.695	32.695	0.00108	32.695	32.695	32.695
0.00156	22.5305	22.027	22.027	0.00132	29.975	29.975	29.975	0.00132	29.975	29.975	29.975
0.00163	22.4227	22.299	22.299	0.00155	29.608	29.608	29.608	0.00155	29.608	29.608	29.608
0.00211	22.4694	22.122	22.122	0.00201	29.321	29.321	29.321	0.00201	29.321	29.321	29.321
0.00259	22.3559	22.051	22.051	0.00224	27.993	27.993	27.993	0.00224	27.993	27.993	27.993
0.00299	22.248	19.045	19.045	0.00248	26.354	26.354	26.354	0.00248	26.354	26.354	26.354
0.00312	22.335	19.567	19.567	0.00263	27.167	27.167	27.167	0.00263	27.167	27.167	27.167
BALDWIN AND SICARDI (1960)				SPECCHIA AND EXPERIMENTAL (1980)				THEORETICAL PARABOLIC			
N D	POSITION	FLAT	EXPERIMENTAL	N D	POSITION	FLAT	EXPERIMENTAL	N D	POSITION	FLAT	EXPERIMENTAL
0.00031	47.151	53.759	53.759	0.00031	47.603	47.603	47.603	0.00031	47.603	47.603	47.603
0.00074	25.599	33.729	33.729	0.00061	25.877	25.877	25.877	0.00061	25.877	25.877	25.877
0.00124	17.948	22.720	22.720	0.00123	10.098	10.098	10.098	0.00123	10.098	10.098	10.098
0.00170	17.414	22.474	22.474	0.00169	10.510	10.510	10.510	0.00169	10.510	10.510	10.510
0.00217	16.349	21.653	21.653	0.00215	16.534	16.534	16.534	0.00215	16.534	16.534	16.534
0.00263	14.597	19.617	19.617	0.00256	14.533	14.533	14.533	0.00256	14.533	14.533	14.533
0.00306	14.692	17.569	17.569	0.00302	14.680	14.680	14.680	0.00302	14.680	14.680	14.680
0.00402	13.926	16.715	16.715	0.00396	13.992	13.992	13.992	0.00396	13.992	13.992	13.992
0.00439	13.926	16.588	16.588	0.00440	13.440	13.440	13.440	0.00440	13.440	13.440	13.440
0.00525	13.565	16.027	16.027	0.00520	13.738	13.738	13.738	0.00520	13.738	13.738	13.738

TEST NUMBER AB-3-1

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42875 1.37795 0.300

PARTICLE SIZE RANGE (MICRONS)

420-590

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM**3)

996.95 15.08 1.463 0.390

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT

(W/MK) (W/MK) (WS/GK)

0.02630 1.0447 0.8007

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER

AXIAL WALL PARTICLE RADIATIVE CONVECTIVE

POSITION TEMPERATURE TEMPERATURE TEMPERATURE HEAT FLUX

(CM) (C) (C) (C) (W/M**2)

0. 62.78 29.44 71.670

3.178 95.56 31.52 169.310

7.948 114.44 34.72 233.179

12.719 133.89 37.99 310.334

17.491 140.56 41.28 335.049

22.264 151.67 44.60 384.111

27.038 166.67 47.94 459.887

31.813 176.67 51.32 512.540

36.589 177.22 54.69 507.938

41.365 193.33 58.08 608.302

46.142 193.89 61.48 601.568

50.919 205.66 64.88 677.418

54.105 203.93 67.15 654.709

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA

KUNII SMITH KUNII SMITH BALDI SICARDI

(1957) (1960) (1962) (1967) (1980) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2756 0.1726 0.1952 0.1648 0.3296 0.3259

PSUDOHOMOGENEOUS PECLET NUMBER

8867.3 14155.1 12516.4 14826.1 7413.9 7497.5

AVERAGE EXPERIMENTAL NUSSELT NUMBER

21.636 34.539 30.541 36.176 18.090 18.294

HEAT FLUX

(W/M**2)

42133.66

432.67

HEAT TRANSFER

COEFFICIENT

(W/M**2K)

432.67

RADIATIVE

H T COEFF

(W/M**2K)

1126.300

611.219

502.212

426.961

415.621

390.142

357.588

342.293

350.435

322.741

329.920

314.172

323.883

[illegible]

TEST NUMBER AB-2-9

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42875 1.37795 0.300

PARTICLE SIZE RANGE (MICRONS)

420-590

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY VOID

(W) (CM/S) (G/CM**3) FRACTION

803.25 2.43 1.469 0.390

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.03127 1.1862 0.8959 33122.31 278.23

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL WALL PARTICLE RADIATIVE CONVECTIVE RADIATIVE

POSITION TEMPERATURE TEMPERATURE TEMPERATURE H T COEFF

(CM) (C) (C) (C) (W/M**2K)

0. 35.00 32.22 5.506 25938.65

3.178 121.11 41.33 246.861 28844.09

7.951 162.78 55.85 418.818 30183.28

12.727 200.56 70.69 624.541 31341.08

17.505 221.67 85.65 744.704 31900.13

22.286 249.44 100.67 945.355 32775.41

27.069 278.89 115.82 1201.627 33571.05

31.854 298.89 131.03 1300.437 34104.50

36.641 313.89 146.21 1508.243 34509.69

41.429 337.78 161.40 1779.847 35084.82

46.219 346.67 176.56 1832.133 35346.92

51.010 361.11 191.64 1977.765 35711.40

54.205 362.78 201.64 1935.873 35812.09

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNITI WILLHITE KRUPICZKA SPECCHIA SPECCHIA

KUNITI KUNITI SMITH BALDI SICARDI SICARDI

(1957) (1960) (1962) (1967) (1980) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.3213 0.2023 0.2279 0.1924 0.3862 0.3818

PSEUDOHOMOGENEOUS PECLET NUMBER

1368.8 2174.6 1930.1 2285.7 1138.9 1151.9

AVERAGE EXPERIMENTAL NUSSELT NUMBER

11.932 18.956 16.824 19.924 9.928 10.041

TEST NUMBER AB-2-8
EXPERIMENTAL DATA
TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY
1.42875 1.37795 0.300
PARTICLE SIZE RANGE (MICRONS)
420-590

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY VOID
(W) (CM/S) (G/CM**3) FRACTION
794.60 3.78 1.469 0.380

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER
CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
0.02921 1.1283 0.8580 33137.52 310.75

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES
POSITION WALL TEMPERATURE PARTICLE TEMPERATURE RADIATIVE CONVECTIVE RADIATIVE
(CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K)

0.178	50.00	32.22	183.333	29391.30	2.132	1547.433
7.949	103.33	47.82	37.908	30569.55	2.819	451.948
12.722	137.78	57.55	307.288	31563.09	3.416	339.817
17.498	167.78	67.39	443.557	32093.49	4.024	286.353
22.275	183.89	77.29	518.203	32847.13	4.448	275.481
27.054	207.78	87.30	659.521	33589.54	5.054	251.723
31.835	232.22	97.36	830.135	33997.15	5.723	231.775
36.617	245.56	107.38	919.371	34231.68	6.204	229.409
41.400	252.78	117.42	953.623	34374.44	6.559	235.437
46.184	275.56	127.46	1156.952	35007.29	7.316	220.529
50.970	282.22	137.51	1191.271	35585.33	7.698	226.724
54.160	300.56	144.18	1275.365	35196.92	8.414	218.252
	295.56				8.425	234.492

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
KUNII SMITH (1967) BALDI
(1957) (1960) SMITH (1960) SICARDI
(1962) (1960)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
0.3023 0.1900 0.2143 0.1810 0.3627 0.3586
PSEUDOHOMOGENEOUS PECLET NUMBER
2173.2 3458.8 3065.6 3630.7 1811.5 1832.1
AVERAGE EXPERIMENTAL NUSSELT NUMBER
14.164 22.543 19.930 23.663 11.805 11.940

TEST NUMBER AB-2-7
LOCAL MUSEUM NUMBER PROFILES
VAC. AND RINT. (1957)

1992 AND 1993 EXPERIMENTAL POSITION

126:415
124:311
14:365

[illegible]

TEST NUMBER AB-2-7
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 1.42875 1.37795 0.300
 PARTICLE SIZE RANGE (MICRONS)
 420-590
 EXPERIMENTAL VARIABLES
 POWER (W) VELOCITY (CM/S) DENSITY (G/CM**3) VOID FRACTION
 806.20 5.15 1.469 0.390
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS PARTICLE PARTICLE HEAT HEAT TRANSFER
 CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
 (W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
 0.02824 1.1004 0.8394 33808.32 343.87
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES
 AXIAL POSITION (CM) WALL TEMPERATURE (C) PARTICLE TEMPERATURE (C) RADIATIVE HEAT FLUX (W/M**2) CONVECTIVE HEAT FLUX (W/M**2) RADIATIVE H T COEFF (W/M**2K) CONVECTIVE H T COEFF (W/M**2K)
 0. 42.78 32.22 21.730 28402.54 2.059 2690.767
 3.178 95.56 36.84 158.722 30357.79 2.703 516.956
 7.948 125.00 44.06 257.557 31420.57 3.102 388.218
 12.720 151.67 51.45 368.513 32350.12 3.677 322.893
 17.494 164.44 58.92 420.735 32807.12 3.987 310.902
 22.269 188.33 66.46 550.293 33612.53 4.515 275.789
 27.047 207.22 74.08 664.634 34235.54 4.992 257.136
 31.825 218.53 81.74 729.457 34503.64 5.340 253.331
 36.605 223.33 89.37 746.665 34781.06 5.574 259.634
 41.385 244.44 97.02 909.933 35438.20 6.172 240.387
 46.167 248.33 104.69 919.880 35579.18 6.404 247.690
 50.949 265.00 112.35 1060.286 36083.99 6.950 236.391
 54.138 265.00 117.46 1040.384 36104.49 7.052 244.716
 DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAO KUNIT WILLHITE KRUPICZKA SPECCHIA
 KUNIT SMITH KUNIT SMITH BALDI SICARDI
 (1957) (1960) (1962) (1967) (1900) (1900)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2934 0.1842 0.2080 0.1756 0.3517 0.3477
 PSEUDOHOMOGENEOUS PECLET NUMBER
 2981.6 4750.0 4206.9 4982.7 2407.7 2515.9
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 16.149 25.727 22.785 26.988 13.474 13.627

TEST NUMBER AB-2-6 LOCAL NUSSLEIT NUMBER PROFILES YAGI AND KUNII (1957)				KUNII AND SMITH (1960)				THEORETICAL PARABOLIC			
POSITION	EXPERIMENTAL	THEORETICAL FLAT	THEORETICAL PARABOLIC	POSITION	EXPERIMENTAL	THEORETICAL FLAT	THEORETICAL PARABOLIC	POSITION	EXPERIMENTAL	THEORETICAL FLAT	THEORETICAL PARABOLIC
0.00060	64.911	204.815	21.360	0.00037	103.481	204.815	21.360	0.00037	103.481	204.815	21.360
0.00149	26.460	38.757	10.961	0.00094	42.183	48.249	16.105	0.00094	42.183	48.249	16.105
0.00238	19.988	25.522	9.432	0.00150	31.865	31.497	12.673	0.00150	31.865	31.497	12.673
0.00327	16.603	20.746	8.932	0.00222	23.659	25.488	10.950	0.00222	23.659	25.488	10.950
0.00417	13.195	16.473	7.971	0.00322	16.370	22.981	9.432	0.00322	16.370	22.981	9.432
0.00506	12.105	15.253	7.465	0.00376	20.832	18.420	8.615	0.00376	20.832	18.420	8.615
0.00595	12.863	14.237	7.114	0.00430	20.538	17.227	8.190	0.00430	20.538	17.227	8.190
0.00684	13.205	13.954	6.830	0.00484	20.832	15.280	7.646	0.00484	20.832	15.280	7.646
0.00773	13.494	13.203	6.359	0.00538	19.490	13.954	7.369	0.00538	19.490	13.954	7.369
0.00862	11.811	12.004	6.239	0.00592	18.829	13.954	7.108	0.00592	18.829	13.954	7.108
0.00951	12.405	11.837	6.129	0.00635	19.776	14.312	6.983	0.00635	19.776	14.312	6.983
0.01040	91.599	45.548	21.360	0.00678	103.495	14.312	6.983	0.00678	103.495	14.312	6.983
0.00042	37.339	45.548	15.676	0.00036	44.227	49.342	16.267	0.00036	44.227	49.342	16.267
0.00129	28.436	33.138	12.522	0.00089	33.309	32.186	12.854	0.00089	33.309	32.186	12.854
0.00218	22.358	27.128	9.511	0.00146	23.643	22.622	11.116	0.00146	23.643	22.622	11.116
0.00306	20.032	21.024	8.812	0.00196	20.643	20.551	9.298	0.00196	20.643	20.551	9.298
0.00395	18.493	17.514	8.203	0.00250	22.1504	19.788	8.744	0.00250	22.1504	19.788	8.744
0.00484	16.493	15.516	7.566	0.00303	21.533	17.564	8.311	0.00303	21.533	17.564	8.311
0.00573	15.226	14.798	7.289	0.00356	20.403	15.801	7.869	0.00356	20.403	15.801	7.869
0.00662	17.631	14.182	7.056	0.00409	20.804	15.137	7.421	0.00409	20.804	15.137	7.421
0.00751	15.567	13.570	6.860	0.00463	19.741	14.574	7.208	0.00463	19.741	14.574	7.208
0.00840	13.570	13.570	6.741	0.00517	19.741	14.574	7.080	0.00517	19.741	14.574	7.080
0.00929	11.570	13.570	6.741	0.00570	19.741	14.574	7.080	0.00570	19.741	14.574	7.080
0.01018	91.599	45.548	21.360	0.00624	103.495	14.574	7.080	0.00624	103.495	14.574	7.080
0.00042	37.339	45.548	15.676	0.00036	44.227	49.342	16.267	0.00036	44.227	49.342	16.267
0.00129	28.436	33.138	12.522	0.00089	33.309	32.186	12.854	0.00089	33.309	32.186	12.854
0.00218	22.358	27.128	9.511	0.00146	23.643	22.622	11.116	0.00146	23.643	22.622	11.116
0.00306	20.032	21.024	8.812	0.00196	20.643	20.551	9.298	0.00196	20.643	20.551	9.298
0.00395	18.493	17.514	8.203	0.00250	22.1504	19.788	8.744	0.00250	22.1504	19.788	8.744
0.00484	16.493	15.516	7.566	0.00303	21.533	17.564	8.311	0.00303	21.533	17.564	8.311
0.00573	15.226	14.798	7.289	0.00356	20.403	15.801	7.869	0.00356	20.403	15.801	7.869
0.00662	17.631	14.182	7.056	0.00409	20.804	15.137	7.421	0.00409	20.804	15.137	7.421
0.00751	15.567	13.570	6.860	0.00463	19.741	14.574	7.208	0.00463	19.741	14.574	7.208
0.00840	13.570	13.570	6.741	0.00517	19.741	14.574	7.080	0.00517	19.741	14.574	7.080
0.00929	11.570	13.570	6.741	0.00570	19.741	14.574	7.080	0.00570	19.741	14.574	7.080
0.01018	91.599	45.548	21.360	0.00624	103.495	14.574	7.080	0.00624	103.495	14.574	7.080
0.00042	37.339	45.548	15.676	0.00036	44.227	49.342	16.267	0.00036	44.227	49.342	16.267
0.00129	28.436	33.138	12.522	0.00089	33.309	32.186	12.854	0.00089	33.309	32.186	12.854
0.00218	22.358	27.128	9.511	0.00146	23.643	22.622	11.116	0.00146	23.643	22.622	11.116
0.00306	20.032	21.024	8.812	0.00196	20.643	20.551	9.298	0.00196	20.643	20.551	9.298
0.00395	18.493	17.514	8.203	0.00250	22.1504	19.788	8.744	0.00250	22.1504	19.788	8.744
0.00484	16.493	15.516	7.566	0.00303	21.533	17.564	8.311	0.00303	21.533	17.564	8.311
0.00573	15.226	14.798	7.289	0.00356	20.403	15.801	7.869	0.00356	20.403	15.801	7.869
0.00662	17.631	14.182	7.056	0.00409	20.804	15.137	7.421	0.00409	20.804	15.137	7.421
0.00751	15.567	13.570	6.860	0.00463	19.741	14.574	7.208	0.00463	19.741	14.574	7.208
0.00840	13.570	13.570	6.741	0.00517	19.741	14.574	7.080	0.00517	19.741	14.574	7.080
0.00929	11.570	13.570	6.741	0.00570	19.741	14.574	7.080	0.00570	19.741	14.574	7.080
0.01018	91.599	45.548	21.360	0.00624	103.495	14.574	7.080	0.00624	103.495	14.574	7.080

TEST NUMBER AB-2-6

EXPERIMENTAL DATA
TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42875 1.37795 0.300

PARTICLE SIZE RANGE (MICRONS)

420-590

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY VOID
(W) (CM/S) (G/CM**3) FRACTION

805.00 6.61 1.469 0.390

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE HEAT HEAT TRANSFER
CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
(W/MK) (W/MK) (W/GK) (W/M**2) (W/M**2K)

0.02755 1.0804 0.8258 33846.42 359.97

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	53.33	31.67	46.834	29279.39	2.162	1351.357
3.178	91.11	35.34	146.734	30701.60	2.631	550.505
7.947	117.22	41.04	231.351	31665.09	3.037	415.660
12.719	141.11	46.86	325.524	32526.97	3.454	345.126
17.492	162.78	52.70	371.315	32947.09	3.712	329.390
22.266	172.78	58.69	470.658	33644.93	4.125	294.911
27.042	190.56	64.70	570.076	34252.48	4.530	272.165
31.819	200.00	70.75	620.319	34577.20	4.799	267.517
36.597	204.44	76.78	635.825	34737.99	4.980	272.099
41.376	222.22	82.82	758.202	35319.04	5.499	253.373
46.155	225.56	89.88	767.069	35442.84	5.512	259.325
50.936	241.67	94.95	890.853	35955.66	6.072	245.066
54.123	238.33	93.99	845.645	35860.06	6.070	257.414

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI	KUNII	WILLHITE	KRUPICZKA	SPECCHIA
KUNII	SMITH	KUNII	BALDI	SICARDI
(1957)	(1960)	SMITH	(1967)	(1960)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2870 0.1600 0.2034 0.1717 0.3438 0.3399

PSEUDOHOMOGENEOUS PECLET NUMBER

3851.9 6140.6 5435.5 6438.2 3216.1 3252.5

AVERAGE EXPERIMENTAL NUSSELT NUMBER

17.281 27.549 24.386 28.864 14.429 14.592

TEST NUMBER AB-2-5

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42875 1.3775 0.300

PARTICLE SIZE RANGE (MICRONS)

420-590

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY VOID
(W) (CM/S) (G/CM**3) FRACTION
(W) 805.00 0.01 1.469 0.390

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT
CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX TRANSFER
(W/MK) (W/MK) (WS/GK) (W/M**2) COEFFICIENT
(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.02710 1.0676 0.8169 33923.37 382.92

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	47.22	31.11	33.716	29469.61	2.093	1828.148
3.178	86.11	34.17	132.823	30961.26	2.557	596.105
7.946	110.56	38.93	209.265	31681.01	2.922	445.099
12.717	122.78	43.78	292.883	32700.52	3.291	367.446
17.490	142.78	48.69	329.557	33069.47	3.503	351.491
22.263	162.22	53.65	420.985	33765.36	3.877	310.995
27.038	176.67	58.66	494.724	34275.20	4.192	290.460
31.814	186.67	63.7	540.412	34627.06	4.444	281.608
36.590	188.89	68.7	547.951	34715.22	4.560	268.929
41.368	207.78	73.7	669.709	35353.62	4.998	263.857
46.146	208.89	78.85	663.381	35404.93	5.102	272.274
50.925	223.33	83.92	764.090	35884.55	5.401	257.403
54.111	222.78	87.31	748.702	35077.63	5.527	264.835

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI	KUNII	WILLHITE	KRUPICZKA	SPECCHIA
(1957)	SMITH (1960)	KUNII (1962)	(1967)	DALCI (1980)
				SICARDI (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2829 0.1774 0.2005 0.1692 0.3387

PSEUDOHOMOGENEOUS PECLET NUMBER

4680.8 7465.7 6606.0 7024.7 3910.1 3954.3

AVERAGE EXPERIMENTAL NUSSELT NUMBER

18.650 29.746 26.321 31.176 15.579 15.755

TEST NUMBER AB-2-4
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) 1.42875 ID (CM) 1.37795 EMISSIVITY 0.300
 PARTICLE SIZE RANGE (MICRONS) 420-590
 EXPERIMENTAL VARIABLES
 POWER (W) 791.00 VELOCITY (CM/S) 9.36 DENSITY (G/CM**3) 1.469 VOID FRACTION 0.390
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS CONDUCTIVITY (W/MK) 0.02675 PARTICLE CONDUCTIVITY (W/MK) 1.0574 PARTICLE SPECIFIC HEAT (WS/GK) 0.8097 HEAT FLUX (W/M**2) 33376.91 HEAT TRANSFER COEFFICIENT (W/M**2K) 393.67
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	50.00	30.56	41.140	29412.49	2.116	1512.642
3.178	83.33	33.16	126.090	30603.51	2.313	11.535
7.946	105.56	37.19	193.844	31516.80	2.835	0.988
12.717	125.56	41.30	265.956	32253.61	3.156	0.793
17.488	135.00	45.45	299.501	32601.38	3.345	30.063
22.261	152.78	49.64	373.500	33238.88	3.671	322.388
27.035	167.78	53.89	452.507	33760.40	3.973	296.502
31.810	173.89	58.15	478.794	33987.65	4.137	293.670
36.585	176.67	62.41	485.104	34092.62	4.246	298.390
41.362	193.33	66.68	583.981	34662.47	4.611	273.688
46.139	194.44	70.97	579.588	34710.98	4.697	281.117
50.916	207.78	75.26	665.464	35159.22	5.022	265.316
54.102	208.33	78.13	661.290	35185.61	5.075	270.227

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 VAGI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII BALDI
 (1957) (1950) SMITH (1967) SICARDI
 (1952) (1980)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2793 0.1753 0.1981 0.3346 0.3309
 PSEUDOHOMOGENEOUS PECLET NUMBER
 5496.3 8769.6 7757.4 9188.7 4593.1 4645.0
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 19.399 30.952 27.379 32.431 16.211 16.394

TEST NUMBER AB-2-3

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42875 1.37795 0.300

PARTICLE SIZE RANGE (MICRONS)

420-590

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY VOID

(W) (CM/S) (G/CM**3) FRACTION

796.65 10.67 1.469 0.330

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.02655 1.0519 0.8058 33652.18 406.85

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL WALL PARTICLE RADIATIVE CONVECTIVE RADIATIVE CONVECTIVE

POSITION TEMPERATURE TEMPERATURE HEAT FLUX HEAT FLUX H T COEFF H T COEFF

(CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K) (W/M**2K)

0. 49.44 30.56 39.856 29787.38 2.110 1576.979

3.178 82.78 32.87 124.931 31076.63 2.503 622.707

7.946 103.33 36.46 187.125 31859.26 2.798 476.383

12.716 123.93 40.11 258.882 32607.52 3.111 391.811

17.488 131.11 43.80 285.228 32899.55 3.267 376.829

22.260 148.33 47.53 360.212 33528.47 3.573 332.617

27.034 158.33 51.29 404.821 33891.91 3.782 316.633

31.808 170.00 55.06 462.808 34309.35 4.027 298.555

36.583 171.11 58.97 460.111 34357.29 4.099 306.108

41.359 187.78 62.68 556.543 34938.79 4.449 279.285

46.135 187.22 66.49 542.723 34930.03 4.495 299.322

50.912 197.78 70.30 605.501 35295.92 4.750 276.888

54.097 196.11 72.84 586.463 35247.32 4.758 285.945

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA SPECCHIA

KUNII SMITH KUNII BALDI SICARDI

(1957) (1960) SMITH (1962) SICARDI (1960)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2779 0.1741 0.1969 0.1662 0.3324 0.3287

PSEUDOHOMOGENEOUS PECLET NUMBER 10476.6 5237.7 5296.8

6266.3 10000.3 8844.6

AVERAGE EXPERIMENTAL NUSSELT NUMBER 33.733 16.865 17.055

20.177 32.200 28.478

TEST NUMBER AB-2-2

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42875 1.37795 0.300

PARTICLE SIZE RANGE (MICRONS)

420-590

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY VOID FRACTION

(W) (CM/S) (G/CM**3) (G/CM**3)

796.65 12.34 1.469 0.390

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT HEAT TRANSFER

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.02627 1.0438 0.8001 33676.45 410.03

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

POSITION WALL TEMPERATURE PARTICLE TEMPERATURE RADIATIVE HEAT FLUX CONVECTIVE HEAT FLUX H T COEFF

(CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K)

0. 50.56 29.44 44.555 30064.49 2.111

3.178 51.67 31.47 124.248 31277.63 2.475

7.946 100.00 34.59 178.030 31932.68 2.734

12.716 119.44 37.78 247.346 32718.05 3.029

17.487 126.11 41.00 260.016 32971.57 3.161

22.259 131.11 44.24 331.355 33527.61 3.421

27.032 153.89 47.52 309.375 33995.47 3.661

31.806 161.11 50.82 421.407 34260.32 3.821

36.580 162.22 54.12 419.867 34307.51 3.884

41.355 177.22 57.42 501.295 34841.76 4.184

46.130 177.78 60.74 496.431 34869.41 4.242

50.906 189.44 64.07 564.170 35279.72 4.500

54.091 188.33 66.29 550.751 35247.64 4.513

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA

KUNII SMITH KUNII BALDI

(1957) (1960) (1962) (1967) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2753 0.1724 0.1950 0.1646 0.3292 0.3255

PSEUDOHOMOGENEOUS PECLET NUMBER

7260.2 11590.1 10248.1 12139.2 6070.5 6138.9

AVERAGE EXPERIMENTAL NUSSELT NUMBER

20.526 32.768 28.973 34.320 17.162 17.356

TEST NUMBER AB-2-1
LOCAL NUSSELT NUMBER PROFILES
YAGI AND KUNITI (1957)

N D POSITION	EXPERIMENTAL	THEORETICAL FLAT
0.	59.141	204.815
0.00027	31.337	55.990
0.00068	24.549	36.382
0.00109	20.594	29.335
0.00150	18.166	25.423
0.00191	16.000	22.868
0.00232	16.847	21.026
0.00273	16.144	19.619
0.00314	16.437	18.500
0.00355	15.116	17.588
0.00396	15.438	16.821
0.00437	14.575	16.169
0.00465	15.243	15.782

N D POSITION	EXPERIMENTAL	THEORETICAL FLAT
0.	83.484	204.815
0.00019	44.235	65.975
0.00048	34.653	42.730
0.00078	29.071	34.342
0.00107	27.973	29.688
0.00136	25.409	26.634
0.00165	23.781	24.434
0.00194	22.789	22.754
0.00223	23.202	21.415
0.00252	21.338	20.321
0.00281	21.792	19.401
0.00310	20.575	18.618
0.00329	21.517	18.153

N D POSITION	EXPERIMENTAL	THEORETICAL FLAT
0.	49.461	204.815
0.00033	26.208	51.429
0.00082	20.511	37.189
0.00131	17.224	27.064
0.00180	16.573	23.498
0.00229	15.054	21.163
0.00278	14.090	19.484
0.00327	13.502	18.203
0.00376	13.747	17.185
0.00425	12.642	16.356
0.00474	12.911	15.659
0.00523	12.190	15.067
0.00555	12.748	14.716

N D POSITION	EXPERIMENTAL	THEORETICAL PARABOLIC
0.	21.360	21.360
0.00017	17.128	17.128
0.00043	13.877	13.877
0.00069	12.083	12.083
0.00094	10.932	10.932
0.00120	10.121	10.121
0.00146	9.512	9.512
0.00171	9.033	9.033
0.00197	8.644	8.644
0.00222	8.320	8.320
0.00248	8.043	8.043
0.00274	7.805	7.805
0.00291	7.662	7.662

N D POSITION	EXPERIMENTAL	THEORETICAL PARABOLIC
0.	21.360	21.360
0.00016	18.099	18.099
0.00041	15.182	15.182
0.00065	13.396	13.396
0.00090	12.182	12.182
0.00114	11.299	11.299
0.00139	10.622	10.622
0.00163	10.034	10.034
0.00188	9.642	9.642
0.00212	9.274	9.274
0.00237	8.958	8.958
0.00261	8.686	8.686
0.00278	8.521	8.521

N D POSITION	EXPERIMENTAL	THEORETICAL PARABOLIC
0.	21.360	21.360
0.00032	16.560	16.560
0.00081	13.189	13.189
0.00129	11.427	11.427
0.00178	10.325	10.325
0.00226	9.558	9.558
0.00275	8.907	8.907
0.00323	8.359	8.359
0.00372	8.173	8.173
0.00420	7.873	7.873
0.00469	7.616	7.616
0.00517	7.395	7.395
0.00549	7.262	7.262

N D POSITION	EXPERIMENTAL	THEORETICAL FLAT
0.	94.434	204.815
0.00017	50.037	69.445
0.00043	39.198	45.280
0.00069	32.884	36.355
0.00094	31.642	31.401
0.00120	28.741	28.150
0.00146	26.901	25.807
0.00171	25.778	24.017
0.00197	26.245	22.590
0.00222	24.137	21.424
0.00248	24.650	20.443
0.00274	23.273	19.608
0.00291	24.339	19.111

N D POSITION	EXPERIMENTAL	THEORETICAL FLAT
0.	98.890	204.815
0.00016	52.398	71.486
0.00041	41.048	46.276
0.00065	34.436	37.141
0.00090	33.138	32.070
0.00114	30.098	28.742
0.00139	28.170	26.344
0.00163	26.995	24.510
0.00188	27.494	23.048
0.00212	25.276	21.836
0.00237	25.813	20.850
0.00261	24.372	19.995
0.00278	25.481	19.486

N D POSITION	EXPERIMENTAL	THEORETICAL FLAT
0.	50.019	204.815
0.00032	26.503	51.704
0.00081	20.762	33.674
0.00129	17.418	27.200
0.00178	16.760	23.614
0.00226	15.223	21.265
0.00275	14.249	19.576
0.00323	13.604	18.208
0.00372	13.931	17.264
0.00420	12.784	16.429
0.00469	13.056	15.728
0.00517	12.327	15.133
0.00549	12.692	14.780

N D POSITION	EXPERIMENTAL	THEORETICAL PARABOLIC
0.	204.815	21.360
0.00017	19.404	19.404
0.00043	15.631	15.631
0.00069	13.871	13.871
0.00094	12.648	12.648
0.00120	11.746	11.746
0.00146	11.043	11.043
0.00171	10.490	10.490
0.00197	10.031	10.031
0.00222	9.646	9.646
0.00248	9.315	9.315
0.00274	9.029	9.029
0.00291	8.857	8.857

N D POSITION	EXPERIMENTAL	THEORETICAL PARABOLIC
0.	21.360	21.360
0.00016	18.513	18.513
0.00041	15.795	15.795
0.00065	14.048	14.048
0.00090	12.821	12.821
0.00114	11.916	11.916
0.00139	11.211	11.211
0.00163	10.646	10.646
0.00188	10.180	10.180
0.00212	9.789	9.789
0.00237	9.453	9.453
0.00261	9.162	9.162
0.00278	8.987	8.987

N D POSITION	EXPERIMENTAL	THEORETICAL PARABOLIC
0.	21.360	21.360
0.00032	16.596	16.596
0.00081	13.232	13.232
0.00129	11.468	11.468
0.00178	10.362	10.362
0.00226	9.593	9.593
0.00275	9.019	9.019
0.00323	8.569	8.569
0.00372	8.204	8.204
0.00420	7.801	7.801
0.00469	7.642	7.642
0.00517	7.420	7.420
0.00549	7.286	7.286

TEST NUMBER AB-2-1
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 1.42875 1.37795 0.300
 PARTICLE SIZE RANGE (MICRONS)
 420-590
 EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID FRACTION
 (W) (CM/S) (G/CM**3) (CM**3)
 802.30 14.26 1.469 0.390
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS CONDUCTIVITY PARTICLE CONDUCTIVITY PARTICLE SPECIFIC HEAT HEAT FLUX HEAT TRANSFER COEFFICIENT
 (W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
 0.02606 1.0379 0.7958 33935.48 414.96
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0	55.00	28.89	56.174	30614.26	2.151	1172.461
3.178	81.67	30.67	125.791	31665.26	2.467	620.958
7.946	100.00	33.41	181.173	32379.96	2.721	486.293
12.716	117.22	36.21	241.408	33040.68	2.980	407.839
17.487	123.89	39.03	263.534	33297.23	3.106	392.383
22.258	136.67	41.87	315.147	33779.14	3.324	356.336
27.031	147.22	44.74	360.762	34173.65	3.520	333.454
31.804	155.56	47.62	398.106	34483.37	3.688	319.492
36.578	156.67	50.51	397.512	34530.21	3.745	325.276
41.352	170.56	53.41	470.170	35035.14	4.013	299.066
46.127	171.11	56.31	466.465	35061.93	4.063	305.426
50.903	182.22	59.23	529.633	35461.05	4.298	283.311
54.087	178.33	61.17	498.847	35329.49	4.258	301.535

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII (1967) BALDI
 (1957) (1960) SMITH (1962) SICARDI
 (1980)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2739 0.1712 0.1936 0.1635 0.3268 0.3232
 PSEUDOHOMOGENEOUS PECLET NUMBER
 8403.3 13418.0 11862.2 14051.2 7027.9 7107.2
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 20.919 33.402 29.529 34.978 17.495 17.692

TEST NUMBER AB-1-9				TEST NUMBER AB-1-9			
LEGAL NUSSELT (1957)				LEGAL NUSSELT (1957)			
YAGI AND KUNITI (1960)				YAGI AND KUNITI (1960)			
N D				N D			
POSITION				POSITION			
FLAT				FLAT			
THEORETICAL				THEORETICAL			
PARABOLIC				PARABOLIC			
0.00126	80.743	29.752	204.815	0.00126	80.743	29.752	204.815
0.00165	19.381	19.878	19.878	0.00165	19.381	19.878	19.878
0.00424	12.337	16.370	16.370	0.00424	12.337	16.370	16.370
0.00583	12.337	16.370	16.370	0.00583	12.337	16.370	16.370
0.00600	10.179	12.324	12.324	0.00600	10.179	12.324	12.324
0.01058	10.179	11.661	11.661	0.01058	10.179	11.661	11.661
0.01217	10.444	11.142	11.142	0.01217	10.444	11.142	11.142
0.01375	19.888	10.126	10.126	0.01375	19.888	10.126	10.126
0.01631	19.204	10.097	10.097	0.01631	19.204	10.097	10.097
0.01797	10.279	9.931	9.931	0.01797	10.279	9.931	9.931
WILLHITE, KUNITI AND SMITH (1962)				WILLHITE, KUNITI AND SMITH (1962)			
N D				N D			
POSITION				POSITION			
FLAT				FLAT			
THEORETICAL				THEORETICAL			
PARABOLIC				PARABOLIC			
0.00075	113.474	204.815	204.815	0.00075	113.474	204.815	204.815
0.00168	29.333	23.831	23.831	0.00168	29.333	23.831	23.831
0.00300	21.701	18.556	18.556	0.00300	21.701	18.556	18.556
0.00303	17.524	15.711	15.711	0.00303	17.524	15.711	15.711
0.00526	15.711	13.963	13.963	0.00526	15.711	13.963	13.963
0.00638	14.703	13.150	13.150	0.00638	14.703	13.150	13.150
0.00750	14.391	12.990	12.990	0.00750	14.391	12.990	12.990
0.00974	13.890	11.558	11.558	0.00974	13.890	11.558	11.558
0.01199	13.391	11.195	11.195	0.01199	13.391	11.195	11.195
0.01274	14.503	10.982	10.982	0.01274	14.503	10.982	10.982
SPECCHIA, BALDWIN AND SICARDI (1960)				SPECCHIA, BALDWIN AND SICARDI (1960)			
N D				N D			
POSITION				POSITION			
FLAT				FLAT			
THEORETICAL				THEORETICAL			
PARABOLIC				PARABOLIC			
0.00127	67.103	204.815	204.815	0.00127	67.103	204.815	204.815
0.00315	12.333	16.425	16.425	0.00315	12.333	16.425	16.425
0.00508	10.393	13.498	13.498	0.00508	10.393	13.498	13.498
0.00698	10.393	12.499	12.499	0.00698	10.393	12.499	12.499
0.00778	8.393	10.997	10.997	0.00778	8.393	10.997	10.997
0.01268	8.393	10.338	10.338	0.01268	8.393	10.338	10.338
0.01458	8.393	10.171	10.171	0.01458	8.393	10.171	10.171
0.01648	8.393	9.624	9.624	0.01648	8.393	9.624	9.624
0.02027	8.393	9.400	9.400	0.02027	8.393	9.400	9.400
0.02154	8.393	9.400	9.400	0.02154	8.393	9.400	9.400
KUNITI AND SMITH (1960)				KUNITI AND SMITH (1960)			
N D				N D			
POSITION				POSITION			
FLAT				FLAT			
THEORETICAL				THEORETICAL			
PARABOLIC				PARABOLIC			
0.00067	128.126	128.087	128.087	0.00067	128.126	128.087	128.087
0.00165	24.503	24.503	24.503	0.00165	24.503	24.503	24.503
0.00266	20.611	17.790	17.790	0.00266	20.611	17.790	17.790
0.00365	17.790	16.609	16.609	0.00365	17.790	16.609	16.609
0.00565	16.609	15.216	15.216	0.00565	16.609	15.216	15.216
0.00764	15.216	13.938	13.938	0.00764	15.216	13.938	13.938
0.00863	13.938	12.673	12.673	0.00863	13.938	12.673	12.673
0.01062	12.673	11.459	11.459	0.01062	12.673	11.459	11.459
0.01126	11.459	11.417	11.417	0.01126	11.459	11.417	11.417
KRUPICZKA (1967)				KRUPICZKA (1967)			
N D				N D			
POSITION				POSITION			
FLAT				FLAT			
THEORETICAL				THEORETICAL			
PARABOLIC				PARABOLIC			
0.00063	134.401	134.707	134.707	0.00063	134.401	134.707	134.707
0.00159	25.703	25.703	25.703	0.00159	25.703	25.703	25.703
0.00259	21.620	21.620	21.620	0.00259	21.620	21.620	21.620
0.00443	18.609	17.422	17.422	0.00443	18.609	17.422	17.422
0.00538	17.422	17.010	17.010	0.00538	17.422	17.010	17.010
0.00633	17.010	16.410	16.410	0.00633	17.010	16.410	16.410
0.00818	16.410	15.216	15.216	0.00818	16.410	15.216	15.216
0.01012	15.216	14.000	14.000	0.01012	15.216	14.000	14.000
0.01075	14.000	13.743	13.743	0.01075	14.000	13.743	13.743
SPECCHIA AND BALDWIN (1980)				SPECCHIA AND BALDWIN (1980)			
N D				N D			
POSITION				POSITION			
FLAT				FLAT			
THEORETICAL				THEORETICAL			
PARABOLIC				PARABOLIC			
0.00126	67.864	67.864	67.864	0.00126	67.864	67.864	67.864
0.00342	12.379	12.379	12.379	0.00342	12.379	12.379	12.379
0.00502	10.917	10.917	10.917	0.00502	10.917	10.917	10.917
0.00690	9.777	9.777	9.777	0.00690	9.777	9.777	9.777
0.00878	8.589	8.589	8.589	0.00878	8.589	8.589	8.589
0.01294	8.589	8.589	8.589	0.01294	8.589	8.589	8.589
0.01442	8.589	8.589	8.589	0.01442	8.589	8.589	8.589
0.01629	8.589	8.589	8.589	0.01629	8.589	8.589	8.589
0.02004	8.589	8.589	8.589	0.02004	8.589	8.589	8.589
0.02130	8.589	8.589	8.589	0.02130	8.589	8.589	8.589

TEST NUMBER AB-1-9

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) 1.42875 ID (CM) 1.37795 EMISSIVITY 0.300

PARTICLE SIZE RANGE (MICRONS) 420-550

EXPERIMENTAL VARIABLES

POWER (W) 610.00 VELOCITY (CM/S) 3.74 DENSITY (G/CM**3) 1.469 VOID FRACTION 0.390

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY (W/MK) 0.02821 PARTICLE CONDUCTIVITY (W/MK) 1.0994 PARTICLE SPECIFIC HEAT (WS/GK) 0.3388 HEAT FLUX (W/M**2) 25544.61 HEAT TRANSFER COEFFICIENT (W/M**2K) 296.55

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	42.78	30.00	26.026	21850.63	2.037	1710.050
3.177	87.22	34.88	134.969	23098.33	2.578	441.261
7.947	115.56	42.46	221.536	23873.02	3.031	326.622
12.718	139.44	50.20	309.812	24508.60	3.472	274.625
17.491	153.33	58.01	361.475	24876.03	3.792	260.969
22.265	173.33	65.87	455.449	25306.27	4.238	236.229
27.041	190.56	73.80	545.011	25815.14	4.658	221.093
31.819	202.78	81.76	608.460	26118.95	5.028	215.819
36.597	208.33	89.69	625.129	26210.03	5.269	221.416
41.376	225.56	97.63	737.512	26672.04	5.765	208.505
46.155	229.44	105.57	742.344	26784.42	5.993	216.220
50.936	245.56	113.50	850.207	27149.22	6.506	205.592
54.124	243.33	113.78	816.655	27125.39	6.557	217.782

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
KUNII SMITH KUNII BALDI
(1957) (1960) SMITH (1962) SICARDI
(1960)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2931 0.1840 0.2077 0.1754 0.3513 0.3474

PSEUDOHOMOGENEOUS PECLET NUMBER

2168.5 345.8 3059.7 3624.0 1809.4 1829.9

AVERAGE EXPERIMENTAL NUSSELT NUMBER

13.941 22.210 19.670 23.293 11.632 11.764

TEST NUMBER AB-1-8
LOCAL NUSSELT NUMBER PROFILES
(1957)

N D POSITION	EXPERIMENTAL	THEORETICAL FLAT	THEORETICAL PARABOLIC
0.	133.976	204.815	21.360
0.00083	23.806	39.320	13.143
0.00207	15.876	22.111	8.824
0.00331	13.070	18.115	8.507
0.00455	12.279	15.917	7.712
0.00578	10.973	14.489	7.176
0.00702	10.077	13.472	6.783
0.00826	11.198	12.699	6.477
0.00950	11.434	12.094	6.294
0.01073	9.193	11.608	6.035
0.01196	9.328	11.202	5.866
0.01320	8.950	10.862	5.723
0.01402	9.422	10.662	5.638

N D POSITION	EXPERIMENTAL	THEORETICAL FLAT	THEORETICAL PARABOLIC
0.	189.060	204.815	21.360
0.00059	33.593	39.080	14.486
0.00147	22.403	25.727	11.024
0.00234	18.444	20.949	9.487
0.00322	17.327	18.313	8.577
0.00410	15.485	16.593	7.960
0.00497	14.220	15.361	7.503
0.00585	15.803	14.422	7.150
0.00673	16.735	13.682	6.863
0.00760	12.972	13.085	6.631
0.00848	13.164	12.583	6.421
0.00935	12.630	12.160	6.260
0.00994	13.296	11.909	6.158

N D POSITION	EXPERIMENTAL	THEORETICAL FLAT	THEORETICAL PARABOLIC
0.	111.865	204.815	21.360
0.00099	19.877	30.680	12.455
0.00248	13.255	20.459	9.321
0.00396	10.913	16.829	8.041
0.00545	10.232	14.829	7.303
0.00693	9.162	13.538	6.809
0.00841	8.414	12.621	6.446
0.00989	9.357	11.927	6.166
0.01138	9.547	10.953	5.942
0.01285	7.645	10.593	5.761
0.01433	7.789	10.292	5.609
0.01580	7.473	10.117	5.479
0.01680	7.867		5.402

N D POSITION	EXPERIMENTAL	THEORETICAL FLAT	THEORETICAL PARABOLIC
0.	213.589	204.815	21.360
0.00052	37.952	41.373	14.926
0.00130	26.309	27.169	11.458
0.00207	20.637	22.082	8.864
0.00285	19.575	19.272	8.913
0.00363	17.494	17.437	8.266
0.00440	16.065	16.122	7.788
0.00518	17.854	15.117	7.414
0.00595	18.228	14.325	7.113
0.00673	14.655	13.685	6.868
0.00750	14.671	13.146	6.655
0.00828	14.269	12.691	6.474
0.00880	15.021	12.421	6.366

N D POSITION	EXPERIMENTAL	THEORETICAL FLAT	THEORETICAL PARABOLIC
0.	223.924	204.815	21.360
0.00050	39.790	42.300	15.102
0.00124	26.535	27.752	11.630
0.00198	21.846	22.541	10.014
0.00272	20.523	19.661	9.048
0.00346	18.342	17.780	8.383
0.00420	16.843	16.430	7.901
0.00494	18.719	15.400	7.520
0.00568	19.111	14.586	7.213
0.00642	15.365	13.929	6.961
0.00716	15.592	13.378	6.745
0.00789	14.960	12.907	6.560
0.00839	15.749	12.630	6.450

N D POSITION	EXPERIMENTAL	THEORETICAL FLAT	THEORETICAL PARABOLIC
0.	113.131	204.815	21.360
0.00098	20.102	30.838	12.497
0.00245	13.406	20.558	9.354
0.00392	11.037	16.900	8.072
0.00538	10.368	14.894	7.329
0.00685	9.266	13.595	6.831
0.00831	8.509	12.671	6.466
0.00978	9.457	11.973	6.184
0.01125	9.655	11.427	5.960
0.01270	7.752	10.991	5.778
0.01417	7.877	10.629	5.621
0.01563	7.550	10.326	5.483
0.01661	7.956	10.149	5.416

TEST NUMBER AB-1-8

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

1.42875 1.37795 0.300

PARTICLE SIZE RANGE (MICRONS)

420-590

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM**3)

603.90 4.77 1.469

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.02753 1.0798 0.8254 25306.12 282.60

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL WALL PARTICLE RADIATIVE CONVECTIVE RADIATIVE

POSITION TEMPERATURE TEMPERATURE HEAT FLUX H T COEFF

(CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K)

0 37.78 30.00 15.457 21684.00 1.987

3.177 80.00 33.79 114.610 22873.19 2.480

7.946 111.67 39.72 211.934 23737.94 2.946

12.717 135.56 45.79 301.338 24371.93 3.357

17.490 148.89 51.94 352.883 24729.24 3.640

22.264 168.89 58.15 448.650 25230.54 4.051

27.039 187.22 64.42 549.236 25682.48 4.465

31.815 180.56 70.68 487.543 25542.76 4.437

36.591 185.00 76.85 498.762 25665.17 4.612

41.369 222.22 83.12 757.287 26522.90 5.444

46.149 227.22 89.47 779.413 26650.33 5.658

50.925 241.11 95.83 882.636 26962.04 6.075

54.117 237.78 100.05 836.985 26908.19 6.077

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA

KUNII SMITH KUNII BALDI

(1957) (1960) (1962) (1967) (1980)

SICARDI

(1967) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2868 0.1799 0.2033 0.1716 0.3435

PSEUDOHOMOGENEOUS PECLET NUMBER

279.1 4430.6 3921.8 4645.2 2320.5

AVERAGE EXPERIMENTAL NUSSELT NUMBER

14.057 22.410 19.836 23.495 11.737

11.870

TEST NUMBER AB-1-7
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 1.42875 1.37795 0.300
 PARTICLE SIZE RANGE (MICRONS)
 420-590

EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID
 (W) (CM/S) (G/CM³) FRACTION
 592.90 6.01 1.469 0.390

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS PARTICLE PARTICLE HEAT HEAT TRANSFER
 CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
 (W/MK) (W/MK) (WS/GK) (W/M²) (W/M²K)
 0.02699 1.0643 0.8146 24901.95 340.61

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES						
AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M ²)	CONVECTIVE HEAT FLUX (W/M ²)	RADIATIVE H T COEFF (W/M ² K)	CONVECTIVE H T COEFF (W/M ² K)
0.	43.33	30.00	27.232	22093.21	2.042	1656.991
3.177	75.56	33.05	102.897	23011.98	2.421	541.358
7.945	97.78	37.76	164.546	23633.96	2.742	393.767
12.715	117.22	42.55	228.107	24167.11	3.055	323.663
17.486	126.67	47.40	257.407	24427.15	3.247	308.154
22.258	142.22	52.27	318.490	24841.90	3.541	276.177
27.031	157.22	57.20	384.492	25233.90	3.844	252.277
31.805	164.44	62.15	412.512	25426.11	4.032	246.548
36.580	167.78	67.08	418.854	25321.34	4.160	253.450
41.355	183.33	72.03	501.721	25911.95	4.508	232.807
46.131	186.11	76.99	505.710	25992.41	4.635	238.204
50.908	198.33	81.96	573.329	26294.00	4.844	225.941
54.093	195.11	85.26	549.195	26252.73	4.955	236.839

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII BALDI
 (1957) (1960) SMITH SICARDI
 (1962) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2819 0.1767 0.1997 0.1686 0.3374 0.3336
 PSEUDOHOMOGENEOUS PECLET NUMBER
 3518.7 5612.8 4966.0
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 16.652 26.563 23.502 27.837 13.912 14.069

TEST NUMBER CC-3-1
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) 1D (CM) EMISSIVITY
 0.95250 0.77470 0.300
 PARTICLE SIZE RANGE (MICRONS)
 690-840
 EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID
 (W) (CM/S) (G/CM**3) FRACTION
 542.60 11.48 1.485 0.397
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS PARTICLE PARTICLE HEAT HEAT TRANSFER
 CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
 (W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
 0.02770 1.0849 0.8289 41442.62 359.63
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0	91.11	26.67	163.493	37036.68	2.537	574.707
2.226	123.89	30.00	281.593	38504.56	2.999	410.100
4.771	139.44	33.30	344.884	39191.78	3.268	371.920
7.316	154.44	37.84	413.289	39845.75	3.544	341.721
10.181	158.33	42.29	425.063	40021.04	3.663	344.890
13.045	168.89	46.75	475.669	40477.75	3.894	331.400
15.767	166.11	50.96	449.680	40370.30	3.905	350.597
19.094	178.33	56.10	511.545	40895.24	4.105	334.577
22.596	191.67	61.54	585.964	41459.57	4.503	316.620
26.099	202.22	67.01	646.879	41904.30	4.784	309.906
30.240	202.78	73.44	633.105	41944.65	4.895	324.298
34.381	210.00	79.83	669.030	42254.02	5.140	324.603
38.523	220.00	86.21	729.119	42671.53	5.450	316.955
43.303	230.00	93.59	789.316	43087.83	5.790	315.859
48.083	240.56	100.96	859.391	43521.11	6.156	311.756
52.864	227.78	108.23	717.834	43053.87	6.005	360.153

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII BALDI
 (1957) (1960) SMITH (1962) SICARDI
 (1962) (1980)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2800 0.1751 2004 0.1689 0.3341 0.3324
 PSEUDOHOMOGENEOUS PECLET NUMBER
 3908.3 6250.2 3460.1 6479.1 3275.6 3200.0
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 9.949 15.911 13.899 16.493 8.338 8.383

TEST NUMBER CC-3-2

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

0.95250 0.77470 0.300

PARTICLE SIZE RANGE (MICRONS)

590-840

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM³) VOID FRACTION

545.60 8.71 1.485 0.397

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY PARTICLE CONDUCTIVITY PARTICLE SPECIFIC HEAT HEAT FLUX HEAT TRANSFER COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M²) (W/M²*2K)

0.02866 1.1124 0.3475 41667.75 365.58

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION WALL TEMPERATURE PARTICLE TEMPERATURE RADIATIVE HEAT FLUX CONVECTIVE HEAT FLUX RADIATIVE H T COEFF CONVECTIVE H T COEFF

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M ²)	CONVECTIVE HEAT FLUX (W/M ²)	RADIATIVE H T COEFF (W/M ² *2K)	CONVECTIVE H T COEFF (W/M ² *2K)
0.	91.11	27.78	161.425	36602.31	2.549	577.931
2.226	124.44	32.10	279.922	38077.70	3.031	412.351
4.771	143.33	37.16	357.314	38900.70	3.365	366.401
7.317	160.56	42.23	437.426	39639.76	3.699	335.176
10.181	185.56	48.08	453.114	39861.58	3.857	339.305
13.046	178.89	53.86	520.499	40426.83	4.163	323.347
15.769	177.22	59.34	496.493	40371.01	4.212	342.484
19.096	191.67	66.02	574.203	40978.41	4.570	326.144
22.599	206.67	73.08	663.262	41598.75	4.865	311.410
26.104	218.89	80.17	739.767	42100.28	5.326	303.502
30.246	220.00	88.51	721.737	42169.72	5.489	320.705
34.388	220.56	96.79	703.691	42605.35	5.859	318.505
38.531	240.56	105.06	844.397	43015.43	6.212	317.464
43.313	251.67	114.88	914.519	43467.71	6.671	317.091
48.095	262.22	124.09	903.049	43894.79	7.117	317.779
52.878	252.78	133.48	844.223	43590.21	7.077	365.400

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

VAGI	KUNII	WILLIAMS	KRUPICZKA	SPECCHIA
KUNII	SMITH	KUNII	(1967)	BALDI
(1957)	(1960)	SMITH	(1962)	SICARDI
				(1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2886 0.1806 0.2066 0.1741 0.3447 0.3429

PSEUDOHOMOGENEOUS PECLET NUMBER

2944.1 4703.9 4112.3 4879.5 2465.0 2478.3

AVERAGE EXPERIMENTAL NUSSELT NUMBER

9.613 15.678 13.707 16.264 8.216 8.260

TEST NUMBER CC-3-3
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) 10 (CM) 0.300
 0.9520 0.7770 0.300
 PARTICLE SIZE RANGE (MICRONS)
 590-840
 EXPERIMENTAL VARIABLES
 POWER (W) 563.50
 VELOCITY (CM/S) 5.51
 DENSITY (G/CM**3) 1.485
 VOID FRACTION 0.397
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS CONDUCTIVITY (W/MK) 0.03081
 PARTICLE CONDUCTIVITY (W/MK) 1.1746
 PARTICLE SPECIFIC HEAT (WS/GK) 0.8875
 HEAT FLUX (W/M**2) 42669.59
 HEAT TRANSFER COEFFICIENT (W/M**2K) 368.03
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES
 AXIAL POSITION (CM) 0
 WALL TEMPERATURE (C) 93.33
 PARTICLE TEMPERATURE (C) 27.78
 RADIATIVE HEAT FLUX (W/M**2) 168.868
 CONVECTIVE HEAT FLUX (W/M**2) 36409.36
 RADIATIVE H T COEFF (W/M**2K) 2.576
 CONVECTIVE H T COEFF (W/M**2K) 555.397
 2.226 132.22 34.59 309.562 38112.38 3.171 390.385
 4.772 157.22 42.59 418.317 39184.35 3.649 341.827
 7.318 178.33 50.69 524.487 40072.47 4.109 313.943
 10.184 188.33 59.83 567.604 40499.43 4.417 315.154
 13.050 203.89 68.95 653.941 41143.19 4.846 304.904
 15.774 206.11 77.57 646.009 41255.31 5.026 320.961
 19.103 222.78 88.07 746.248 41935.54 5.540 311.300
 22.608 242.78 99.14 806.684 42729.54 6.173 297.490
 26.115 258.33 110.25 999.042 43342.36 6.747 292.690
 30.260 261.67 123.28 990.684 43515.92 7.087 314.454
 34.406 273.89 136.19 1035.618 44009.53 7.666 319.597
 38.552 287.78 149.05 1154.338 44535.81 8.321 321.175
 43.338 300.56 163.85 1294.047 45066.49 9.027 329.664
 48.125 315.00 178.59 1339.720 45631.31 9.821 334.519
 52.912 305.00 193.13 1106.867 45401.49 9.895 405.853
 DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNITI WILLHITE KRUPICZKA SPECCHIA
 KUNITI SMITH KUNITI BALOI SICARDI
 (1957) (1960) SMITH (1962) SICARDI (1980)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.3078 0.1930 0.2205 0.1858 0.3684 0.3664
 PSEUDOHOMOGENEOUS PECLET NUMBER
 1826.3 2912.3 2549.9 3025.2 1526.1 1534.4
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 9.262 14.770 12.932 15.342 7.740 7.782

TEST NUMBER BA-1-1
EXPERIMENTAL DATA
TUBE CHARACTERISTICS

CO (CM) ID (CM) EMISSIVITY
2.54000 2.47904 0.300
PARTICLE SIZE RANGE (MICRONS)
177-250

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY VOID
(W) (CM/S) (G/CM**3) FRACTION
1064.60 7.23 1.455 0.415

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT
CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX TRANSFER
(W/MK) (W/MK) (WS/GK) (W/M**2) COEFFICIENT
0.02589 1.0329 0.7922 25485.08 372.43

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0	49.44	29.44	41.981	22985.27	2.099	1149.264
2.224	65.56	30.47	80.023	23460.56	2.281	668.731
4.766	85.00	31.68	134.215	24024.63	2.517	450.538
7.310	103.33	32.91	194.233	24546.25	2.758	348.535
10.171	102.22	34.30	187.412	24517.85	2.759	360.986
13.033	121.11	35.71	258.539	25044.75	3.027	293.268
15.752	116.11	37.06	235.151	24309.57	2.975	315.110
19.076	122.22	38.70	257.093	25061.32	3.078	300.304
22.575	135.00	40.45	310.352	25431.80	3.262	268.969
26.075	148.89	42.21	374.814	25005.47	3.514	241.910
30.212	151.67	44.32	384.722	25883.10	3.584	241.114
34.349	165.00	46.43	453.605	26233.99	3.826	221.261
38.487	163.33	48.56	439.229	26195.93	3.827	228.234
43.262	173.89	51.01	496.067	26471.00	4.037	215.420
48.037	171.67	53.46	476.733	26420.50	4.033	223.512
52.813	166.11	55.92	562.440	26788.41	4.320	205.763

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI	KUNII	WILLHITE	KRUPICZKA	SPECCHIA	SPECCHIA
KUNII	SMITH	KUNII	(1967)	BAI DI	SICARDI
(1957)	(1960)	SMITH	(1962)	SICARDI	(1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2443	0.1516	0.1789	0.1507	0.2881	0.2911
PSEUDOHOMOGENEOUS PECLET NUMBER					
8455.1	13621.2	11542.9	13702.8	7168.1	7096.0

AVERAGE EXPERIMENTAL NUSSELT NUMBER

37.796	60.890	51.599	61.255	32.043	31.721

TEST NUMBER BA-1-2
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) 1.0000 ID (CM) 0.3000 EMISSIVITY 0.3000
 PARTICLE SIZE RANGE (MICRONS) 177-250
 EXPERIMENTAL VARIABLES
 POWER (W) 1076.30 VELOCITY (CM/S) 6.13 DENSITY (G/CM³) 1.455 VOID FRACTION 0.415
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS CONDUCTIVITY (W/MK) 0.02619 PARTICLE CONDUCTIVITY (W/MK) 1.0415 PARTICLE SPECIFIC HEAT (WS/GK) 0.7984 HEAT FLUX (W/M²) 25713.32 HEAT TRANSFER COEFFICIENT (W/M²K) 356.60
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M ²)	CONVECTIVE HEAT FLUX (W/M ²)	RADIATIVE H T COEFF (W/M ² K)	CONVECTIVE H T COEFF (W/M ² K)
0.	51.11	31.11	42.656	22993.75	2.133	1149.688
2.224	68.89	32.32	85.462	23516.14	2.337	643.108
4.767	90.00	33.74	146.265	24124.98	2.600	428.817
7.310	108.89	35.19	210.493	24658.50	2.856	334.600
10.172	108.33	36.84	205.025	24646.40	2.868	344.749
13.034	128.89	38.51	286.521	25213.92	3.170	278.974
15.754	123.89	40.10	261.283	25081.43	3.118	299.344
19.078	140.00	42.06	330.699	25513.90	3.376	250.555
22.578	143.89	44.13	345.295	25627.74	3.461	256.898
26.079	158.89	46.22	419.512	26025.27	3.723	230.991
30.216	162.78	48.71	435.710	26131.24	3.820	229.056
34.355	176.67	51.21	512.767	26489.99	4.088	211.156
38.493	174.44	53.72	493.049	26440.04	4.064	219.020
43.269	186.33	56.63	375.599	26792.70	4.370	203.427
48.046	185.00	59.53	546.094	26717.83	4.352	212.944
52.823	201.11	62.44	650.794	27117.25	4.693	195.555

 DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII (1967) BALDI
 (1957) (1960) SMITH (1962) SICARDI
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2468 0.1532 0.1808 0.1523 0.2912 0.2942
 PSEUDOHOMOGENEOUS PECLET NUMBER 7150.0 11515.2 9760.8 11587.0 6059.4 5998.8
 AVERAGE EXPERIMENTAL NUSSELT NUMBER 35.821 57.690 48.901 58.050 30.356 30.053

TEST NUMBER BA-1-3
EXPERIMENTAL DATA
TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY
2.54000 2.47904 0.300
PARTICLE SIZE RANGE (MICRONS)
177-250

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY VOID
(W) (CM/S) (G/CM**3) FRACTION
1074.10 5.14 1.485 0.415

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER
CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
0.02648 1.0498 0.8044 25607.70 336.38

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	51.67	32.22	41.800	22731.43	2.150	1169.045
2.224	72.22	33.65	92.141	23326.48	2.389	604.744
4.767	93.89	35.32	156.093	23941.14	2.665	408.797
7.311	113.89	37.04	226.268	24495.83	2.944	318.753
10.173	113.89	38.99	222.237	24499.86	2.967	327.099
13.035	135.56	40.96	311.870	25085.49	3.297	265.178
15.755	130.00	42.84	202.308	24942.08	3.239	266.163
19.080	139.44	45.14	321.291	25197.09	3.407	267.181
22.580	152.78	47.58	383.322	25549.54	3.644	242.869
26.081	166.33	50.05	464.834	25950.73	3.930	219.400
30.219	172.78	53.00	484.579	26060.76	4.046	217.638
34.358	187.78	55.96	573.490	26444.21	4.351	200.613
38.498	186.67	58.93	568.673	26424.66	4.374	205.871
43.275	198.89	62.36	634.835	26725.29	4.650	195.759
48.052	195.33	65.80	621.780	26722.18	4.691	201.620
52.830	214.44	69.24	734.499	27106.63	5.058	186.679

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

VAGI (1957)	KUNII SMITH (1960)	WILLHITE KUNII SMITH (1962)	KRUPICZKA (1967)	SPECCHIA BALDI SICARDI (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2492	0.1548	0.1826	0.1538	0.2942

PSEUDOHOMOGENEOUS PECLET NUMBER

6981.0	9629.6	9692.0	5067.0	5016.4

AVERAGE EXPERIMENTAL NUSSELT NUMBER

33.462	53.875	45.679	54.223	28.348	28.065

TEST NUMBER BA-1-4

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

2.54000 2.47904 0.300

PARTICLE SIZE RANGE (MICRONS)

177-250

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM³) VOID FRACTION

1081.10 4.15 1.455 0.415

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M²) (W/M²·K)

0.02684 1.0601 0.9116 25675.55 306.79

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL WALL PARTICLE RADIATIVE CONVECTIVE RADIATIVE

POSITION TEMPERATURE TEMPERATURE TEMPERATURE HEAT FLUX HEAT FLUX H T COEFF

(CM) (C) (C) (C) (W/M²) (W/M²) (W/M²·K)

0 53.33 32.78 44.652 2254.29 2.173

2.224 76.67 34.53 103.208 23169.22 2.449

4.767 100.00 36.59 174.808 23819.12 2.757

7.311 122.22 38.70 257.109 24422.12 3.078

10.174 123.89 41.10 239.168 24171.38 3.130

13.037 147.22 43.53 363.415 25064.60 3.505

15.758 142.78 45.65 335.973 24975.54 3.466

19.083 152.78 48.69 380.768 25237.76 3.658

22.584 167.22 51.71 451.429 25606.95 3.934

26.086 185.00 54.76 507.868 26047.46 4.284

30.225 189.44 58.40 576.715 26162.44 4.416

34.366 206.67 62.06 693.198 26573.50 4.794

38.507 207.22 65.74 687.759 26595.38 4.861

43.266 227.11 69.99 756.617 26929.01 5.205

48.065 220.56 74.23 770.015 26919.70 5.262

52.845 236.11 78.49 892.329 27270.30 5.661

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

VAGI KUNII WILLHITE KRUPICZKA SPECCHIA

KUNII SMITH KUNII SMITH BALDI SICARDI

(1957) (1960) (1962) (1967) (1980) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2522 0.1567 0.1848 0.1557 0.2978 0.3008

PSEUDOHOMOGENEOUS PECLET NUMBER

4818.0 7754.4 6576.8 7806.8 4080.0 4039.5

AVERAGE EXPERIMENTAL NUSSELT NUMBER

30.155 48.533 41.163 48.861 25.536 25.262

TEST NUMBER BA-1-5

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

2.54000 2.47904 0.300

PARTICLE SIZE RANGE (MICRONS)

177-250

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM**3)

1099.80 2.85 1.455

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE CONDUCTIVITY PARTICLE SPECIFIC HEAT HEAT FLUX HEAT TRANSFER

(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.02764 1.0831 0.8276 25994.59 284.53

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

POSITION WALL TEMPERATURE PARTICLE TEMPERATURE RADIATIVE HEAT FLUX CONVECTIVE HEAT FLUX RADIATIVE H T COEFF

(CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K)

0. 55.56 33.33 48.931 22414.46 2.202

2.224 83.89 35.88 122.383 23213.03 2.349

4.768 109.44 38.88 205.072 23914.38 2.306

7.312 135.00 41.96 307.116 24594.01 3.301

10.176 137.78 45.48 312.551 24673.39 3.386

13.040 163.89 49.03 441.333 25340.54 3.842

15.761 158.89 52.42 405.237 25224.41 3.806

19.087 171.67 56.56 469.205 25549.26 4.076

22.589 187.22 60.96 557.239 25933.75 4.413

26.093 207.22 65.42 680.616 26408.58 4.856

30.234 212.78 70.72 717.196 26548.13 5.049

34.376 231.11 76.04 854.854 26964.46 5.513

38.519 231.67 81.38 843.803 26992.28 5.614

43.300 248.33 87.53 979.209 27350.30 6.089

48.082 248.89 93.68 964.298 27391.02 6.213

52.864 262.22 99.82 1073.335 27678.20 6.640

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA

KUNII SMITH KUNII (1967) BALDI

(1957) (1960) SMITH (1962) SICARDI

(1957) (1960) SMITH (1962) SICARDI

(1957) (1960) SMITH (1962) SICARDI

(1957) (1960) SMITH (1962) SICARDI

(1957) (1960) SMITH (1962) SICARDI

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(1957) (1960) SMITH (1962) SICARDI

(1957) (1960) SMITH (1962) SICARDI

(1957) (1960) SMITH (1962) SICARDI

(1957) (1960) SMITH (1962) SICARDI

(1957) (1960) SMITH (1962) SICARDI

TEST NUMBER BA-1-6
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 2.54000 2.47904 0.300
 PARTICLE SIZE RANGE (MICRONS)
 177-250
 EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID FRACTION
 (W) (CM/S) (G/CM**3) (G/CM**3)
 1130.10 1.88 1.455 0.415
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS PARTICLE PARTICLE HEAT HEAT TRANSFER
 CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
 (W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
 0.02889 1.1191 0.8519 26301.76 229.58
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES
 AXIAL POSITION WALL TEMPERATURE PARTICLE TEMPERATURE RADIATIVE HEAT FLUX CONVECTIVE HEAT FLUX RADIATIVE H T COEFF CONVECTIVE H T COEFF
 (CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K) (W/M**2K)
 0. 62.78 33.33 67.130 22057.68 2.280 749.129
 2. 225 39.44 37.16 171.659 23052.26 2.756 370.102
 4. 769 131.11 41.69 289.796 23879.54 3.241 267.056
 7. 315 160.56 46.37 428.457 24616.73 3.752 215.582
 10. 179 166.67 51.69 451.212 24775.38 3.924 215.485
 13. 045 198.33 57.08 644.196 25520.17 4.561 180.675
 15. 769 194.44 62.24 603.490 25445.91 4.565 192.478
 19. 096 212.78 66.54 723.223 25867.69 5.014 179.339
 22. 601 230.56 75.23 852.348 26262.51 5.487 169.076
 26. 107 254.44 81.99 1057.223 26759.84 6.131 155.173
 30. 252 262.22 90.03 1111.855 26939.38 6.457 155.417
 34. 399 286.11 98.11 1353.566 27391.09 7.200 145.694
 38. 546 287.78 106.19 1344.341 27449.03 7.403 151.161
 43. 332 311.67 115.52 1616.717 27873.80 8.242 142.106
 48. 119 315.00 124.05 1623.896 27963.72 8.540 147.064
 52. 908 340.56 134.21 1963.093 28367.61 9.513 137.474
 DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAOI KUNIT WILLHITE KRUPICZKA SPECCHIA
 KUNIT SMITH KUNIT BALDI SICARDI
 (1957) (1960) SMITH (1967) (1960)
 (1962)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2693 0.1677 0.1973 0.1663 0.3187 0.3219
 PSEUDOHOMOGENEOUS PECLET NUMBER
 2139.7 3437.3 2920.0 3465.5 1808.0 1790.5
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 21.132 33.948 28.840 34.227 17.857 17.683

TEST NUMBER DA-1-7
LOCAL NUMBER
VACANT AND UNINITIALIZED PROFILES

THE EXPERIMENTAL

Position
0.
53.116
FLAK
20

[illegible]

TEST NUMBER BA-2-1

EXPERIMENTAL DATA
TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY
2.54000 2.47904 0.300
PARTICLE SIZE RANGE (MICRONS)
177-250

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY VOID
(W) (CM/S) (G/CM**3) FRACTION
1433.80 6.80 1.455 0.415

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY PARTICLE CONDUCTIVITY PARTICLE SPECIFIC HEAT HEAT FLUX HEAT TRANSFER COEFFICIENT
(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
0.02618 1.0412 0.7982 34116.69 333.76

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	58.89	27.22	68.903	29676.39	2.176	937.149
2.225	84.44	28.69	138.180	30643.63	2.479	949.657
4.768	110.56	30.43	226.262	31611.37	2.824	994.524
7.312	130.00	32.21	304.190	32317.60	3.111	330.489
10.175	135.56	34.24	325.703	32519.80	3.215	320.983
13.039	138.33	36.30	437.614	33327.52	3.586	273.069
15.760	153.33	38.27	406.462	33153.90	3.532	288.134
19.086	163.33	40.67	456.536	33505.20	3.722	273.154
22.588	180.00	43.23	551.079	34077.89	4.035	249.165
26.091	197.22	45.83	662.662	34655.92	4.377	228.914
30.231	202.22	48.92	691.980	34926.31	4.514	227.179
34.372	217.78	52.04	805.268	35333.53	4.859	213.184
38.514	217.78	55.16	797.790	35341.01	4.906	217.324
43.294	231.67	58.77	906.629	35785.20	5.244	206.971
48.074	231.67	62.38	897.409	35784.42	5.301	211.444
52.855	247.78	66.00	1037.186	36294.94	5.706	199.671

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
KUNII SMITH KUNII (1967) BALDI
(1957) (1960) SMITH (1960) SICARDI
(1960)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2467 0.1532 0.1807 0.1522 0.2911 0.2940
PSEUDOHOMOGENEOUS PECLET NUMBER
7699.1 12399.7 10510.5
AVERAGE EXPERIMENTAL NUSSELT NUMBER 12476.9 6524.9 6459.5
33.541 54.018 45.788 54.355 28.425 28.141

TEST NUMBER BA-2-2
EXPERIMENTAL DATA
TUBE CHARACTERISTICS
OD (CM) 10 CM
2.54000 2.47904 0.300
PARTICLE SIZE RANGE (MICRONS)
177-250
EXPERIMENTAL VARIABLES
POWER VELOCITY DENSITY VOID
(W) (CM/S) (G/CM**3) FRACTION
1417.80 5.54 1.455 0.415
AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
GAS PARTICLE PARTICLE
CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT HEAT HEAT TRANSFER
(W/MK) (W/MK) (WS/GK) FLUX COEFFICIENT
(W/M**2) (W/M**2K)
0.02666 1.0548 0.8079 33647.28 319.28
AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES
POSITION WALL PARTICLE RADIATIVE CONVECTIVE RADIATIVE CONVECTIVE
(CM) TEMPERATURE TEMPERATURE TEMPERATURE HEAT FLUX H T COEFF H T COEFF
(C) (C) (C) (W/M**2) (W/M**2) (W/M**2K) (W/M**2K)
0. 80.00 30.56 65.405 28004.72 2.221 985.066
2.225 88.89 32.26 145.544 30087.59 2.570 530.956
4.768 116.11 34.27 240.781 31045.88 2.942 379.366
7.313 138.33 36.35 334.619 31825.81 3.281 312.061
10.176 142.78 38.71 351.371 31983.53 3.376 307.328
13.041 167.78 41.10 481.459 32833.13 3.801 259.199
15.762 162.78 43.39 447.584 32671.40 3.749 273.663
19.089 173.33 45.19 503.683 33028.21 3.962 259.771
22.591 190.00 49.17 604.667 33578.25 4.293 238.423
26.094 208.33 52.19 730.351 34167.16 4.677 218.812
30.236 214.44 55.78 769.453 34365.90 4.950 216.399
34.378 231.67 59.41 905.023 34899.64 5.254 202.597
38.521 232.22 63.04 900.610 34925.62 5.323 206.439
43.302 247.22 67.24 1028.466 35379.49 5.714 196.574
48.083 247.78 71.45 1022.248 35407.23 5.797 200.802
52.866 262.22 75.66 1156.397 35832.20 6.198 192.065
DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
YAGI KUNII WILLHITE KRUPICZKA SPECCHIA SPECCHIA
KUNII SMITH KUNII BALDI SICARDI
(1957) (1960) SMITH (1962) SICARDI (1980)
THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
0.2507 0.1557 0.1836 0.1547 0.2959 0.2989
PSEUDOHOMOGENEOUS PECLET NUMBER
6442.6 10371.1 8794.6 10439.6 5457.0 5402.6
AVERAGE EXPERIMENTAL NUSSELT NUMBER
31.576 50.830 43.104 51.166 26.745 26.479

TEST NUMBER BA-2-3

EXPERIMENTAL DATA
TUBE CHARACTERISTICSOD (CM) 10.12
2.54000 2.47904 0.300
PARTICLE SIZE RANGE (MICRONS)
177-250

EXPERIMENTAL VARIABLES

POWER (W) 1407.10
VELOCITY (CM/S) 4.62
DENSITY (G/CM**3) 1.455
VOID FRACTION 0.415

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY (W/MK) 0.02715
PARTICLE CONDUCTIVITY (W/MK) 1.0689
SPECIFIC HEAT (NS/GK) 0.8178
HEAT FLUX (W/M**2) 33302.59
HEAT TRANSFER COEFFICIENT (W/M**2K) 310.17

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	60.56	33.33	61.403	28452.57	2.256	1045.196
2.225	92.22	35.33	150.462	29591.25	2.645	520.124
4.768	120.86	37.69	252.159	30584.19	3.043	389.099
7.313	149.89	40.13	353.909	31391.12	3.411	302.434
10.177	149.44	42.90	376.208	31572.43	3.531	296.331
13.042	175.00	45.71	514.994	32414.37	3.983	250.714
15.764	171.11	48.40	485.197	32295.12	3.954	263.189
19.091	182.22	51.69	547.041	32658.93	4.191	250.201
22.594	200.56	55.19	604.950	33242.08	4.574	228.579
26.098	220.00	58.74	807.121	33841.74	5.005	209.862
30.240	227.78	62.98	861.883	34083.20	5.230	206.815
34.383	245.00	67.24	1007.101	34592.90	5.666	194.604
38.527	246.67	71.51	1011.307	34652.00	5.774	197.840
43.309	262.22	76.46	1154.070	35099.43	6.212	188.944
48.092	262.78	81.40	1145.124	35129.44	6.313	193.679
52.876	278.33	86.34	1301.448	35562.11	6.779	185.229

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
KUNII SMITH KUNII (1967) BALDI
(1957) (1960) SMITH (1963) SICARDI
(1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2548 0.1583 0.1867 0.1572 0.3010 0.3040

PSEUDOHOMOGENEOUS PECLET NUMBER

6353.1 8613.1 7307.0 8673.4 4531.6 4485.7

AVERAGE EXPERIMENTAL NUSSELT NUMBER

30.180 48.559 41.195 48.898 25.548 25.295

TEST NUMBER BA-2-3 LEGAL MUSELL (1950), YARD AND KUNII (1950), N.D. EXPERIMENTAL				KUNII AND SMITH (1960) N.D. EXPERIMENTAL				THEORETICAL PARABOLIC			
POSITION	FLAT	THEORETICAL	PARABOLIC	POSITION	FLAT	THEORETICAL	PARABOLIC	POSITION	FLAT	THEORETICAL	PARABOLIC
0.00017	101.769	204.815	21.360	0.00010	163.746	204.815	21.360	0.00010	204.815	21.360	21.360
0.00036	325.976	48.000	16.360	0.00022	81.000	48.000	16.360	0.00022	81.000	16.360	16.360
0.00055	229.490	40.000	14.720	0.00034	54.450	40.000	14.720	0.00034	54.450	14.720	14.720
0.00076	234.461	34.882	12.556	0.00047	44.497	34.882	12.556	0.00047	44.497	12.556	12.556
0.00098	224.461	30.000	12.509	0.00061	36.357	30.000	12.509	0.00061	36.357	12.509	12.509
0.00113	222.473	26.000	11.109	0.00073	30.914	26.000	11.109	0.00073	30.914	11.109	11.109
0.00139	222.491	22.471	10.530	0.00085	26.971	22.471	10.530	0.00085	26.971	10.530	10.530
0.00155	220.491	19.000	9.057	0.00101	23.497	19.000	9.057	0.00101	23.497	9.057	9.057
0.00185	200.197	16.000	8.586	0.00117	20.587	16.000	8.586	0.00117	20.587	8.586	8.586
0.00215	18.027	13.000	8.566	0.00133	18.707	13.000	8.566	0.00133	18.707	8.566	8.566
0.00234	18.026	10.000	8.052	0.00149	16.452	10.000	8.052	0.00149	16.452	8.052	8.052
0.00259	18.926	7.000	8.052	0.00165	14.674	7.000	8.052	0.00165	14.674	7.000	7.000
KUNII AND SMITH (1960) N.D. EXPERIMENTAL				SPECCHIA AND SICARDI (1980) N.D. EXPERIMENTAL				THEORETICAL PARABOLIC			
POSITION	FLAT	THEORETICAL	PARABOLIC	POSITION	FLAT	THEORETICAL	PARABOLIC	POSITION	FLAT	THEORETICAL	PARABOLIC
0.00012	138.916	204.815	21.360	0.00010	164.091	204.815	21.360	0.00010	204.815	21.360	21.360
0.00026	49.107	97.000	17.258	0.00022	82.000	97.000	17.258	0.00022	82.000	17.258	17.258
0.00040	40.244	46.000	15.659	0.00034	54.782	46.000	15.659	0.00034	54.782	15.659	15.659
0.00056	39.446	39.000	14.947	0.00047	44.632	39.000	14.947	0.00047	44.632	14.947	14.947
0.00072	33.023	33.000	13.072	0.00061	36.632	33.000	13.072	0.00061	36.632	13.072	13.072
0.00085	33.023	29.000	12.246	0.00073	30.166	29.000	12.246	0.00073	30.166	12.246	12.246
0.00101	33.023	26.468	11.624	0.00085	26.166	26.468	11.624	0.00085	26.166	11.624	11.624
0.00124	32.777	22.977	11.009	0.00101	23.204	22.977	11.009	0.00101	23.204	11.009	11.009
0.00148	32.777	20.949	10.611	0.00117	20.814	20.949	10.611	0.00117	20.814	10.611	10.611
0.00171	32.777	18.948	9.452	0.00133	18.915	18.948	9.452	0.00133	18.915	9.452	9.452
0.00198	32.777	16.948	8.452	0.00149	16.915	16.948	8.452	0.00149	16.915	8.452	8.452
0.00221	32.777	14.948	8.452	0.00165	14.915	14.948	8.452	0.00165	14.915	8.452	8.452
0.00239	32.777	12.948	8.452	0.00181	12.915	12.948	8.452	0.00181	12.915	8.452	8.452
BALDI AND SICARDI (1980) N.D. EXPERIMENTAL				SPECCHIA AND SICARDI (1980) N.D. EXPERIMENTAL				THEORETICAL PARABOLIC			
POSITION	FLAT	THEORETICAL	PARABOLIC	POSITION	FLAT	THEORETICAL	PARABOLIC	POSITION	FLAT	THEORETICAL	PARABOLIC
0.00020	65.132	204.815	21.360	0.00010	65.298	204.815	21.360	0.00010	204.815	21.360	21.360
0.00025	32.455	45.000	15.052	0.00022	45.475	45.000	15.052	0.00022	45.475	15.052	15.052
0.00030	32.455	37.000	14.095	0.00034	37.154	37.000	14.095	0.00034	37.154	14.095	14.095
0.00035	32.455	32.000	12.885	0.00047	32.221	32.000	12.885	0.00047	32.221	12.885	12.885
0.00040	32.455	28.000	11.885	0.00061	28.221	28.000	11.885	0.00061	28.221	11.885	11.885
0.00045	32.455	24.000	10.885	0.00073	24.221	24.000	10.885	0.00073	24.221	10.885	10.885
0.00050	32.455	20.000	9.885	0.00085	20.221	20.000	9.885	0.00085	20.221	9.885	9.885
0.00055	32.455	16.000	8.885	0.00101	16.221	16.000	8.885	0.00101	16.221	8.885	8.885
0.00060	32.455	12.000	7.885	0.00117	12.221	12.000	7.885	0.00117	12.221	7.885	7.885
0.00065	32.455	8.000	6.885	0.00133	8.221	8.000	6.885	0.00133	8.221	6.885	6.885
0.00070	32.455	4.000	5.885	0.00149	4.221	4.000	5.885	0.00149	4.221	5.885	5.885
0.00075	32.455	0.000	4.885	0.00165	0.221	0.000	4.885	0.00165	0.221	4.885	4.885
0.00080	32.455	0.000	3.885	0.00181	0.221	0.000	3.885	0.00181	0.221	3.885	3.885
0.00085	32.455	0.000	2.885	0.00197	0.221	0.000	2.885	0.00197	0.221	2.885	2.885
0.00090	32.455	0.000	1.885	0.00213	0.221	0.000	1.885	0.00213	0.221	1.885	1.885
0.00095	32.455	0.000	0.885	0.00229	0.221	0.000	0.885	0.00229	0.221	0.885	0.885
0.00100	32.455	0.000	0.000	0.00245	0.221	0.000	0.000	0.00245	0.221	0.000	0.000

TEST NUMBER BA-2-4

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

2.54000 2.47804 0.300

PARTICLE SIZE RANGE (MICRONS)

177-250

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM**3)

1378.00 3.74 1.455

VOID

FRACTION

0.415

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT HEAT TRANSFER

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.02757 1.0812 0.8263 32490.57 289.30

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	61.11	33.89	61.723	27484.75	2.267	1009.644
2.225	96.11	36.28	161.780	28691.30	2.704	479.357
4.769	126.67	39.11	275.428	29719.54	3.146	339.437
7.314	150.56	42.03	383.866	30498.62	3.537	281.029
10.178	157.78	45.36	415.302	30755.00	3.694	273.397
13.043	185.56	48.74	575.756	31602.42	4.208	230.981
15.768	181.67	51.97	542.702	31491.70	4.185	242.816
19.093	194.44	55.92	619.401	31886.96	4.472	230.196
22.697	213.89	60.13	754.209	32468.80	4.905	211.164
26.102	233.33	64.39	906.940	33031.00	5.368	195.520
30.245	242.22	69.48	974.656	33289.53	5.642	192.707
34.390	260.56	74.59	1142.018	33793.91	6.141	181.720
38.535	261.67	79.71	1138.537	33838.05	6.257	185.969
43.318	278.33	85.62	1303.734	34282.09	6.765	177.896
48.103	280.56	91.54	1310.264	34356.70	6.932	181.767
52.888	295.56	97.46	1472.237	34741.78	7.432	175.375

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI	KUNII	WILLHITE	KRUPICZKA	SPECCHIA
KUNII	SMITH	KUNII	(1967)	BALDI
(1957)	(1960)	SMITH	(1962)	SICARDI
				(1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2583 0.1606 0.1893 0.1595 0.3053 0.3084

PSEUDOHOMOGENEOUS PECLET NUMBER

4912.4 6905.8 5886.1 6986.5 3648.9 3612.9

AVERAGE EXPERIMENTAL NUSSELT NUMBER

27.761 44.650 37.892 44.976 23.490 23.259

TEST NUMBER BA-2-5

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

2.54000 2.47904 0.300

PARTICLE SIZE RANGE (MICRONS)

177-250

EXPERIMENTAL VARIABLES

POWER (W) VELOCITY (CM/S) DENSITY (G/CM³)

1398.60 2.83 1.455

VOID FRACTION

0.415

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY (W/MK) PARTICLE CONDUCTIVITY (W/MK) PARTICLE SPECIFIC HEAT (J/GK) HEAT FLUX (W/M²) HEAT TRANSFER COEFFICIENT (W/M²K)

0.02831 1.1024 0.8408 32729.06 281.47

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM) WALL TEMPERATURE (C) PARTICLE TEMPERATURE (C) RADIATIVE HEAT FLUX (W/M²) CONVECTIVE HEAT FLUX (W/M²) RADIATIVE H T COEFF (W/M²K) CONVECTIVE H T COEFF (W/M²K)

0.	64.44	33.89	70.389	27217.47	2.304	890.754
2.225	105.56	37.02	194.180	28609.49	2.833	417.463
4.769	138.89	40.76	328.107	29339.19	3.344	302.657
7.315	166.11	44.81	464.001	30338.87	3.820	251.520
10.180	175.00	49.01	507.535	30839.83	4.028	244.783
13.046	205.00	53.47	701.993	31737.64	4.633	209.454
15.770	202.78	57.75	674.994	31603.87	4.654	218.467
19.099	218.33	62.97	782.639	32141.16	5.038	206.881
22.604	238.89	68.53	946.224	32722.41	5.554	192.077
26.111	260.56	74.16	1143.252	33305.42	6.133	178.698
30.256	269.44	80.86	1218.587	33553.71	6.462	177.923
34.403	291.11	87.59	1449.060	34102.45	7.124	167.564
38.550	294.44	94.34	1468.990	34203.13	7.341	170.927
43.337	313.89	102.13	1638.672	34671.33	8.022	163.732
48.124	316.67	109.92	1706.807	34751.16	8.263	168.133
52.913	332.78	117.69	1914.035	35132.24	8.899	163.341

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAOI	KUNII	WILLHITE	KRUPICZKA	SPECCHIA	SPECCHIA
(1957)	(1960)	(1962)	(1967)	(1980)	(1980)
	SMITH	SMITH	BALDI	SICARDI	SICARDI

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2645 0.1648 0.1938 0.1633 0.3128 0.3159

PSEUDOHOMOGENEOUS PECLET NUMBER

3244.1 5214.2 4427.6 5255.0 2742.9 2716.1

AVERAGE EXPERIMENTAL NUSSELT NUMBER

24.507 39.390 33.448 39.698 20.721 20.518

TEST NUMBER BA-2-5				LOCAL NUSSELL NUMBER				YAGI AND KUNII (1957)				SMITH AND KUNII (1960)				SMITH AND KUNII (1967)			
POSITION		THEORETICAL PARABOLIC		POSITION		THEORETICAL PARABOLIC		POSITION		THEORETICAL PARABOLIC		POSITION		THEORETICAL PARABOLIC		POSITION		THEORETICAL PARABOLIC	
0.00028	0.00033	0.00039	0.00050	0.00065	0.00082	0.00115	0.00155	0.00205	0.00265	0.00335	0.00415	0.00505	0.00605	0.00715	0.00835	0.00965	0.01105	0.01255	0.01415
20.4	33.5	48.5	63.5	78.5	93.5	108.5	123.5	138.5	153.5	168.5	183.5	198.5	213.5	228.5	243.5	258.5	273.5	288.5	303.5
1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
1.1	1.2	1.3	1																

TEST NUMBER BA-2-6

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) 1.95 EMISSIVITY 0.300
 2.54000 2.47904
 PARTICLE SIZE RANGE (MICRONS)

EXPERIMENTAL VARIABLES

POWER (W) 1419.00 VELOCITY (CM/S) 1.95 DENSITY (G/CM**3) 1.455 VOID FRACTION 0.415

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY (W/MK) 0.02965 PARTICLE CONDUCTIVITY (W/MK) 1.1410 PARTICLE SPECIFIC HEAT (WS/GK) 0.8663 HEAT FLUX (W/M**2) 32705.56 HEAT TRANSFER COEFFICIENT (W/M**2K) 226.57

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	70.00	34.44	84.334	26565.29	2.372	747.149
2.225	118.89	38.89	242.737	28152.22	3.034	351.910
4.771	157.22	44.22	413.778	29341.59	3.670	259.644
7.317	188.33	49.72	592.087	30264.56	4.271	218.331
10.184	200.56	56.00	662.985	30624.77	4.586	211.848
13.051	235.00	62.37	927.178	31572.03	5.371	182.891
15.777	260.56	68.56	1150.966	32235.70	6.037	167.901
19.108	252.22	76.12	1052.579	32050.41	5.977	181.994
22.616	274.44	84.02	1264.445	32815.68	5.640	171.282
26.125	301.11	92.04	1562.002	33247.80	7.471	159.023
30.273	313.89	101.57	1700.713	33553.43	8.010	158.032
34.424	341.67	111.16	2079.022	34138.57	9.019	148.102
38.575	350.00	120.79	2175.831	34330.12	9.493	149.775
43.367	373.33	131.91	2537.351	34774.32	10.510	144.039
48.160	379.44	143.02	2599.561	34922.73	10.995	147.714
52.954	392.78	154.08	2805.096	35176.13	11.752	147.367

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

VAGI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII BALDI
 (1957) (1960) SMITH (1967) SICARDI
 (1962) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2757 0.1717 0.2020 0.1702 0.3264 0.3296

PSEUDOHOMOGENEOUS PECLET NUMBER

2214.5 3555.2 3021.8 3586.2 1069.9 1851.8

AVERAGE EXPERIMENTAL NUSSELT NUMBER

20.376 32.712 27.804 32.997 17.205 17.039

TEST NUMBER BA-3-1

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY
2.54000 2.47904 0.300
PARTICLE SIZE RANGE (MICRONS)
177-250

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY VOID
(W) (CM/S) (G/CM**3) FRACTION
1393.80 4.82 1.455 0.415

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER
CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
0.02682 1.0595 0.8112 33020.01 307.49

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES
AXIAL WALL PARTICLE RADIATIVE CONVECTIVE RADIATIVE CONVECTIVE
POSITION TEMPERATURE TEMPERATURE HEAT FLUX H T COEFF H T COEFF
(CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K) (W/M**2K)

0.	65.56	28.89	83.044	28560.66	2.265	779.145
2.225	87.78	30.90	144.584	29366.98	2.542	516.309
4.768	114.44	33.26	236.083	30304.33	2.908	373.289
7.313	137.22	35.69	330.655	31086.00	3.257	306.173
10.176	142.22	38.46	349.151	31259.53	3.365	301.256
13.040	165.00	41.26	464.925	32017.07	3.757	258.740
15.762	166.67	43.94	468.805	32077.00	3.820	261.376
19.089	175.00	47.23	511.597	32353.04	4.004	253.208
22.591	195.56	50.72	639.659	33010.07	4.416	227.916
26.095	212.78	54.27	759.922	33546.05	4.794	211.637
30.237	222.22	58.50	826.162	33839.10	5.046	206.684
34.380	237.22	62.75	946.349	34288.67	5.424	196.532
38.523	241.67	67.02	976.145	34427.49	5.589	197.129
43.305	252.22	71.95	1064.550	34739.17	5.905	192.703
48.087	258.33	76.88	1112.280	34922.82	6.130	192.460
52.870	267.78	81.81	1197.472	35194.87	6.439	189.253

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
KUNII SMITH KUNII BALDI
(1957) (1960) SMITH (1967) SICARDI
(1962) (1900)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2520 0.1536 0.1846 0.1555 0.2976 0.3006

PSEUDOHOMOGENEOUS PECLET NUMBER

5369.3 8641.9 7329.4 8700.2 4547.0 4501.8

AVERAGE EXPERIMENTAL NUSSELT NUMBER

30.245 48.680 41.286 49.008 25.613 25.358

TEST NUMBER BA-3-1 LOCAL NUSSELL NUMBER PROFILES YAGI AND KUNII (1957)				KUNII AND SMITH (1960)				THEORETICAL PARABOLIC			
POSITION	EXPERIMENTAL	THEORETICAL	FLAT	POSITION	EXPERIMENTAL	THEORETICAL	FLAT	POSITION	EXPERIMENTAL	THEORETICAL	FLAT
0	76.697	204.815	204.815	0	123.445	123.445	123.445	0	123.445	123.445	123.445
0.00017	50.844	70.880	70.880	0.00010	181.833	181.833	181.833	0.00010	181.833	181.833	181.833
0.00036	36.777	49.350	49.350	0.00022	59.193	59.193	59.193	0.00022	59.193	59.193	59.193
0.00055	30.374	40.374	40.374	0.00034	48.570	48.570	48.570	0.00034	48.570	48.570	48.570
0.00072	26.977	36.977	36.977	0.00047	47.084	47.084	47.084	0.00047	47.084	47.084	47.084
0.00113	22.473	32.473	32.473	0.00059	44.185	44.185	44.185	0.00059	44.185	44.185	44.185
0.00143	22.473	32.473	32.473	0.00069	41.194	41.194	41.194	0.00069	41.194	41.194	41.194
0.00195	22.473	32.473	32.473	0.00083	36.537	36.537	36.537	0.00083	36.537	36.537	36.537
0.00226	22.473	32.473	32.473	0.00100	32.837	32.837	32.837	0.00100	32.837	32.837	32.837
0.00256	19.406	20.126	20.126	0.00120	31.330	31.330	31.330	0.00120	31.330	31.330	31.330
0.00287	19.406	20.126	20.126	0.00148	30.532	30.532	30.532	0.00148	30.532	30.532	30.532
0.00318	19.406	20.126	20.126	0.00178	30.092	30.092	30.092	0.00178	30.092	30.092	30.092
0.00359	18.010	17.528	17.528	0.00205	30.092	30.092	30.092	0.00205	30.092	30.092	30.092
0.00394	18.010	17.528	17.528	0.00235	30.092	30.092	30.092	0.00235	30.092	30.092	30.092
0.00435	18.010	17.528	17.528	0.00265	30.092	30.092	30.092	0.00265	30.092	30.092	30.092
WILLHITE, KUNII AND SMITH (1962)				KRUPICZKA (1967)				THEORETICAL PARABOLIC			
POSITION	EXPERIMENTAL	THEORETICAL	FLAT	POSITION	EXPERIMENTAL	THEORETICAL	FLAT	POSITION	EXPERIMENTAL	THEORETICAL	FLAT
0	104.696	204.815	204.815	0	124.377	124.377	124.377	0	124.377	124.377	124.377
0.00012	69.404	81.967	81.967	0.00010	182.305	182.305	182.305	0.00010	182.305	182.305	182.305
0.00026	50.202	57.256	57.256	0.00022	59.592	59.592	59.592	0.00022	59.592	59.592	59.592
0.00050	40.523	46.722	46.722	0.00034	48.997	48.997	48.997	0.00034	48.997	48.997	48.997
0.00071	35.828	39.530	39.530	0.00047	46.345	46.345	46.345	0.00047	46.345	46.345	46.345
0.00086	34.184	36.923	36.923	0.00059	44.764	44.764	44.764	0.00059	44.764	44.764	44.764
0.00104	34.090	36.923	36.923	0.00069	40.465	40.465	40.465	0.00069	40.465	40.465	40.465
0.00123	32.912	32.912	32.912	0.00083	36.437	36.437	36.437	0.00083	36.437	36.437	36.437
0.00143	32.912	32.912	32.912	0.00100	33.055	33.055	33.055	0.00100	33.055	33.055	33.055
0.00168	32.912	32.912	32.912	0.00120	31.449	31.449	31.449	0.00120	31.449	31.449	31.449
0.00193	32.912	32.912	32.912	0.00148	30.639	30.639	30.639	0.00148	30.639	30.639	30.639
0.00210	32.912	32.912	32.912	0.00178	30.203	30.203	30.203	0.00178	30.203	30.203	30.203
0.00235	32.912	32.912	32.912	0.00205	30.203	30.203	30.203	0.00205	30.203	30.203	30.203
0.00265	32.912	32.912	32.912	0.00235	30.203	30.203	30.203	0.00235	30.203	30.203	30.203
0.00288	32.912	32.912	32.912	0.00265	30.203	30.203	30.203	0.00265	30.203	30.203	30.203
BALDI AND SICARDI (1980)				SPECCHIA AND SICARDI (1980)				THEORETICAL PARABOLIC			
POSITION	EXPERIMENTAL	THEORETICAL	FLAT	POSITION	EXPERIMENTAL	THEORETICAL	FLAT	POSITION	EXPERIMENTAL	THEORETICAL	FLAT
0	64.951	204.815	204.815	0	64.306	64.306	64.306	0	64.306	64.306	64.306
0.00020	43.057	45.621	45.621	0.00030	43.629	43.629	43.629	0.00030	43.629	43.629	43.629
0.00042	31.145	37.363	37.363	0.00040	30.835	30.835	30.835	0.00040	30.835	30.835	30.835
0.00065	23.735	28.633	28.633	0.00055	25.301	25.301	25.301	0.00055	25.301	25.301	25.301
0.00090	17.607	22.633	22.633	0.00070	21.897	21.897	21.897	0.00070	21.897	21.897	21.897
0.00113	14.958	20.633	20.633	0.00085	19.611	19.611	19.611	0.00085	19.611	19.611	19.611
0.00139	12.826	18.545	18.545	0.00100	17.545	17.545	17.545	0.00100	17.545	17.545	17.545
0.00168	11.747	16.933	16.933	0.00120	15.933	15.933	15.933	0.00120	15.933	15.933	15.933
0.00200	10.727	15.433	15.433	0.00140	14.747	14.747	14.747	0.00140	14.747	14.747	14.747
0.00236	9.877	14.333	14.333	0.00160	13.747	13.747	13.747	0.00160	13.747	13.747	13.747
0.00266	9.277	13.433	13.433	0.00180	12.747	12.747	12.747	0.00180	12.747	12.747	12.747
0.00303	8.747	12.633	12.633	0.00200	11.747	11.747	11.747	0.00200	11.747	11.747	11.747
0.00339	8.277	11.933	11.933	0.00220	10.747	10.747	10.747	0.00220	10.747	10.747	10.747
0.00375	7.747	11.233	11.233	0.00240	9.747	9.747	9.747	0.00240	9.747	9.747	9.747
0.00415	7.277	10.533	10.533	0.00260	8.747	8.747	8.747	0.00260	8.747	8.747	8.747

TEST NUMBER BA-3-2

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

2.54000 2.47904 0.300

PARTICLE SIZE RANGE (MICRONS)

177-255

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM³)

1425.60 4.12 1.455

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY PARTICLE CONDUCTIVITY PARTICLE SPECIFIC HEAT

(W/MK) (W/MK) (WS/GK)

0.02729 1.0729 0.8206

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION WALL TEMPERATURE PARTICLE TEMPERATURE

(CM) (C) (C)

0. 68.33 31.67

2.225 92.22 33.94

4.769 120.00 36.62

7.314 143.89 39.38

10.177 149.44 42.52

13.042 174.44 45.69

15.764 176.11 48.75

19.091 185.56 52.48

22.594 207.22 56.45

26.099 226.67 60.49

30.242 236.11 65.30

34.386 253.33 70.14

38.530 257.22 75.00

43.313 269.44 80.60

48.097 278.00 86.21

52.882 286.11 91.81

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNITI WILLHITE KRUPICZKA SPECCHIA

(1957) (1960) (1962) (1967) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2559 0.1591 0.1875 0.1580 0.3024 0.3054

PSEUDOHOMOGENEOUS PECLET NUMBER 7710.7 4028.2 3988.3

AVERAGE EXPERIMENTAL NUSSELT NUMBER 29.383 47.271 40.107 47.606 24.870 24.624

HEAT FLUX (W/M²)

85.219 153.238 252.035 355.487 377.040 511.604 515.038 567.042 711.583 858.754 925.542 1080.721 1106.356 1219.372 1263.828 1375.127

CONVECTIVE COEFFICIENT (W/M²K)

26914.40 29778.05 30759.29 31581.82 31775.29 32606.22 32667.05 32978.97 33667.73 34266.50 34557.37 35064.59 35187.43 35540.58 35707.77 36019.33

RADIATIVE COEFFICIENT (W/M²K)

2.324 2.629 3.023 3.401 3.528 3.974 4.044 4.261 4.720 5.168 5.442 5.899 6.071 6.457 6.694 7.077

CONVECTIVE H T COEFF (W/M²K)

788.574 510.951 368.912 302.182 297.162 253.253 256.483 247.816 223.300 206.199 202.309 191.406 193.098 188.201 189.137 185.381

HEAT TRANSFER COEFFICIENT (W/M²K)

33683.55 303.95

VOID FRACTION 0.415

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION WALL TEMPERATURE PARTICLE TEMPERATURE

(CM) (C) (C)

0. 68.33 31.67

2.225 92.22 33.94

4.769 120.00 36.62

7.314 143.89 39.38

10.177 149.44 42.52

13.042 174.44 45.69

15.764 176.11 48.75

19.091 185.56 52.48

22.594 207.22 56.45

26.099 226.67 60.49

30.242 236.11 65.30

34.386 253.33 70.14

38.530 257.22 75.00

43.313 269.44 80.60

48.097 278.00 86.21

52.882 286.11 91.81

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNITI WILLHITE KRUPICZKA SPECCHIA

(1957) (1960) (1962) (1967) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2559 0.1591 0.1875 0.1580 0.3024 0.3054

PSEUDOHOMOGENEOUS PECLET NUMBER 7710.7 4028.2 3988.3

AVERAGE EXPERIMENTAL NUSSELT NUMBER 29.383 47.271 40.107 47.606 24.870 24.624

HEAT FLUX (W/M²)

85.219 153.238 252.035 355.487 377.040 511.604 515.038 567.042 711.583 858.754 925.542 1080.721 1106.356 1219.372 1263.828 1375.127

CONVECTIVE COEFFICIENT (W/M²K)

26914.40 29778.05 30759.29 31581.82 31775.29 32606.22 32667.05 32978.97 33667.73 34266.50 34557.37 35064.59 35187.43 35540.58 35707.77 36019.33

TEST NUMBER BA-3-3

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

2.54000 2.47904 0.300

PARTICLE SIZE RANGE (MICRONS)

177-250

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM**3)

1414.80 3.50 1.455

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX

(W/MK) (W/MK) (WS/GK) (W/M**2)

0.02767 1.0840 0.8283 33314.31

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL WALL PARTICLE RADIATIVE CONVECTIVE RADIATIVE

POSITION TEMPERATURE TEMPERATURE TEMPERATURE HEAT FLUX HEAT FLUX H T COEFF

(CM) (C) (C) (C) (W/M**2) (W/M**2) (W/M**2K)

0. 70.00 32.22 80.728 28366.54 2.349 750.879

2.225 96.11 34.85 164.657 29207.26 2.688 479.083

4.769 126.11 37.95 275.405 30317.83 3.124 343.900

7.314 151.67 41.15 391.588 31170.65 3.543 282.033

10.178 157.78 44.79 416.571 31376.94 3.687 277.690

13.043 183.33 48.47 561.743 32197.07 4.165 238.739

15.766 186.67 52.01 575.546 32308.96 4.274 239.531

19.094 197.78 56.34 642.043 32661.05 4.539 230.918

22.536 218.89 60.94 792.420 33304.41 5.017 210.860

25.103 238.89 65.62 954.091 33832.78 5.506 195.606

30.247 249.44 71.19 1039.237 34202.74 5.830 191.875

34.392 267.22 76.79 1206.525 34699.70 6.336 182.218

38.538 271.11 82.41 1232.205 34819.13 6.530 184.519

43.322 286.11 88.89 1384.760 35225.60 7.021 176.610

48.107 291.11 95.37 1423.955 35372.51 7.275 180.714

62.893 303.33 101.85 1556.914 35693.90 7.727 177.155

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

VAGI KUNII WILLHITE KRUPICZKA SPECCHIA

KUNII SMITH KUNII BALDI

(1957) (1960) SMITH SICARDI

(1962) (1960) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2592 0.1612 0.1839 0.1600 0.3063 0.3094

PSEUDOHOMOGENEOUS PECLET NUMBER

4029.7 6400.6 5500.3 6528.5 3409.4 3375.6

AVERAGE EXPERIMENTAL NUSSELT NUMBER

27.527 44.269 37.572 44.595 23.269 23.060

TEST NUMBER BA-3-4
EXPERIMENTAL DATA
TUBE CHARACTERISTICS
OD (CM) ID (CM) EMISSIVITY
2.54000 2.47904 0.300
PARTICLE SIZE RANGE (MICRONS)
177-250

EXPERIMENTAL VARIABLES
POWER VELOCITY DENSITY VOID
(W) (CM/S) (G/CM**3) FRACTION
1467.20 2.27 1.455 0.415

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS	PARTICLE	PARTICLE	HEAT	HEAT TRANSFER
CONDUCTIVITY	CONDUCTIVITY	SPECIFIC HEAT	FLUX	COEFFICIENT
(W/MK)	(W/MK)	(WS/GK)	(W/M**2)	(W/M**2K)
0.02906	1.1241	0.8552	34023.02	238.82

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	78.33	32.22	112.701	28184.56	2.444	611.231
2.226	115.00	36.27	232.273	29439.17	2.950	373.947
4.770	150.56	41.09	385.889	30612.38	3.525	279.641
7.315	183.89	45.97	392.862	30729.51	3.640	284.742
10.181	191.11	51.54	606.747	31896.00	4.347	228.349
13.049	221.67	57.29	824.552	32810.27	5.016	199.599
15.779	226.67	62.80	852.802	32966.54	5.204	201.174
19.103	242.22	69.34	974.484	33418.17	5.643	193.522
22.610	255.56	76.70	1186.816	34061.72	6.295	180.359
26.118	290.56	83.96	1454.536	34712.34	7.041	168.023
30.266	303.89	92.61	1596.481	35057.93	7.556	165.931
34.415	327.22	101.30	1893.391	35612.18	8.381	157.630
38.566	335.00	110.01	1976.759	35809.96	8.795	159.164
43.356	353.33	120.06	2234.753	36220.27	9.580	155.268
48.147	363.89	130.10	2374.042	36463.88	10.155	155.971
52.940	371.11	140.10	2457.788	36641.81	10.639	158.615

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
KUNII SMITH KUNII (1967) BALDI
(1957) (1960) SMITH (1962) SICCARDI
(1957) (1960) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
0.2708 0.1686 0.1984 0.1672 0.3205 0.3236
PSEUDOHOMOGENEOUS PECLET NUMBER
2584.2 4150.8 3526.7 4185.5 2183.3 2162.1
AVERAGE EXPERIMENTAL NUSSELT NUMBER
21.866 35.121 29.840 35.414 18.474 18.294

TEST NUMBER BA-3-5

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

2.54000 2.47904 0.300

PARTICLE SIZE RANGE (MICRONS)

177-250

EXPERIMENTAL VARIABLES

POWER (W) VELOCITY (CM/S)

1456.00 2.01

DENSITY (G/CM³)

1.455

VOID FRACTION

0.415

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS

CONDUCTIVITY (W/MK)

0.02952 1.1372

PARTICLE CONDUCTIVITY (W/MK)

1.1372

PARTICLE SPECIFIC HEAT (WS/GK)

0.8638

HEAT FLUX (W/M²)

33625.76

HEAT TRANSFER COEFFICIENT (W/M²K)

230.57

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)

WALL TEMPERATURE (C)

PARTICLE TEMPERATURE (C)

RADIATIVE HEAT FLUX (W/M²)CONVECTIVE HEAT FLUX (W/M²)RADIATIVE H T COEFF (W/M²K)CONVECTIVE H T COEFF (W/M²K)

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M ²)	CONVECTIVE HEAT FLUX (W/M ²)	RADIATIVE H T COEFF (W/M ² K)	CONVECTIVE H T COEFF (W/M ² K)
0.226	80.56	32.78	118.300	27715.03	2.476	580.082
2.771	119.33	37.26	243.815	28977.58	3.007	357.431
4.771	155.00	42.59	405.254	30156.42	3.514	268.262
7.317	186.11	48.08	580.944	31115.13	4.209	225.422
10.183	198.67	54.35	638.945	31440.70	4.490	220.916
13.051	227.22	60.69	862.999	32324.17	5.182	194.104
16.775	234.44	66.78	910.822	32537.81	5.431	194.065
19.106	249.44	74.23	1030.598	32959.40	5.882	188.110
22.614	275.56	82.14	1262.847	33647.62	6.633	173.970
26.123	301.11	90.17	1568.180	34279.73	7.434	162.511
30.271	315.56	99.79	1730.673	34634.56	8.010	160.474
34.422	337.78	103.32	2024.636	35134.36	8.862	153.790
38.573	348.33	118.94	2155.963	35379.31	9.398	154.227
43.364	366.67	130.02	2424.054	35763.53	10.244	151.129
48.157	379.44	141.11	2808.953	36032.34	10.947	151.186
52.951	385.00	152.14	2660.364	36177.96	11.425	155.364

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI

KUNII

WILLHITE

KRUPICZKA

SPECCHIA

SPECCHIA

KUNII

SMITH

KUNII

(1967)

BALDI

SICARDI

(1957)

(1960)

SMITH

(1962)

(1980)

(1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2746

0.1710

0.2012

0.1695

0.3251

0.3283

PSEUDOHOMOGENEOUS PECLET NUMBER

2286.5

3571.2

3120.1

3702.8

1930.9

1912.3

AVERAGE EXPERIMENTAL NUSSELT NUMBER

20.818

33.426

28.409

33.714

17.581

17.411

TEST NUMBER BA-2-5 LOCAL NUSSELL NUMBER PROFILES YAGI AND KUNII (1957)				KUNII AND SMITH (1960)				THEORETICAL PARABOLIC				THEORETICAL PARABOLIC			
N D	POSITION	FLAT	THEORETICAL	N D	POSITION	FLAT	THEORETICAL	N D	POSITION	FLAT	THEORETICAL	N D	POSITION	FLAT	THEORETICAL
0.00039	52	437	247.815	0.00024	84	162	204.815	0.00039	52	437	247.815	0.00039	52	437	247.815
0.00044	224	278	337.401	0.00052	93	98	337.401	0.00044	224	278	337.401	0.00044	224	278	337.401
0.00128	200	412	327.401	0.00080	10	350	327.401	0.00128	200	412	327.401	0.00128	200	412	327.401
0.00226	20	508	223.534	0.00111	10	350	223.534	0.00226	20	508	223.534	0.00226	20	508	223.534
0.00334	17	553	177.534	0.00146	9	478	177.534	0.00334	17	553	177.534	0.00334	17	553	177.534
0.00385	15	779	153.336	0.00184	8	478	153.336	0.00385	15	779	153.336	0.00385	15	779	153.336
0.00458	14	767	143.336	0.00234	7	704	143.336	0.00458	14	767	143.336	0.00458	14	767	143.336
0.00500	13	665	134.336	0.00284	7	704	134.336	0.00500	13	665	134.336	0.00500	13	665	134.336
0.00560	14	767	143.336	0.00334	7	704	143.336	0.00560	14	767	143.336	0.00560	14	767	143.336
0.00623	14	707	143.336	0.00384	7	704	143.336	0.00623	14	707	143.336	0.00623	14	707	143.336
0.00766	13	730	133.113	0.00419	6	642	133.113	0.00766	13	730	133.113	0.00766	13	730	133.113
0.00832	13	730	133.113	0.00471	6	642	133.113	0.00832	13	730	133.113	0.00832	13	730	133.113
0.00921	13	730	133.113	0.00522	6	642	133.113	0.00921	13	730	133.113	0.00921	13	730	133.113
0.01021	13	730	133.113	0.00572	6	642	133.113	0.01021	13	730	133.113	0.01021	13	730	133.113
0.01121	13	730	133.113	0.00622	6	642	133.113	0.01121	13	730	133.113	0.01121	13	730	133.113
0.01221	13	730	133.113	0.00672	6	642	133.113	0.01221	13	730	133.113	0.01221	13	730	133.113
0.01321	13	730	133.113	0.00722	6	642	133.113	0.01321	13	730	133.113	0.01321	13	730	133.113
0.01421	13	730	133.113	0.00772	6	642	133.113	0.01421	13	730	133.113	0.01421	13	730	133.113
0.01521	13	730	133.113	0.00822	6	642	133.113	0.01521	13	730	133.113	0.01521	13	730	133.113
0.01621	13	730	133.113	0.00872	6	642	133.113	0.01621	13	730	133.113	0.01621	13	730	133.113
0.01721	13	730	133.113	0.00922	6	642	133.113	0.01721	13	730	133.113	0.01721	13	730	133.113
0.01821	13	730	133.113	0.00972	6	642	133.113	0.01821	13	730	133.113	0.01821	13	730	133.113
0.01921	13	730	133.113	0.01022	6	642	133.113	0.01921	13	730	133.113	0.01921	13	730	133.113
0.02021	13	730	133.113	0.01072	6	642	133.113	0.02021	13	730	133.113	0.02021	13	730	133.113
0.02121	13	730	133.113	0.01122	6	642	133.113	0.02121	13	730	133.113	0.02121	13	730	133.113
0.02221	13	730	133.113	0.01172	6	642	133.113	0.02221	13	730	133.113	0.02221	13	730	133.113
0.02321	13	730	133.113	0.01222	6	642	133.113	0.02321	13	730	133.113	0.02321	13	730	133.113
0.02421	13	730	133.113	0.01272	6	642	133.113	0.02421	13	730	133.113	0.02421	13	730	133.113
0.02521	13	730	133.113	0.01322	6	642	133.113	0.02521	13	730	133.113	0.02521	13	730	133.113
0.02621	13	730	133.113	0.01372	6	642	133.113	0.02621	13	730	133.113	0.02621	13	730	133.113
0.02721	13	730	133.113	0.01422	6	642	133.113	0.02721	13	730	133.113	0.02721	13	730	133.113
0.02821	13	730	133.113	0.01472	6	642	133.113	0.02821	13	730	133.113	0.02821	13	730	133.113
0.02921	13	730	133.113	0.01522	6	642	133.113	0.02921	13	730	133.113	0.02921	13	730	133.113
0.03021	13	730	133.113	0.01572	6	642	133.113	0.03021	13	730	133.113	0.03021	13	730	133.113
0.03121	13	730	133.113	0.01622	6	642	133.113	0.03121	13	730	133.113	0.03121	13	730	133.113
0.03221	13	730	133.113	0.01672	6	642	133.113	0.03221	13	730	133.113	0.03221	13	730	133.113
0.03321	13	730	133.113	0.01722	6	642	133.113	0.03321	13	730	133.113	0.03321	13	730	133.113
0.03421	13	730	133.113	0.01772	6	642	133.113	0.03421	13	730	133.113	0.03421	13	730	133.113
0.03521	13	730	133.113	0.01822	6	642	133.113	0.03521	13	730	133.113	0.03521	13	730	133.113
0.03621	13	730	133.113	0.01872	6	642	133.113	0.03621	13	730	133.113	0.03621	13	730	133.113
0.03721	13	730	133.113	0.01922	6	642	133.113	0.03721	13	730	133.113	0.03721	13	730	133.113
0.03821	13	730	133.113	0.01972	6	642	133.113	0.03821	13	730	133.113	0.03821	13	730	133.113
0.03921	13	730	133.113	0.02022	6	642	133.113	0.03921	13	730	133.113	0.03921	13	730	133.113
0.04021	13	730	133.113	0.02072	6	642	133.113	0.04021	13	730	133.113	0.04021	13	730	133.113
0.04121	13	730	133.113	0.02122	6	642	133.113	0.04121	13	730	133.113	0.04121	13	730	133.113
0.04221	13	730	133.113	0.02172	6	642	133.113	0.04221	13	730	133.113	0.04221	13	730	133.113
0.04321	13	730	133.113	0.02222	6	642	133.113	0.04321	13	730	133.113	0.04321	13	730	133.113
0.04421	13	730	133.113	0.02272	6	642	133.113	0.04421	13	730	133.113	0.04421	13	730	133.113
0.04521	13	730	133.113	0.02322	6	642	133.113	0.04521	13	730	133.113	0.04521	13	730	133.113
0.04621	13	730	133.113	0.02372	6	642	133.113	0.04621	13	730	133.113	0.04621	13	730	133.113
0.04721	13	730	133.113	0.02422	6	642	133.113	0.04721	13	730	133.113	0.04721	13	730	133.113
0.04821	13	730	133.113	0.02472	6	642	133.113	0.04821	13	730	133.113	0.04821	13	730	133.113
0.04921	13	730	133.113	0.02522	6	642	133.113	0.04921	13	730	133.113	0.04921	13	730	133.113
0.05021	13	730	133.113	0.02572	6	642	133.113	0.05021	13	730	133.113	0.05021	13	730	133.113
0.05121	13	730	133.113	0.02622	6	642	133.113	0.05121	13	730	133.113	0.05121	13	730	133.113
0.05221	13	730	133.113	0.02672	6	642	133.113	0.05221	13	730	133.113	0.05221	13	730	133.113
0.05321	13	730	133.113	0.02722	6	642	133.113	0.05321	13	730	133.113	0.05321	13	730	133.113
0.05421	13	730	133.113	0.02772	6	642	133.113	0.05421	13	730	133.113	0.05421	13	730	133.113
0.05521	13	730	133.113	0.02822	6	642	133.113	0.05521	13	730	133.113	0.05521	13	730	133.113
0.05621	13	730	133.113	0.02872	6	642	133.113	0.05621	13	730	133.113	0.05621	13	730	133.113
0.05721	13	730	133.113	0.02922	6	642	133.113	0.05721	13	730	133.113	0.05721	13	730	133.113
0.05821	13	730	133.113	0.02972	6	642	133.113	0.05821	13	730	133.113	0.05821	13	730	133.113
0.05921	13	730	133.113	0.03022	6	642	133.113	0.05921	13	730	133.113	0.05921	13	730	133.113
0.06021	13	730	133.113	0.03072	6	642	133.113	0.06021	13	730	133.113	0.06021	13	730	133.113
0.06121	13	730	133.113	0.03122	6	642	133.113	0.06121	13	730	133.113	0.06121	13	730	133.113
0.06221	13	730	133.113	0.03172	6	642	133.113	0.06221	13	730	133.113	0.06221	13	730	133.113
0.06321	13	730	133.113	0.03222	6	642	133.113	0.06321	13	730	133.113	0.06321	13	730	133.113
0.06421	13	730	133.113	0.03272	6	642	133.113	0.06421	13	730	133.113	0.06421	13	730	133.113
0.06521	13	730	133.113	0.03322	6	642	133.113	0.06521	13	730	133.113	0.06521	13	730	133.113
0.06621	13	730	133.113	0.03372	6	642	133.113	0.06621	13	730	133.113	0.06621	13	730	133.113
0.06721	13	730	133.113	0.03422	6	642	133.113	0.06721	13	730	133.113	0.06721	13	730	133.113
0.06821	13	730	133.113	0.03472	6	642	133.113	0.06821	13	730	133.113	0.06821	13	730	133.113
0.06921	13	730	133.113	0.03522	6	642	133.113	0.06921	13	730	133.113	0.06921	13	730	133.113
0.07021	13	730	133.113	0.03572	6	642	133.113	0.07021	13	730	133.113	0.07021	13	730	133.113
0.07121	13	730	133.113	0.03622											

TEST NUMBER BA-3-6
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 2.54000 2.47904 0.300
 PARTICLE SIZE RANGE (MICRONS)
 177-250
 EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID
 (W) (CM/S) (G/CM**3) FRACTION
 1469.00 1.75 1.455 0.415
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS CONDUCTIVITY PARTICLE CONDUCTIVITY PARTICLE SPECIFIC HEAT HEAT FLUX HEAT TRANSFER COEFFICIENT
 (W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
 0.03019 1.1568 0.8764 33723.92 222.93
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	82.22	33.33	122.305	27549.46	2.502	563.512
2.226	123.89	38.48	204.683	28925.15	3.099	338.659
4.771	163.33	44.80	448.099	30171.80	3.774	254.122
7.318	196.11	50.93	643.109	31160.14	4.430	214.629
10.185	207.78	58.14	711.622	31511.64	4.756	210.591
13.053	240.00	65.44	964.834	32415.31	5.527	185.702
15.778	247.22	72.45	1014.050	32624.76	5.802	185.565
19.110	263.33	81.00	1152.211	33052.77	6.319	181.336
22.618	291.11	90.09	1441.719	33763.92	7.172	167.963
26.128	317.78	99.31	1763.396	34389.97	8.072	157.412
30.278	333.33	110.26	1952.137	34752.56	8.751	155.793
34.430	357.78	121.26	2305.568	35263.27	9.748	149.096
38.583	368.69	132.29	2493.982	35506.74	10.372	150.069
43.376	380.69	144.99	2774.032	35890.63	11.374	147.155
48.171	402.22	157.69	2981.237	36151.60	12.192	147.842
52.966	407.78	170.31	3027.863	36299.92	12.751	152.863

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII BALDI
 (1957) (1960) (1962) (1967) (1980)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2802 0.1746 0.2053 0.1730 0.3320 0.3352
 PSEUDOHOMOGENEOUS PECLET NUMBER
 1971.0 3163.0 2689.5 3191.6 1603.5 1647.5
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 19.724 31.652 26.914 31.938 16.647 16.487

TEST NUMBER BA-3-6 LOCAL NUMBER PROFILES LOGG AND KUNIL (1957)				KUNIL AND SMITH (1960)				THEORETICAL PARABOLIC			
N D	POSITION	EXPERIMENTAL	FLAT	N D	POSITION	EXPERIMENTAL	FLAT	N D	POSITION	EXPERIMENTAL	FLAT
0	00045	49 911	44 815	0	00028	40 093	40 815	0	00028	40 093	40 815
0	00097	30 540	30 967	0	00061	38 170	38 967	0	00061	38 170	38 967
0	00149	13 648	13 981	0	00093	30 567	30 981	0	00093	30 567	30 981
0	00201	11 648	11 981	0	00125	22 608	22 981	0	00125	22 608	22 981
0	00253	16 937	16 937	0	00157	22 608	22 981	0	00157	22 608	22 981
0	00305	16 937	16 937	0	00189	22 608	22 981	0	00189	22 608	22 981
0	00357	16 937	16 937	0	00221	22 608	22 981	0	00221	22 608	22 981
0	00409	16 937	16 937	0	00253	22 608	22 981	0	00253	22 608	22 981
0	00461	16 937	16 937	0	00285	22 608	22 981	0	00285	22 608	22 981
0	00513	16 937	16 937	0	00317	22 608	22 981	0	00317	22 608	22 981
0	00565	16 937	16 937	0	00349	22 608	22 981	0	00349	22 608	22 981
0	00617	16 937	16 937	0	00381	22 608	22 981	0	00381	22 608	22 981
0	00669	16 937	16 937	0	00413	22 608	22 981	0	00413	22 608	22 981
0	00721	16 937	16 937	0	00445	22 608	22 981	0	00445	22 608	22 981
0	00773	16 937	16 937	0	00477	22 608	22 981	0	00477	22 608	22 981
0	00825	16 937	16 937	0	00509	22 608	22 981	0	00509	22 608	22 981
0	00877	16 937	16 937	0	00541	22 608	22 981	0	00541	22 608	22 981
0	00929	16 937	16 937	0	00573	22 608	22 981	0	00573	22 608	22 981
0	01000	16 937	16 937	0	00605	22 608	22 981	0	00605	22 608	22 981
0	01052	16 937	16 937	0	00637	22 608	22 981	0	00637	22 608	22 981
0	01104	16 937	16 937	0	00669	22 608	22 981	0	00669	22 608	22 981
0	01156	16 937	16 937	0	00701	22 608	22 981	0	00701	22 608	22 981
0	01208	16 937	16 937	0	00733	22 608	22 981	0	00733	22 608	22 981
0	01260	16 937	16 937	0	00765	22 608	22 981	0	00765	22 608	22 981
0	01312	16 937	16 937	0	00797	22 608	22 981	0	00797	22 608	22 981
0	01364	16 937	16 937	0	00829	22 608	22 981	0	00829	22 608	22 981
0	01416	16 937	16 937	0	00861	22 608	22 981	0	00861	22 608	22 981
0	01468	16 937	16 937	0	00893	22 608	22 981	0	00893	22 608	22 981
0	01520	16 937	16 937	0	00925	22 608	22 981	0	00925	22 608	22 981
0	01572	16 937	16 937	0	00957	22 608	22 981	0	00957	22 608	22 981
0	01624	16 937	16 937	0	00989	22 608	22 981	0	00989	22 608	22 981
0	01676	16 937	16 937	0	01021	22 608	22 981	0	01021	22 608	22 981
0	01728	16 937	16 937	0	01053	22 608	22 981	0	01053	22 608	22 981
0	01780	16 937	16 937	0	01085	22 608	22 981	0	01085	22 608	22 981
0	01832	16 937	16 937	0	01117	22 608	22 981	0	01117	22 608	22 981
0	01884	16 937	16 937	0	01149	22 608	22 981	0	01149	22 608	22 981
0	01936	16 937	16 937	0	01181	22 608	22 981	0	01181	22 608	22 981
0	01988	16 937	16 937	0	01213	22 608	22 981	0	01213	22 608	22 981
0	02040	16 937	16 937	0	01245	22 608	22 981	0	01245	22 608	22 981
0	02092	16 937	16 937	0	01277	22 608	22 981	0	01277	22 608	22 981
0	02144	16 937	16 937	0	01309	22 608	22 981	0	01309	22 608	22 981
0	02196	16 937	16 937	0	01341	22 608	22 981	0	01341	22 608	22 981
0	02248	16 937	16 937	0	01373	22 608	22 981	0	01373	22 608	22 981
0	02300	16 937	16 937	0	01405	22 608	22 981	0	01405	22 608	22 981
0	02352	16 937	16 937	0	01437	22 608	22 981	0	01437	22 608	22 981
0	02404	16 937	16 937	0	01469	22 608	22 981	0	01469	22 608	22 981
0	02456	16 937	16 937	0	01501	22 608	22 981	0	01501	22 608	22 981
0	02508	16 937	16 937	0	01533	22 608	22 981	0	01533	22 608	22 981
0	02560	16 937	16 937	0	01565	22 608	22 981	0	01565	22 608	22 981
0	02612	16 937	16 937	0	01597	22 608	22 981	0	01597	22 608	22 981
0	02664	16 937	16 937	0	01629	22 608	22 981	0	01629	22 608	22 981
0	02716	16 937	16 937	0	01661	22 608	22 981	0	01661	22 608	22 981
0	02768	16 937	16 937	0	01693	22 608	22 981	0	01693	22 608	22 981
0	02820	16 937	16 937	0	01725	22 608	22 981	0	01725	22 608	22 981
0	02872	16 937	16 937	0	01757	22 608	22 981	0	01757	22 608	22 981
0	02924	16 937	16 937	0	01789	22 608	22 981	0	01789	22 608	22 981
0	02976	16 937	16 937	0	01821	22 608	22 981	0	01821	22 608	22 981
0	03028	16 937	16 937	0	01853	22 608	22 981	0	01853	22 608	22 981
0	03080	16 937	16 937	0	01885	22 608	22 981	0	01885	22 608	22 981
0	03132	16 937	16 937	0	01917	22 608	22 981	0	01917	22 608	22 981
0	03184	16 937	16 937	0	01949	22 608	22 981	0	01949	22 608	22 981
0	03236	16 937	16 937	0	01981	22 608	22 981	0	01981	22 608	22 981
0	03288	16 937	16 937	0	02013	22 608	22 981	0	02013	22 608	22 981
0	03340	16 937	16 937	0	02045	22 608	22 981	0	02045	22 608	22 981
0	03392	16 937	16 937	0	02077	22 608	22 981	0	02077	22 608	22 981
0	03444	16 937	16 937	0	02109	22 608	22 981	0	02109	22 608	22 981
0	03496	16 937	16 937	0	02141	22 608	22 981	0	02141	22 608	22 981
0	03548	16 937	16 937	0	02173	22 608	22 981	0	02173	22 608	22 981
0	03600	16 937	16 937	0	02205	22 608	22 981	0	02205	22 608	22 981
0	03652	16 937	16 937	0	02237	22 608	22 981	0	02237	22 608	22 981
0	03704	16 937	16 937	0	02269	22 608	22 981	0	02269	22 608	22 981
0	03756	16 937	16 937	0	02301	22 608	22 981	0	02301	22 608	22 981
0	03808	16 937	16 937	0	02333	22 608	22 981	0	02333	22 608	22 981
0	03860	16 937	16 937	0	02365	22 608	22 981	0	02365	22 608	22 981
0	03912	16 937	16 937	0	02397	22 608	22 981	0	02397	22 608	22 981
0	03964	16 937	16 937	0	02429	22 608	22 981	0	02429	22 608	22 981
0	04016	16 937	16 937	0	02461	22 608	22 981	0	02461	22 608	22 981
0	04068	16 937	16 937	0	02493	22 608	22 981	0	02493	22 608	22 981
0	04120	16 937	16 937	0	02525	22 608	22 981	0	02525	22 608	22 981
0	04172	16 937	16 937	0	02557	22 608	22 981	0	02557	22 608	22 981
0	04224	16 937	16 937	0	02589	22 608	22 981	0	02589	22 608	22 981
0	04276	16 937	16 937	0	02621	22 608	22 981	0	02621	22 608	22 981
0	04328	16 937	16 937	0	02653	22 608	22 981	0	02653	22 608	22 981
0	04380	16 937	16 937	0	02685	22 608	22 981	0	02685	22 608	22 981
0	04432	16 937	16 937	0	02717	22 608	22 981	0	02717	22 608	22 981
0	04484	16 937	16 937	0	02749	22 608	22 981	0	02749	22 608	22 981
0	04536	16 937	16 937	0	02781	22 608	22 981	0	02781	22 608	22 981
0	04588	16 937	16 937	0	02813	22 608	22 981	0	02813	22 608	22 981
0	04640	16 937	16 937	0	02845	22 608	22 981	0	02845	22 608	22 981
0	04692	16 937	16 937	0	02877	22 608	22 981	0	02877	22 608	22 981
0	04744	16 937	16 937	0	02909	22 608	22 981	0	02909	22 608	22 981
0	04796	16 937	16 937	0	02941	22 608	22 981	0	02941	22 608	22 981
0	04848	16 937	16 937	0	02973	22 608	22 981	0	02973	22 608	22 981
0	04900	16 937	16 937	0	03005	22 608	22 981	0	03005	22 608	22 981
0	04952	16 937	16 937	0	03037	22 608	22 981	0	03037	22 608	22 981
0	05004	16 937	16 937	0	03069	22 608	22 981	0	03069	22 608	22 981
0	05056	16 937	16 937	0	03101	22 608	22 981	0	03101	22 608	22 981
0	05108	16 937	16 937	0	03133	22 608	22 981	0	03133	22 608	22 981
0	05160	16 937	16 937	0	03165	22 608	22 981	0	03165	22 608	22 981
0	05212	16 937	16 937	0	03197	22 608	22 981	0	03197	22 608	22 981
0	05264	16 937	16 937	0	03229						

TEST NUMBER BB-1-1

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) 10 (CM) EMISSIVITY

2.54000 2.47904 0.300

PARTICLE SIZE RANGE (MICRONS)

420-590

EXPERIMENTAL VARIABLES

POWER (W) VELOCITY (CM/S) DENSITY (G/CM**3)

1090.30 3.70 1.469 0.386

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.02676 1.0576 0.8100 25817.34 256.23

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM) WALL TEMPERATURE (C) PARTICLE TEMPERATURE (C) RADIATIVE HEAT FLUX (W/M**2) CONVECTIVE HEAT FLUX (W/M**2) RADIATIVE H T COEFF (W/M**2K) CONVECTIVE H T COEFF (W/M**2K)

0.	70.56	28.89	98.681	22860.41	2.320	548.650
2.225	89.44	30.88	150.044	23388.50	2.562	399.344
4.768	113.89	33.21	233.977	24055.12	2.900	298.145
7.313	132.78	35.59	310.105	24557.47	3.191	252.683
10.176	136.67	38.30	322.683	24663.83	3.280	250.732
13.040	139.56	41.03	412.588	25150.82	3.603	219.612
15.761	157.22	43.65	416.021	25198.23	3.663	221.854
19.087	163.89	46.84	446.293	25371.21	3.813	216.763
22.589	180.56	50.23	539.700	25785.23	4.141	197.858
26.091	196.87	53.67	640.577	26173.80	4.480	183.036
30.232	203.33	57.75	679.103	26337.63	4.665	180.917
34.373	217.22	61.86	776.499	26661.12	4.998	171.605
38.515	220.00	65.97	788.373	26733.33	5.118	173.562
43.295	230.00	70.72	860.320	26963.87	5.401	169.281
48.075	235.00	75.46	891.199	27084.09	5.586	169.764
52.856	236.67	80.19	892.267	27133.36	5.702	173.397

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI	KUNII	WILLHITE	KRUPICZKA	SPECCHIA
KUNII	SMITH	KUNII	(1967)	BALDI
(1957)	(1960)	SMITH		SICARDI
		(1962)		(1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2845 0.1787 0.2004 0.1694 0.3413 0.3363

PSEUDOHOMOGENEOUS PECLET NUMBER

3837.9 6110.3 5449.2 6445.1 3199.8 3247.0

AVERAGE EXPERIMENTAL NUSSELT NUMBER

22.323 35.540 31.695 37.488 18.612 18.886

TEST NUMBER BB-1-2

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) 1D (CM) EMISSIVITY

2.54000 2.47904 0.300

PARTICLE SIZE RANGE (MICRONS)

420-590

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM**3) VOID FRACTION

1058.00 3.10 1.469 0.286

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY PARTICLE CONDUCTIVITY PARTICLE SPECIFIC HEAT HEAT FLUX HEAT TRANSFER

(W/MK) (W/MK) (WS/GK) (W/M**2) COEFFICIENT

0.02728 1.0726 0.8204 24954.11 239.12

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION WALL TEMPERATURE PARTICLE TEMPERATURE RADIATIVE HEAT FLUX CONVECTIVE HEAT FLUX RADIATIVE H T COEFF CONVECTIVE H T COEFF

(CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K) (W/M**2K)

0. 73.33 32.22 98.109 21950.60 2.386 533.934

2. 225 34.45 183.458 22539.47 2.677 369.122

4. 769 120.00 37.16 250.939 23165.64 3.029 279.683

7. 314 140.56 39.89 338.012 23604.43 3.358 235.268

10. 177 145.00 42.99 353.348 23799.03 3.464 233.292

13. 042 165.56 46.12 457.532 24294.91 3.831 203.408

15. 763 167.22 49.11 460.462 24340.57 3.899 206.085

19. 090 175.56 52.78 502.182 24541.64 4.090 199.883

22. 592 192.78 56.66 605.946 24939.86 4.452 183.219

26. 096 210.00 60.60 722.514 25322.22 4.836 169.494

30. 237 216.11 65.28 758.538 25463.02 5.029 168.622

34. 360 231.11 69.88 872.118 25783.98 5.412 160.019

38. 623 234.44 74.69 888.433 25864.05 5.561 161.899

43. 304 245.56 80.12 975.510 26097.97 5.897 157.753

48. 085 250.00 85.55 1001.851 26199.90 6.092 159.317

52. 867 252.78 90.23 1011.875 26270.00 6.253 162.335

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA SPECCHIA

KUNII KUNII KUNII BALDI SICARDI SICARDI

(1957) (1960) SMITH (1962) (1980) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2894 0.1819 0.2038 0.1723 0.3473 0.3422

PSEUDOHOMOGENEOUS PECLET NUMBER 3199.0 5090.3 4541.5

AVERAGE EXPERIMENTAL NUSSELT NUMBER 5371.4 2665.6 2705.0

20.485 32.596 29.082 34.396 17.070 17.322

TEST NUMBER BB-1-3

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

2.54000 2.47904 0.300

PARTICLE SIZE RANGE (MICRONS)

420-590

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY VOID

(W) (CM/S) (G/CM**3) FRACTION

1046.30 1.95 1.469 0.386

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.02845 1.1064 0.8435 24430.51 212.15

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL WALL PARTICLE RADIATIVE CONVECTIVE RADIATIVE

POSITION TEMPERATURE TEMPERATURE HEAT FLUX HEAT FLUX H T COEFF

(CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K)

0. 75.00 32.78 101.814 21019.03 2.411

2.225 105.00 36.25 193.693 21770.74 2.817

4.770 132.78 40.34 300.288 22442.37 3.249

7.316 157.78 44.34 417.122 23024.11 3.683

10.180 163.33 49.30 537.514 23158.63 3.837

13.045 167.78 54.12 577.965 23608.53 4.324

15.767 191.11 58.72 599.303 23779.81 4.451

19.056 203.33 64.36 562.177 24046.22 4.765

23.600 221.67 70.33 790.274 24426.07 5.222

26.105 242.22 76.37 955.023 24829.47 5.758

30.249 249.44 83.55 1002.687 24981.09 6.044

34.394 267.78 90.74 1169.014 25319.80 6.603

38.340 272.22 97.93 1193.413 25417.66 6.847

43.325 286.67 106.22 1330.808 25677.12 7.375

48.110 293.33 114.49 1380.539 25810.31 7.719

52.696 293.89 122.70 1353.586 25852.50 7.907

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA

(1957) (1960) SMITH (1967) BALDI SPECCHIA

(1962) SICARDI

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.3004 0.1890 0.2116 0.1790 0.3557

PSEUDOHOMOGENEOUS PECLET NUMBER

1991.8 3165.5 2826.9 3343.3 1657.7 1682.2

AVERAGE EXPERIMENTAL NUSSELT NUMBER

17.509 27.826 24.850 29.389 14.572 14.787

TEST NUMBER 99-1-3			KUNII AND SMITH (1967)			KUNII AND SMITH (1960)			THEORETICAL PARABOLIC FLAT			THEORETICAL PARABOLIC FLAT		
TEST NUMBER	NUMBER	PROFILES	POSITION	EXPERIMENTAL	THEORETICAL	POSITION	EXPERIMENTAL	THEORETICAL	POSITION	EXPERIMENTAL	THEORETICAL	POSITION	EXPERIMENTAL	THEORETICAL
000045	41	1274	000045	204	815	000028	65	957	000028	65	957	000028	65	957
000096	20	0760	000096	204	815	000031	31	907	000031	31	907	000031	31	907
000147	16	0035	000147	222	705	000139	26	705	000139	26	705	000139	26	705
000205	16	0035	000205	222	705	000139	26	705	000139	26	705	000139	26	705
000317	14	0035	000317	222	705	000139	26	705	000139	26	705	000139	26	705
000384	14	0035	000384	222	705	000139	26	705	000139	26	705	000139	26	705
000544	14	0035	000544	222	705	000139	26	705	000139	26	705	000139	26	705
000608	14	0035	000608	222	705	000139	26	705	000139	26	705	000139	26	705
000774	14	0035	000774	222	705	000139	26	705	000139	26	705	000139	26	705
000869	14	0035	000869	222	705	000139	26	705	000139	26	705	000139	26	705
000969	14	0035	000969	222	705	000139	26	705	000139	26	705	000139	26	705
001061	14	0035	001061	222	705	000139	26	705	000139	26	705	000139	26	705
WILLHITE, KUNII AND SMITH (1962)			KUNII AND SMITH (1967)			KUNII AND SMITH (1967)			KUNII AND SMITH (1967)			KUNII AND SMITH (1967)		
TEST NUMBER	NUMBER	PROFILES	POSITION	EXPERIMENTAL	THEORETICAL	POSITION	EXPERIMENTAL	THEORETICAL	POSITION	EXPERIMENTAL	THEORETICAL	POSITION	EXPERIMENTAL	THEORETICAL
000032	58	365	000032	204	815	000027	59	028	000027	59	028	000027	59	028
000068	28	1493	000068	204	815	000031	33	694	000031	33	694	000031	33	694
000104	23	8723	000104	204	815	000086	28	203	000086	28	203	000086	28	203
000145	23	8723	000145	204	815	000122	28	203	000122	28	203	000122	28	203
000224	21	1032	000224	204	815	000139	24	048	000139	24	048	000139	24	048
000271	20	3322	000271	204	815	000271	22	438	000271	22	438	000271	22	438
000320	19	3600	000320	204	815	000313	20	821	000313	20	821	000313	20	821
000428	17	5099	000428	204	815	000401	19	899	000401	19	899	000401	19	899
000467	16	1558	000467	204	815	000461	20	292	000461	20	292	000461	20	292
000545	16	1558	000545	204	815	000519	19	805	000519	19	805	000519	19	805
000612	16	1558	000612	204	815	000525	20	090	000525	20	090	000525	20	090
000749	17	3773	000749	204	815	000575	20	090	000575	20	090	000575	20	090
BALDI AND SICARDI (1980)			BALDI AND SICARDI (1980)			BALDI AND SICARDI (1980)			BALDI AND SICARDI (1980)			BALDI AND SICARDI (1980)		
TEST NUMBER	NUMBER	PROFILES	POSITION	EXPERIMENTAL	THEORETICAL	POSITION	EXPERIMENTAL	THEORETICAL	POSITION	EXPERIMENTAL	THEORETICAL	POSITION	EXPERIMENTAL	THEORETICAL
000054	34	2383	000054	204	815	000050	34	732	000050	34	732	000050	34	732
000116	16	2088	000116	204	815	000114	16	956	000114	16	956	000114	16	956
000177	13	9988	000177	204	815	000175	14	205	000175	14	205	000175	14	205
000316	12	3744	000316	204	815	000243	14	191	000243	14	191	000243	14	191
000381	12	3744	000381	204	815	000243	14	191	000243	14	191	000243	14	191
000462	11	9233	000462	204	815	000243	14	191	000243	14	191	000243	14	191
000545	11	1233	000545	204	815	000243	14	191	000243	14	191	000243	14	191
000730	10	8888	000730	204	815	000243	14	191	000243	14	191	000243	14	191
000830	10	8888	000830	204	815	000243	14	191	000243	14	191	000243	14	191
000930	10	8888	000930	204	815	000243	14	191	000243	14	191	000243	14	191
001043	10	8888	001043	204	815	000243	14	191	000243	14	191	000243	14	191
001175	10	8888	001175	204	815	000243	14	191	000243	14	191	000243	14	191

TEST NUMBER BB-1-4
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 2.54000 2.47904 0.300
 PARTICLE SIZE RANGE (MICRONS)
 420-590
 EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID FRACTION
 (W) (CM/S) (G/CM**3) (G/CM**3)
 1094.40 1.65 1.469 0.386
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS CONDUCTIVITY PARTICLE CONDUCTIVITY PARTICLE SPECIFIC HEAT HEAT FLUX HEAT TRANSFER COEFFICIENT
 (W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
 0.02905 1.1235 0.8549 25339.93 196.86
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES
 AXIAL POSITION (CM) WALL TEMPERATURE (C) PARTICLE TEMPERATURE (C) RADIATIVE HEAT FLUX (W/M**2) CONVECTIVE HEAT FLUX (W/M**2) RADIATIVE H T COEFF (W/M**2K) CONVECTIVE H T COEFF (W/M**2K)
 0. 65.56 31.11 78.794 21129.78 2.288
 2.225 112.78 35.28 225.429 22333.68 2.909
 4.775 145.00 40.26 359.179 23117.14 3.429
 7.316 171.67 45.38 493.362 23737.34 3.922
 10.181 180.56 51.19 537.458 23946.83 4.155
 13.048 207.78 57.07 714.277 24538.78 4.740
 16.771 212.22 62.70 734.428 24643.90 4.912
 19.101 226.67 69.59 834.581 24850.89 5.313
 22.607 247.78 76.88 1006.611 25371.38 5.890
 26.114 259.44 84.26 1208.062 25776.92 6.524
 30.260 279.44 93.02 1292.385 25972.19 6.933
 34.407 298.89 101.79 1499.296 26307.91 7.607
 38.555 305.00 110.57 1546.261 26431.21 7.953
 43.343 321.11 120.66 1728.503 26697.20 8.623
 48.131 329.44 130.74 1807.261 26849.92 9.095
 52.920 327.22 140.72 1727.202 26868.27 9.261
 DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA SPECCHIA
 KUNII SMITH KUNII (1967) BALDI SICARDI
 (1957) (1960) SMITH (1962) SICARDI (1980)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.3059 0.1926 0.2156 0.1823 0.3678 0.3624
 PSEUDOHOMOGENEOUS PECLET NUMBER
 1679.3 2667.2 2383.0 2818.2 1396.7 1417.4
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 15.953 25.338 22.638 26.772 13.269 13.465

[illegible]

TEST NUMBER BB-1-5
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) 1D (CM) EMISSIVITY
 2.54000 2.47304 0.300
 PARTICLE SIZE RANGE (MICRONS)
 420-590
 EXPERIMENTAL VARIABLES
 POWER (W) VELOCITY (CM/S) DENSITY (G/CM³) VOID FRACTION
 1122.10 1.36 1.469 0.386
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS PARTICLE PARTICLE HEAT HEAT TRANSFER
 CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
 (W/MK) (W/MK) (WS/GK) (W/M²) (W/M²2K)
 0.02987 1.1476 0.8704 25794.03 190.99
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES
 AXIAL POSITION (CM) WALL TEMPERATURE (C) PARTICLE TEMPERATURE (C) RADIATIVE HEAT FLUX (W/M²) CONVECTIVE HEAT FLUX (W/M²) RADIATIVE H T COEFF (W/M²2K) CONVECTIVE H T COEFF (W/M²2K)
 0. 82.22 30.56 127.720 21640.28 2.472
 2.226 119.44 35.70 251.585 22583.50 3.004
 4.771 154.44 41.80 404.955 23429.21 3.955
 7.317 182.78 48.07 559.041 24080.81 4.150
 10.183 193.33 53.19 613.416 24325.68 4.440
 13.050 222.22 62.38 816.260 24940.58 5.107
 15.775 226.89 69.27 854.639 25090.45 5.354
 19.105 244.44 77.65 972.163 25411.55 5.830
 22.612 266.11 86.60 1164.441 25820.83 6.487
 26.121 290.00 95.59 1409.522 26253.80 7.250
 30.268 301.11 106.26 1511.568 26462.82 7.758
 34.417 322.78 116.94 1760.016 26811.53 8.589
 38.567 330.00 127.62 1829.614 26951.28 9.040
 43.357 347.78 139.69 2052.854 27222.05 9.875
 48.148 356.11 152.13 2130.775 27376.48 10.446
 52.939 352.78 164.22 2007.550 27407.12 10.647
 DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII (1967) BALDI
 (1957) (1960) SMITH SICARDI
 (1952) (1980)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.3137 0.1976 0.2211 0.1869 0.3774 0.3719
 PSEUDOHOMOGENEOUS PECLET NUMBER
 1378.2 2187.3 1953.3
 AVERAGE EXPERIMENTAL NUSSELT NUMBER 2312.4 1145.4 1162.4
 15.096 23.958 21.417 25.328 12.546 12.732

TEST NUMBER BB-1-5				TEST NUMBER BB-1-5				TEST NUMBER BB-1-5				TEST NUMBER BB-1-5			
LOCAL NUSSELT NUMBER PROFILES				LOCAL NUSSELT NUMBER PROFILES				LOCAL NUSSELT NUMBER PROFILES				LOCAL NUSSELT NUMBER PROFILES			
KUNII AND KRUPICZKA (1967)				KUNII AND KRUPICZKA (1967)				KUNII AND KRUPICZKA (1967)				KUNII AND KRUPICZKA (1967)			
POSITION	FLAT	THEORETICAL	PARABOLIC	POSITION	FLAT	THEORETICAL	PARABOLIC	POSITION	FLAT	THEORETICAL	PARABOLIC	POSITION	FLAT	THEORETICAL	PARABOLIC
0.00041	204.140	815	21.360	0.00041	204.140	815	21.360	0.00041	204.140	815	21.360	0.00041	204.140	815	21.360
0.00093	32.132	37.282	14.079	0.00093	32.132	37.282	14.079	0.00093	32.132	37.282	14.079	0.00093	32.132	37.282	14.079
0.00134	14.169	18.933	8.782	0.00134	14.169	18.933	8.782	0.00134	14.169	18.933	8.782	0.00134	14.169	18.933	8.782
0.00196	13.960	18.966	8.803	0.00196	13.960	18.966	8.803	0.00196	13.960	18.966	8.803	0.00196	13.960	18.966	8.803
0.00273	12.377	17.123	8.153	0.00273	12.377	17.123	8.153	0.00273	12.377	17.123	8.153	0.00273	12.377	17.123	8.153
0.00375	12.470	15.566	7.693	0.00375	12.470	15.566	7.693	0.00375	12.470	15.566	7.693	0.00375	12.470	15.566	7.693
0.00506	11.423	13.814	6.638	0.00506	11.423	13.814	6.638	0.00506	11.423	13.814	6.638	0.00506	11.423	13.814	6.638
0.00677	10.725	13.103	6.639	0.00677	10.725	13.103	6.639	0.00677	10.725	13.103	6.639	0.00677	10.725	13.103	6.639
0.00897	10.788	12.433	6.371	0.00897	10.788	12.433	6.371	0.00897	10.788	12.433	6.371	0.00897	10.788	12.433	6.371
0.00996	10.351	11.898	6.154	0.00996	10.351	11.898	6.154	0.00996	10.351	11.898	6.154	0.00996	10.351	11.898	6.154
0.01154	10.494	11.035	5.742	0.01154	10.494	11.035	5.742	0.01154	10.494	11.035	5.742	0.01154	10.494	11.035	5.742
0.01392	10.672	10.684	5.647	0.01392	10.672	10.684	5.647	0.01392	10.672	10.684	5.647	0.01392	10.672	10.684	5.647
0.01631	10.557	10.387	5.520	0.01631	10.557	10.387	5.520	0.01631	10.557	10.387	5.520	0.01631	10.557	10.387	5.520
KUNII AND SMITH (1960)				KUNII AND SMITH (1960)				KUNII AND SMITH (1960)				KUNII AND SMITH (1960)			
POSITION	FLAT	THEORETICAL	PARABOLIC	POSITION	FLAT	THEORETICAL	PARABOLIC	POSITION	FLAT	THEORETICAL	PARABOLIC	POSITION	FLAT	THEORETICAL	PARABOLIC
0.00046	47.018	43.905	21.360	0.00046	47.018	43.905	21.360	0.00046	47.018	43.905	21.360	0.00046	47.018	43.905	21.360
0.00093	30.294	28.172	12.501	0.00093	30.294	28.172	12.501	0.00093	30.294	28.172	12.501	0.00093	30.294	28.172	12.501
0.00134	23.179	22.020	9.843	0.00134	23.179	22.020	9.843	0.00134	23.179	22.020	9.843	0.00134	23.179	22.020	9.843
0.00196	19.806	19.806	9.098	0.00196	19.806	19.806	9.098	0.00196	19.806	19.806	9.098	0.00196	19.806	19.806	9.098
0.00273	17.692	18.292	8.570	0.00273	17.692	18.292	8.570	0.00273	17.692	18.292	8.570	0.00273	17.692	18.292	8.570
0.00375	17.205	16.911	8.076	0.00375	17.205	16.911	8.076	0.00375	17.205	16.911	8.076	0.00375	17.205	16.911	8.076
0.00506	15.216	15.946	7.703	0.00506	15.216	15.946	7.703	0.00506	15.216	15.946	7.703	0.00506	15.216	15.946	7.703
0.00677	13.306	14.126	7.081	0.00677	13.306	14.126	7.081	0.00677	13.306	14.126	7.081	0.00677	13.306	14.126	7.081
0.00897	12.071	13.253	6.557	0.00897	12.071	13.253	6.557	0.00897	12.071	13.253	6.557	0.00897	12.071	13.253	6.557
0.00996	12.141	12.553	6.357	0.00996	12.141	12.553	6.357	0.00996	12.141	12.553	6.357	0.00996	12.141	12.553	6.357
0.01154	12.390	12.360	6.125	0.01154	12.390	12.360	6.125	0.01154	12.390	12.360	6.125	0.01154	12.390	12.360	6.125
BALDWIN AND SICARDI (1980)				BALDWIN AND SICARDI (1980)				BALDWIN AND SICARDI (1980)				BALDWIN AND SICARDI (1980)			
POSITION	FLAT	THEORETICAL	PARABOLIC	POSITION	FLAT	THEORETICAL	PARABOLIC	POSITION	FLAT	THEORETICAL	PARABOLIC	POSITION	FLAT	THEORETICAL	PARABOLIC
0.00079	27.543	24.867	13.360	0.00079	27.543	24.867	13.360	0.00079	27.543	24.867	13.360	0.00079	27.543	24.867	13.360
0.00134	13.695	11.563	8.567	0.00134	13.695	11.563	8.567	0.00134	13.695	11.563	8.567	0.00134	13.695	11.563	8.567
0.00196	11.775	10.563	8.221	0.00196	11.775	10.563	8.221	0.00196	11.775	10.563	8.221	0.00196	11.775	10.563	8.221
0.00273	11.503	10.364	7.931	0.00273	11.503	10.364	7.931	0.00273	11.503	10.364	7.931	0.00273	11.503	10.364	7.931
0.00375	10.364	10.364	7.703	0.00375	10.364	10.364	7.703	0.00375	10.364	10.364	7.703	0.00375	10.364	10.364	7.703
0.00506	10.050	10.364	7.456	0.00506	10.050	10.364	7.456	0.00506	10.050	10.364	7.456	0.00506	10.050	10.364	7.456
0.00677	9.914	10.270	7.005	0.00677	9.914	10.270	7.005	0.00677	9.914	10.270	7.005	0.00677	9.914	10.270	7.005
0.00897	9.496	10.270	6.636	0.00897	9.496	10.270	6.636	0.00897	9.496	10.270	6.636	0.00897	9.496	10.270	6.636
0.00996	9.603	10.161	6.505	0.00996	9.603	10.161	6.505	0.00996	9.603	10.161	6.505	0.00996	9.603	10.161	6.505
0.01154	9.796	10.431	6.638	0.01154	9.796	10.431	6.638	0.01154	9.796	10.431	6.638	0.01154	9.796	10.431	6.638
0.01392	9.603	10.161	6.505	0.01392	9.603	10.161	6.505	0.01392	9.603	10.161	6.505	0.01392	9.603	10.161	6.505
0.01631	9.603	10.161	6.505	0.01631	9.603	10.161	6.505	0.01631	9.603	10.161	6.505	0.01631	9.603	10.161	6.505

TEST NUMBER 88-1-6

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

2.54000 2.47904 0.300

PARTICLE SIZE RANGE (MICRONS)

420-590

EXPERIMENTAL VARIABLES

POWDER VELOCITY DENSITY

(M) (CM/S) (G/CM³)

1084.50 1.12 1.469

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT TRANSFER HEAT TRANSFER

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M²) (W/M²2K)

0.03067 1.1705 0.8850 24739.35 180.73

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M ²)	CONVECTIVE HEAT FLUX (W/M ²)	RADIATIVE H T COEFF (W/M ² 2K)	CONVECTIVE H T COEFF (W/M ² 2K)
0.	83.89	31.11	131.821	20653.86	2.498	391.336
2.226	123.33	37.09	265.158	21597.56	3.075	250.421
4.771	159.44	44.17	427.144	22417.17	3.705	194.462
7.318	190.56	51.44	603.173	23083.39	4.336	165.933
10.184	202.22	59.72	865.948	23333.63	4.673	163.754
13.052	232.22	68.07	887.194	23922.34	5.405	145.732
15.777	238.89	76.05	924.925	24053.75	5.680	147.779
19.108	256.67	85.80	1067.869	24397.77	6.250	142.792
22.616	278.89	96.12	1275.374	24781.97	6.978	135.609
26.123	303.89	106.53	1546.969	25180.42	7.838	127.587
30.274	316.87	118.86	1672.638	25394.86	8.456	128.385
34.424	340.00	131.21	1968.044	25719.08	9.426	123.181
38.576	347.78	143.54	2034.966	25858.28	9.964	126.610
43.367	366.11	157.71	2276.023	26102.26	10.921	125.251
48.159	376.11	171.83	2378.271	26204.08	11.642	128.571
62.952	371.11	185.77	2196.987	26313.37	11.854	141.970

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
KUNII SMITH KUNII BALDI
(1957) (1960) (1962) SICARDI
(1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.3211 0.2024 0.2263 0.1914 0.3866 0.3809

PSEUDOHOMOGENEOUS PECLET NUMBER 1888.0 934.8 948.6

AVERAGE EXPERIMENTAL NUSSELT NUMBER 13.955 22.132 19.796 23.410 11.590 11.762

TEST NUMBER AB-1-6
LOCAL NUSSELLT NUMBER PROFILES

YAGI AND KUNITA (1957)	EXPERIMENTAL	THEORETICAL
NO. 1	1.0	1.0
NO. 2	1.0	1.0
NO. 3	1.0	1.0
NO. 4	1.0	1.0
NO. 5	1.0	1.0
NO. 6	1.0	1.0
NO. 7	1.0	1.0
NO. 8	1.0	1.0
NO. 9	1.0	1.0
NO. 10	1.0	1.0
NO. 11	1.0	1.0
NO. 12	1.0	1.0
NO. 13	1.0	1.0
NO. 14	1.0	1.0
NO. 15	1.0	1.0
NO. 16	1.0	1.0
NO. 17	1.0	1.0
NO. 18	1.0	1.0
NO. 19	1.0	1.0
NO. 20	1.0	1.0
NO. 21	1.0	1.0
NO. 22	1.0	1.0
NO. 23	1.0	1.0
NO. 24	1.0	1.0
NO. 25	1.0	1.0
NO. 26	1.0	1.0
NO. 27	1.0	1.0
NO. 28	1.0	1.0
NO. 29	1.0	1.0
NO. 30	1.0	1.0
NO. 31	1.0	1.0
NO. 32	1.0	1.0
NO. 33	1.0	1.0
NO. 34	1.0	1.0
NO. 35	1.0	1.0
NO. 36	1.0	1.0
NO. 37	1.0	1.0
NO. 38	1.0	1.0
NO. 39	1.0	1.0
NO. 40	1.0	1.0
NO. 41	1.0	1.0
NO. 42	1.0	1.0
NO. 43	1.0	1.0
NO. 44	1.0	1.0
NO. 45	1.0	1.0
NO. 46	1.0	1.0
NO. 47	1.0	1.0
NO. 48	1.0	1.0
NO. 49	1.0	1.0
NO. 50	1.0	1.0
NO. 51	1.0	1.0
NO. 52	1.0	1.0
NO. 53	1.0	1.0
NO. 54	1.0	1.0
NO. 55	1.0	1.0
NO. 56	1.0	1.0
NO. 57	1.0	1.0
NO. 58	1.0	1.0
NO. 59	1.0	1.0
NO. 60	1.0	1.0
NO. 61	1.0	1.0
NO. 62	1.0	1.0
NO. 63	1.0	1.0
NO. 64	1.0	1.0
NO. 65	1.0	1.0
NO. 66	1.0	1.0
NO. 67	1.0	1.0
NO. 68	1.0	1.0
NO. 69	1.0	1.0
NO. 70	1.0	1.0
NO. 71	1.0	1.0
NO. 72	1.0	1.0
NO. 73	1.0	1.0
NO. 74	1.0	1.0
NO. 75	1.0	1.0
NO. 76	1.0	1.0
NO. 77	1.0	1.0
NO. 78	1.0	1.0
NO. 79	1.0	1.0
NO. 80	1.0	1.0
NO. 81	1.0	1.0
NO. 82	1.0	1.0
NO. 83	1.0	1.0
NO. 84	1.0	1.0
NO. 85	1.0	1.0
NO. 86	1.0	1.0
NO. 87	1.0	1.0
NO. 88	1.0	1.0
NO. 89	1.0	1.0
NO. 90	1.0	1.0
NO. 91	1.0	1.0
NO. 92	1.0	1.0
NO. 93	1.0	1.0
NO. 94	1.0	1.0
NO. 95	1.0	1.0
NO. 96	1.0	1.0
NO. 97	1.0	1.0
NO. 98	1.0	1.0
NO. 99	1.0	1.0
NO. 100	1.0	1.0

[illegible]

TEST NUMBER BB-2-1
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 2.54000 2.47904 0.300
 PARTICLE SIZE RANGE (MICRONS)
 420-590
 EXPERIMENTAL VARIABLES
 POWER (W) VELOCITY (CM/S) DENSITY (G/CM³) VOID FRACTION
 1409.40 3.80 1.469 0.386
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS CONDUCTIVITY (W/MK) PARTICLE CONDUCTIVITY (W/MK) PARTICLE SPECIFIC HEAT (WS/GK) HEAT FLUX (W/M²) HEAT TRANSFER COEFFICIENT (W/M²K)
 0.02753 1.0798 0.8254 33195.99 268.65
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M ²)	CONVECTIVE HEAT FLUX (W/M ²)	RADIATIVE H T COEFF (W/M ² K)	CONVECTIVE H T COEFF (W/M ² K)
0.225	82.22	33.33	122.305	28646.78	2.302	585.957
4.770	107.22	35.75	205.034	29513.95	2.841	412.334
7.316	136.11	38.59	319.453	30489.38	3.276	312.652
10.180	159.44	41.52	432.087	31255.06	3.671	265.033
13.045	164.44	44.84	453.944	31422.07	3.795	262.720
15.768	168.89	48.21	595.308	32194.47	4.260	228.844
19.096	191.11	51.43	607.008	32270.06	4.346	231.031
22.600	200.56	55.38	664.491	32566.34	4.577	224.321
26.106	221.11	59.57	814.214	33185.14	5.040	205.431
30.250	240.56	63.83	974.271	33750.26	5.513	190.975
34.394	248.89	68.90	1040.157	33994.62	5.779	188.869
38.540	255.56	73.99	1196.686	34457.62	6.247	179.876
43.324	270.00	79.10	1230.011	34589.28	6.443	181.190
48.109	282.22	84.99	1351.018	34921.51	6.850	177.059
52.894	287.22	90.88	1391.613	35066.13	7.088	178.598
	287.22	96.73	1371.762	35085.98	7.201	184.187

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII BALDI
 (1957) (1960) (1962) (1980) (1980)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2917 0.1834 0.2055 0.1738 0.3502 0.3451
 PSEUDOHOMOGENEOUS PECLET NUMBER
 3916.3 6229.9 5559.4 6575.2 3262.4 3310.6
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 22.829 36.316 32.407 38.329 19.017 19.298

TEST NUMBER BB-2-2
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 2.54000 2.47904 0.300
 PARTICLE SIZE RANGE (MICRONS)
 420-590
 EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID
 (W) (CM/S) (G/CM**3) FRACTION
 1441.00 3.26 1.469 0.386
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS PARTICLE PARTICLE HEAT HEAT HEAT
 CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX TRANSFER
 (W/MK) (W/MK) (WS/GK) (W/M**2) COEFFICIENT
 0.02794 1.0917 0.8336 33759.48 252.54
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	85.56	33.33	132.722	28755.82	2.541	550.643
2.226	119.33	36.16	225.934	29715.05	2.927	385.046
4.770	145.00	39.50	360.789	30775.59	3.420	291.707
7.316	171.11	42.94	497.364	31621.33	3.880	246.704
10.782	205.00	46.92	717.215	32671.75	4.537	206.674
13.043	203.33	50.94	693.532	32631.08	4.564	214.128
15.773	207.22	54.74	715.741	32756.33	4.694	214.826
19.102	217.22	59.39	782.793	33063.00	4.960	209.486
22.607	240.00	64.34	967.776	33727.53	5.509	191.999
26.113	260.00	69.35	1151.008	34288.23	6.037	179.850
30.259	268.89	75.32	1228.908	34540.28	6.349	178.436
34.405	287.78	81.31	1428.608	35040.55	5.920	169.715
38.553	292.78	87.32	1471.389	35153.00	5.162	171.244
43.339	307.22	94.26	1635.299	35552.98	7.679	166.941
48.126	313.89	101.19	1702.082	35732.26	8.002	167.994
52.913	313.33	108.07	1668.888	35744.96	8.131	174.144

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII BALDI
 (1957) (1960) SMITH (1967) SICARDI
 (1962) (1980)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2956 0.1859 0.2083 0.1761 0.3550 0.3498
 PSEUDOHOMOGENEOUS PECLET NUMBER
 3352.9 5391.2 4759.1
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 21.180 33.578 30.063 35.556 17.636 17.897

TEST NUMBER	BB-2-2	LOCAL	NUSSELL	NUMBER	PROFILES	THEORETICAL	THEORETICAL	THEORETICAL	KUNII	AND SMITH	THEORETICAL	THEORETICAL	THEORETICAL
YAGI	(1957)	YAGI	(1957)	YAGI	(1957)	PARABOLIC	PARABOLIC	PARABOLIC	N D	EXPERIMENTAL	FLAT	FLAT	FLAT
POSITION	POSITION	POSITION	POSITION	POSITION	POSITION	POSITION	POSITION	POSITION	POSITION	POSITION	POSITION	POSITION	POSITION
0.00027	45.235	204.815	204.815	204.815	204.815	204.815	204.815	0.00017	73.514	73.514	270.815	270.815	270.815
0.00057	32.516	17.206	17.206	17.206	17.206	17.206	17.206	0.00036	58.585	58.585	49.209	49.209	49.209
0.00085	22.745	12.329	12.329	12.329	12.329	12.329	12.329	0.00055	40.255	40.255	32.446	32.446	32.446
0.00122	16.089	10.807	10.807	10.807	10.807	10.807	10.807	0.00078	32.850	32.850	24.756	24.756	24.756
0.00169	12.076	8.171	8.171	8.171	8.171	8.171	8.171	0.00119	24.742	24.742	18.797	18.797	18.797
0.00226	9.630	6.567	6.567	6.567	6.567	6.567	6.567	0.00170	18.033	18.033	14.063	14.063	14.063
0.00290	7.615	5.070	5.070	5.070	5.070	5.070	5.070	0.00235	13.703	13.703	10.047	10.047	10.047
0.00362	6.195	4.147	4.147	4.147	4.147	4.147	4.147	0.00316	10.866	10.866	8.585	8.585	8.585
0.00440	5.171	3.593	3.593	3.593	3.593	3.593	3.593	0.00408	8.740	8.740	7.125	7.125	7.125
0.00519	4.431	3.052	3.052	3.052	3.052	3.052	3.052	0.00509	7.347	7.347	6.168	6.168	6.168
0.00605	3.921	2.742	2.742	2.742	2.742	2.742	2.742	0.00625	6.975	6.975	5.956	5.956	5.956
0.00697	3.563	2.596	2.596	2.596	2.596	2.596	2.596	0.00760	6.350	6.350	5.483	5.483	5.483
0.00793	3.303	2.398	2.398	2.398	2.398	2.398	2.398	0.00924	5.544	5.544	4.822	4.822	4.822
0.00894	3.115	2.275	2.275	2.275	2.275	2.275	2.275	0.01116	4.613	4.613	4.041	4.041	4.041
0.00999	2.980	2.173	2.173	2.173	2.173	2.173	2.173	0.01332	3.987	3.987	3.524	3.524	3.524
0.01109	2.880	2.099	2.099	2.099	2.099	2.099	2.099	0.01574	3.522	3.522	3.182	3.182	3.182
0.01230	2.800	2.058	2.058	2.058	2.058	2.058	2.058	0.01836	3.161	3.161	2.853	2.853	2.853
0.01350	2.732	2.038	2.038	2.038	2.038	2.038	2.038	0.02119	2.885	2.885	2.603	2.603	2.603
0.01470	2.672	2.024	2.024	2.024	2.024	2.024	2.024	0.02424	2.673	2.673	2.403	2.403	2.403
0.01590	2.615	2.013	2.013	2.013	2.013	2.013	2.013	0.02749	2.505	2.505	2.244	2.244	2.244
0.01710	2.560	2.003	2.003	2.003	2.003	2.003	2.003	0.03094	2.353	2.353	2.103	2.103	2.103
0.01830	2.507	1.994	1.994	1.994	1.994	1.994	1.994	0.03459	2.214	2.214	1.973	1.973	1.973

TEST NUMBER BB-2-3
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 2.54000 2.47904 0.300
 PARTICLE SIZE RANGE (MICRONS)
 420-590
 EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID
 (W) (CM/S) (G/CM**3) FRACTION
 1462.00 2.74 1.469 0.985
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS PARTICLE PARTICLE HEAT HEAT TRANSFER
 CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
 (W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
 0.02850 1.1079 0.8445 34090.56 241.70
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	87.78	33.89	138.729	28781.02	2.574	534.081
2.226	120.00	37.26	250.724	29885.89	3.030	361.224
4.771	152.78	41.25	397.232	30974.46	3.562	277.735
7.317	180.00	45.36	547.201	31845.70	4.064	236.528
10.183	187.78	50.04	587.585	32096.47	4.266	233.031
13.050	215.56	54.78	780.766	32940.84	4.856	204.889
15.774	220.56	59.33	810.228	33097.76	5.025	205.288
19.104	233.33	64.90	905.612	33475.16	5.377	198.787
22.610	256.11	70.81	1106.915	34123.12	5.974	184.150
26.118	278.33	76.81	1330.670	34722.64	6.603	172.301
30.265	287.22	83.94	1413.950	34960.03	6.956	172.018
34.412	307.78	91.10	1653.370	35487.21	7.631	163.778
38.561	313.33	98.27	1704.755	35640.51	7.927	165.723
43.349	329.44	106.54	1907.309	36030.72	8.557	161.643
48.138	336.67	114.81	1985.745	36217.60	8.950	163.245
52.928	335.56	123.00	1934.574	36227.97	9.102	170.440

 DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI	KUNII	WILLHITE	KRUPICZKA	SPECCHIA	SPECCHIA
KUNII	SMITH	KUNII	(1967)	BALDI	SICARDI
(1957)	(1960)	SMITH	(1962)	SICARDI	(1980)

 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.3009 0.1893 0.2120 0.1792 0.3615 0.3563
 PSEUDOHOMOGENEOUS PECLET NUMBER
 2804.1 4456.2 3979.6 4706.6 2333.6 2368.1
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 19.916 31.650 28.265 33.429 16.574 16.819

TEST NUMBER BB-2-3 LOCAL NUSSELL NUMBER PROFILES YAGI AND KUNII (1957)				KUNII AND SMITH (1960)				THEORETICAL PARABOLIC			
N.D.	POSITION	FLAT	EXPERIMENTAL	N.D.	POSITION	FLAT	EXPERIMENTAL	FLAT	EXPERIMENTAL	FLAT	EXPERIMENTAL
0.00032	49	059		0.00020	70	019		21.360		21.360	
0.00036	22	016		0.00033	46	053		21.360		21.360	
0.00106	19	044		0.00066	36	059		12.624		12.624	
0.00116	18	034		0.00092	30	064		14.754		14.754	
0.00125	16	031		0.00142	22	067		11.146		11.146	
0.00223	15	039		0.00172	22	067		11.146		11.146	
0.00237	15	040		0.00203	22	067		11.146		11.146	
0.00321	14	024		0.00234	22	067		11.146		11.146	
0.00431	14	024		0.00271	22	067		11.146		11.146	
0.00490	13	064		0.00308	22	067		11.146		11.146	
0.00539	13	064		0.00345	22	067		11.146		11.146	
0.00647	13	064		0.00389	22	067		11.146		11.146	
0.00759	13	064		0.00437	22	067		11.146		11.146	
WILLHITE,				KRUPICZKA							
N.D.	POSITION	FLAT	EXPERIMENTAL	N.D.	POSITION	FLAT	EXPERIMENTAL	THEORETICAL PARABOLIC			
0.00022	62	036		0.00019	73	052		21.360		21.360	
0.00046	42	054		0.00041	50	051		12.624		12.624	
0.00074	32	054		0.00062	32	054		14.754		14.754	
0.00131	24	042		0.00091	22	054		11.146		11.146	
0.00159	24	042		0.00134	22	054		11.146		11.146	
0.00192	23	031		0.00163	22	054		11.146		11.146	
0.00232	23	031		0.00192	22	054		11.146		11.146	
0.00264	20	023		0.00225	22	054		11.146		11.146	
0.00345	19	021		0.00252	22	054		11.146		11.146	
0.00387	19	021		0.00287	22	054		11.146		11.146	
0.00485	19	021		0.00327	22	054		11.146		11.146	
0.00495	19	021		0.00369	22	054		11.146		11.146	
0.00530	20	044		0.00439	22	054		11.146		11.146	
SPECCHIA,				AND SICARDI							
N.D.	POSITION	FLAT	EXPERIMENTAL	N.D.	POSITION	FLAT	EXPERIMENTAL	THEORETICAL PARABOLIC			
0.00038	26	066		0.00038	25	066		21.360		21.360	
0.00062	19	089		0.00061	19	089		12.624		12.624	
0.00115	14	092		0.00124	16	084		14.754		14.754	
0.00129	14	092		0.00172	14	084		11.146		11.146	
0.00271	13	127		0.00237	14	084		11.146		11.146	
0.00328	13	127		0.00332	13	084		11.146		11.146	
0.00347	11	089		0.00361	13	084		11.146		11.146	
0.00569	11	089		0.00471	13	084		11.146		11.146	
0.00580	11	089		0.00500	13	084		11.146		11.146	
0.00623	11	089		0.00579	13	084		11.146		11.146	
0.00903	11	089		0.00681	13	084		11.146		11.146	

TEST NUMBER BB-2-4
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 2.54000 2.47904 0.300
 PARTICLE SIZE RANGE (MICRONS)
 420-590

EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID
 (W) (CM/S) (G/CM**3) FRACTION
 1466.90 2.26 1.469 0.366
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT HEAT TRANSFER
 CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
 (W/MK) (W/MK) (WS/GK) (W/H**2) (W/M**2K)
 0.02916 1.1267 0.8570 33924.80 223.52

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0	91.67	33.89	151.488	28319.74	2.622	490.149
2.226	127.78	37.93	282.778	29524.41	3.147	329.608
4.771	163.33	42.72	452.201	30664.76	3.749	254.250
7.319	193.33	47.67	631.078	31586.63	4.332	216.843
10.785	202.78	53.30	685.836	31877.56	4.588	213.263
13.062	233.33	59.01	920.824	32750.23	5.282	187.915
15.777	238.89	64.48	957.101	32524.35	5.486	188.782
19.108	253.89	71.19	1083.374	33343.83	5.930	182.504
22.616	276.67	78.30	1307.142	33946.83	6.590	171.132
26.125	301.67	85.51	1590.481	34568.17	7.358	159.922
30.274	312.78	94.08	1711.559	34848.25	7.826	159.346
34.424	335.56	102.69	2014.843	35365.53	8.652	151.870
38.575	341.67	111.31	2078.450	35521.67	9.023	154.201
43.366	360.00	121.24	2344.233	35914.05	9.818	150.416
48.158	368.33	131.16	2449.041	36107.89	10.326	152.240
52.950	366.11	140.98	2362.735	36114.59	10.495	160.413

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII (1967) BALDI SICARDI
 (1957) (1960) SMITH (1962) SICARDI (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.3069 0.1933 0.2163 0.1829 0.3691 0.3637
 PSEUDOHOMOGENEOUS PECLET NUMBER 2255.7 3646.1 3257.7 3852.7 1909.3 1937.6
 AVERAGE EXPERIMENTAL NUSSELT NUMBER 18.052 28.670 25.616 30.295 15.014 15.236

TEST NUMBER BB-2-5

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

2.54000 2.47904 0.300

PARTICLE SIZE RANGE (MICRONS)

420-590

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY VOID

(W) (CM/S) (G/CM**3) FRACTION

1482.00 1.82 1.469 0.386

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.03008 1.1536 0.8744 33958.11 211.90

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION WALL TEMPERATURE PARTICLE TEMPERATURE RADIATIVE CONVECTIVE RADIATIVE CONVECTIVE

(CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K) (W/M**2K)

0.	95.00	34.44	161.648	27973.82	2.669	461.953
2.226	136.11	39.41	317.750	29313.18	3.286	303.126
4.773	202.78	45.41	704.011	31336.32	4.474	199.130
7.321	207.22	51.60	723.240	31477.02	4.647	202.266
10.188	218.89	58.54	798.500	31821.16	4.980	198.453
13.057	251.67	65.57	1076.524	32718.18	5.785	175.816
15.732	258.33	72.32	1125.457	32807.65	6.050	176.906
19.115	275.00	80.56	1281.399	33346.84	6.590	171.502
22.624	300.00	89.31	1556.614	33961.97	7.388	161.191
26.135	327.22	98.17	1904.544	34580.28	8.315	150.969
30.285	340.00	108.69	2062.038	34875.15	8.915	150.775
34.437	365.56	119.26	2450.656	35389.02	9.950	143.684
38.591	373.89	129.84	2557.061	35576.25	10.478	145.774
43.385	393.33	142.02	2876.291	35938.62	11.453	143.004
48.179	401.11	154.17	2976.908	36113.36	12.055	146.241
52.975	397.78	166.16	2840.201	36133.08	12.262	156.003

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA

KUNII SMITH KUNII BALDI

(1957) (1960) SMITH (1962) SICARDI

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.3156 0.1989 0.2225 0.1881 0.3796 0.3743

PSEUDOHOMOGENEOUS PECLET NUMBER

1835.4 2912.4 2603.9 3079.3 1525.1 1547.7

AVERAGE EXPERIMENTAL NUSSELT NUMBER

16.643 26.410 23.612 27.924 13.830 14.035

TEST NUMBER BB-3-1
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 2.54000 2.47004 0.300
 PARTICLE SIZE RANGE (MICRONS)
 420-530
 EXPERIMENTAL VARIABLES
 POWER (W) VELOCITY (CM/S) DENSITY (G/CM**3) VOID FRACTION
 875.70 3.51 1.469 0.386
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS PARTICLE PARTICLE HEAT HEAT TRANSFER
 CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
 (W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
 0.02601 1.0363 0.7947 20814.38 244.05
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES
 AXIAL WALL PARTICLE RADIATIVE CONVECTIVE RADIATIVE CONVECTIVE
 POSITION TEMPERATURE TEMPERATURE TEMPERATURE HEAT FLUX HEAT FLUX H T COEFF H T COEFF
 (CM) (C) (C) (C) (W/M**2) (W/M**2) (W/M**2K) (W/M**2K)
 0. 56.67 23.33 70.470 18697.48 2.114
 2.224 74.44 24.97 114.969 19109.65 2.324
 4.767 94.44 26.89 174.290 19502.94 2.580
 7.311 111.11 28.85 231.454 19932.03 2.814
 10.173 113.89 31.07 238.149 19996.30 2.876
 13.035 130.56 33.31 304.539 20355.18 3.132
 15.755 130.56 35.45 300.266 20359.45 3.157
 19.080 136.67 38.06 323.169 20492.27 3.278
 22.580 150.56 40.84 366.419 20762.51 3.522
 26.080 164.44 43.64 466.580 21065.24 3.780
 30.219 170.00 46.97 481.772 21181.04 3.916
 34.357 181.67 50.32 546.646 21411.94 4.162
 38.497 184.44 53.68 556.840 21472.10 4.258
 43.273 192.22 57.55 599.903 21625.92 4.454
 48.050 196.67 61.42 621.330 21716.91 4.594
 52.827 197.22 65.28 615.206 21737.08 4.663
 DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII BALDI
 (1957) (1960) SMITH (1967) SICARDI
 (1962) (1980)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2775 0.1742 0.1954 0.3277
 PSEUDOHOMOGENEOUS PECLET NUMBER 0.1652 0.3326
 3865.0 6158.6 5488.6 6491.9 3225.1 3272.7
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 21.800 34.737 30.958 36.617 18.191 18.460

TEST NUMBER BB-3-2
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 2.54000 2.47904 0.300
 PARTICLE SIZE RANGE (MICRONS)
 420-590
 EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID FRACTION
 (W) (CM/S) (G/CM**3) (CM**3)
 871.50 3.15 1.469 0.386
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS CONDUCTIVITY PARTICLE CONDUCTIVITY PARTICLE SPECIFIC HEAT HEAT FLUX HEAT TRANSFER COEFFICIENT
 (W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
 0.02650 1.0503 0.8047 2650.71 234.22
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0	50.56	26.67	74.155	18439.19	2.178	544.107
2.224	79.44	28.56	123.086	18865.13	2.413	370.762
4.767	100.56	30.78	188.309	19331.45	2.695	277.051
7.311	118.33	33.04	252.298	19713.24	2.955	231.135
10.174	121.67	35.62	261.078	19787.94	3.034	229.955
13.037	140.00	38.21	333.820	20168.73	3.329	198.198
15.757	140.56	40.69	336.314	20185.12	3.368	202.121
19.082	147.78	43.72	365.836	20335.94	3.516	195.430
22.583	152.78	46.94	439.739	20635.10	3.796	178.139
26.084	177.78	50.19	522.147	20927.05	4.092	164.020
30.224	182.78	54.06	545.025	21029.51	4.234	163.365
34.363	195.56	57.94	622.221	21268.61	4.522	154.547
38.504	198.33	61.62	632.221	21327.57	4.631	156.236
43.281	207.78	66.31	690.471	21503.47	4.881	152.001
48.060	211.11	70.79	703.925	21572.59	5.017	153.739
52.638	211.67	75.25	695.567	21594.71	5.099	158.299

 DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII (1957)	KUNII SMITH (1960)	WILLHITE KUNII SMITH (1962)	KRUPICZKA (1967)	SPECCHIA BALDI SICARDI (1980)	SPECCHIA SICARDI (1980)
THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)	0.2821	0.1771	0.1987	0.1680	0.3382
PSEUDOHOMOGENEOUS PECLET NUMBER	3267.1	5203.1	4639.1	5487.0	2724.7
AVERAGE EXPERIMENTAL NUSSELT NUMBER	20.584	32.780	29.227	34.569	17.166
					2765.0
					17.420

TEST NUMBER BB-3-3

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

2.54000 2.47904 0.300

PARTICLE SIZE RANGE (MICRONS)

420-530

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM³) VOID FRACTION

882.00 2.61 1.469 0.386

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY PARTICLE CONDUCTIVITY PARTICLE SPECIFIC HEAT HEAT FLUX HEAT TRANSFER COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M²) (W/M²K)

0.02694 1.0630 0.8137 20811.70 219.71

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM) WALL TEMPERATURE (C) PARTICLE TEMPERATURE (C) RADIATIVE HEAT FLUX (W/M²) CONVECTIVE HEAT FLUX (W/M²) RADIATIVE H T COEFF (W/M²K) CONVECTIVE H T COEFF (W/M²K)

0.	63.33	27.78	79.254	18401.12	2.229	517.531
2.225	85.00	30.05	137.346	18835.57	2.500	343.701
4.768	108.33	32.72	213.291	19392.34	2.821	256.464
7.312	127.78	35.45	287.851	19802.15	3.118	214.469
10.175	132.22	38.54	301.505	19899.05	3.219	212.421
13.039	151.67	41.67	390.466	20293.08	3.550	184.489
15.760	153.33	44.66	392.794	20332.03	3.615	187.097
19.085	161.11	48.32	427.182	20490.54	3.787	181.663
22.587	176.67	52.19	510.490	20792.37	4.101	167.039
26.089	192.78	56.11	607.304	21093.67	4.444	154.342
30.230	198.89	60.77	638.844	21212.83	4.626	153.580
34.371	213.33	65.44	735.980	21471.79	4.976	145.185
38.512	216.11	70.12	745.398	21530.76	5.106	147.482
43.292	227.22	75.52	822.524	21726.95	5.422	143.220
48.072	231.11	80.91	840.314	21804.73	5.595	145.173
52.852	231.67	86.27	828.505	21830.19	5.698	150.145

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI	KUNII	WILLHITE	KRUPICZKA	SPECCHIA	SPECCHIA
KUNII	SMITH	KUNII	(1967)	BALDI	SICARDI
(1957)	(1960)	SMITH	(1962)	SICARDI	(1900)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2862 0.1798 0.2016 0.1705 0.3434 0.3384

PSEUDOHOMOGENEOUS PECLET NUMBER

2706.8 4308.5 3843.0 4545.3 2256.3 2289.6

AVERAGE EXPERIMENTAL NUSSELT NUMBER

19.028 30.288 27.015 31.952 15.861 16.095

TEST NUMBER BB-3-4
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 2.54000 2.47804 0.300
 PARTICLE SIZE RANGE (MICRONS)
 420-550
 EXPERIMENTAL VARIABLES
 POWER (W) VELOCITY (CM/S) DENSITY (G/CM³) VOID FRACTION
 896.80 2.21 1.489 0.386
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS CONDUCTIVITY (W/MK) PARTICLE CONDUCTIVITY (W/MK) PARTICLE SPECIFIC HEAT (WS/GK) HEAT FLUX (W/M²) HEAT TRANSFER COEFFICIENT (W/M²K)
 0.02742 1.0768 0.8293 21081.95 211.49
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M ²)	CONVECTIVE HEAT FLUX (W/M ²)	RADIATIVE H T COEFF (W/M ² K)	CONVECTIVE H T COEFF (W/M ² K)
0.	66.11	28.89	84.530	18488.46	2.271	498.705
2.225	90.00	31.59	150.495	19021.13	2.576	325.626
4.768	115.56	34.75	237.580	19572.59	2.940	242.227
7.313	136.11	38.00	320.891	20001.89	3.269	203.859
10.176	141.67	41.68	339.627	20120.97	3.397	201.236
13.040	162.78	45.40	443.175	20541.81	3.776	175.003
15.762	163.89	48.95	441.495	20571.05	3.841	178.901
19.088	173.33	53.30	487.250	20759.42	4.059	172.946
22.531	189.44	57.90	579.965	21083.48	4.409	160.143
26.094	207.22	62.56	696.136	21388.42	4.812	147.831
30.235	213.33	68.09	728.833	21506.44	5.018	148.073
34.378	228.89	73.64	842.371	21776.04	5.426	140.263
38.520	231.67	79.19	850.433	21836.32	5.577	143.209
43.001	243.89	85.58	942.687	22044.48	5.955	139.252
48.083	248.89	91.97	970.048	22133.89	6.182	141.094
52.864	249.44	98.32	953.716	22169.05	6.311	146.698

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA SPECCHIA
 KUNII SMITH KUNII (1967) BALDI SICARDI SICARDI
 (1957) (1960) (1962) (1980) (1980)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.2907 0.1828 0.2048 0.1732 0.3490 0.3439
 PSEUDOHOMOGENEOUS PECLET NUMBER
 2283.4 3632.7 3241.5
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 18.033 28.689 25.599 30.277 15.023 15.245

TEST NUMBER BB-3-5

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

2.54000 2.47804 0.300

PARTICLE SIZE RANGE (MICRONS)

420-590

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM**3) VOID FRACTION

922.20 1.78 1.489 0.386

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (W/5K) (W/M**2) (W/M**2K)

0.02812 1.0967 0.8370 21539.40 198.72

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL WALL PARTICLE RADIATIVE CONVECTIVE RADIATIVE

POSITION TEMPERATURE TEMPERATURE HEAT FLUX H T COEFF H T COEFF

(CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K)

0. 69.44 29.44 92.545 18649.41 2.314

2.225 97.22 32.83 172.530 19268.27 2.679

4.769 123.89 36.81 258.115 19841.42 3.079

7.314 147.22 40.89 369.091 20323.85 3.471

10.178 153.89 45.53 393.838 20468.49 3.635

13.043 177.22 50.21 518.605 20922.02 4.083

15.765 180.00 54.69 523.579 20984.13 4.194

19.092 191.67 60.16 589.490 21210.15 4.483

22.096 210.00 65.97 708.479 21545.92 4.919

26.101 228.89 71.84 847.484 21874.39 5.396

30.244 237.22 78.80 901.492 22026.27 5.691

34.388 254.44 85.79 1045.361 22307.22 6.198

38.532 256.87 92.77 1045.102 22382.22 6.377

43.315 271.67 100.80 1177.041 22590.49 6.889

48.099 277.78 108.83 1216.313 22710.36 7.199

52.884 276.67 116.78 1172.183 22727.19 7.331

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA

KUNII SMITH KUNII BALDI SICARDI

(1957) (1960) SMITH (1967) SICARDI (1980)

(1962) (1930)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.2972 0.1870 0.2094 0.1771 0.3578 0.3518

PSEUDOHOMOGENEOUS PECLET NUMBER

1826.6 2904.0 2592.7 3066.3 1520.7 1543.2

AVERAGE EXPERIMENTAL NUSSELT NUMBER

16.574 26.349 23.524 27.822 13.798 14.002

TEST NUMBER 88-3-6

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

2.54000 2.47904 0.300

PARTICLE SIZE RANGE (MICRONS)

420-590

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY VOID

(W) (CM/S) (G/CM**3) FRACTION

947.90 1.35 1.469 0.386

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.02918 1.1275 0.8575 21907.52 182.02

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL WALL PARTICLE RADIATIVE CONVECTIVE RADIATIVE CONVECTIVE

POSITION TEMPERATURE TEMPERATURE TEMPERATURE HEAT FLUX HEAT FLUX H T COEFF H T COEFF

(CM) (C) (C) (C) (W/M**2) (W/M**2K) (W/M**2K) (W/M**2K)

0. 74.44 30.00 105.594 18672.49 2.376

2.225 108.33 34.48 209.800 19416.01 2.841

4.770 138.33 39.77 327.340 20045.88 3.323

7.316 165.00 45.19 456.374 20579.33 3.809

10.181 173.69 51.36 495.248 20760.75 4.042

13.046 199.44 57.58 650.993 21237.00 4.589

15.770 204.44 63.53 672.635 21338.77 4.773

19.099 217.78 70.80 756.979 21583.17 5.150

22.604 237.22 78.50 902.412 21916.19 5.685

26.110 258.69 86.27 1089.240 22261.12 6.310

30.256 268.33 95.48 1159.049 22422.64 6.705

34.402 287.78 104.71 1349.865 22707.24 7.373

38.550 294.44 113.93 1396.702 22823.13 7.737

43.336 310.56 124.55 1563.604 23048.72 8.407

48.123 318.33 135.14 1624.590 23177.21 8.868

52.911 314.44 145.61 1519.023 23188.16 8.997

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

KUNII WILLIAMS KRUPICZKA SPECCHIA

KUNII SMITH KUNII BALDI

(1957) (1960) SMITH SICARDI

(1962) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.3072 0.1934 0.2165 0.1630 0.3640

PSEUDOHOMOGENEOUS PECLET NUMBER

1373.6 2181.4 1949.1 2305.1 1142.3

AVERAGE EXPERIMENTAL NUSSELT NUMBER

14.689 23.329 20.844 24.652 12.217

12.397

TEST NUMBER BC-1-1

EXPERIMENTAL DATA
TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

2.54000 2.47904 0.300

PARTICLE SIZE RANGE (MICRONS)

590-840

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY VOID FRACTION

(W) (CM/S) (G/CM**3) (1.485) 0.372

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT

(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.02705 1.0660 0.8158 24896.15 256.59

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL WALL PARTICLE RADIATIVE CONVECTIVE RADIATIVE CONVECTIVE

POSITION TEMPERATURE TEMPERATURE HEAT FLUX HEAT FLUX H T COEFF H T COEFF

(CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K) (W/M**2K)

0. 76.67 33.33 105.583 22250.38 2.437 513.470

2.225 93.33 35.29 154.271 22696.95 2.658 391.066

4.769 116.11 37.59 234.069 23292.43 2.901 296.625

7.313 133.33 39.93 303.715 23732.15 3.252 254.075

10.177 137.22 42.58 316.243 23834.49 3.342 251.848

13.040 135.56 43.26 403.394 24288.16 3.658 220.217

15.761 157.22 47.83 406.713 24333.95 3.718 222.444

19.087 163.33 50.96 432.688 24486.95 3.859 217.911

22.589 180.00 54.29 526.557 24804.22 4.189 197.942

26.092 195.56 57.65 622.966 25244.38 4.517 183.059

30.232 200.56 61.65 648.770 25365.15 4.671 182.613

34.373 213.89 65.67 739.770 25664.56 4.991 173.152

38.515 215.56 69.69 742.131 25710.96 5.088 176.266

43.294 226.67 74.33 821.195 25956.63 5.391 170.390

48.074 229.44 78.97 831.584 26027.42 5.526 172.967

52.654 230.66 83.58 827.201 26064.24 5.628 177.340

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNITI WILLHITE KRUPICZKA SPECCHIA

KUNITI SMITH KUNITI BALDI SICARDI

(1957) (1960) SMITH (1967) SICARDI (1980)

(1957) (1960) SMITH (1967) SICARDI (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.3047 0.1893 0.2100 0.1789 0.3687 0.3590

PSEUDOHOMOGENEOUS PECLET NUMBER

3526.9 5560.8 5118.5 6008.7 2914.8 2993.6

AVERAGE EXPERIMENTAL NUSSELT NUMBER

20.874 32.912 30.294 35.563 17.251 17.718

TEST NUMBER BC-1-2
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 2.54000 2.47904 0.300
 PARTICLE SIZE RANGE (MICRONS)
 590-840

EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID FRACTION
 (W) (CM/S) (G/CM**3) (CM**3)

1060.20 2.89 1.485 0.372
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT TRANSFER
 CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
 (W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.02740 1.0762 0.8229 24995.89 236.50
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	77.78	32.22	111.048	22067.26	2.438	484.403
2.225	98.33	34.64	172.838	22610.32	2.713	354.975
4.769	122.78	37.47	262.017	23238.52	3.071	272.400
7.314	142.22	40.36	345.160	23724.52	3.309	232.913
10.178	146.11	43.65	357.512	23625.84	3.489	232.528
13.042	167.78	46.96	468.618	24347.06	3.879	201.523
15.764	168.89	50.14	467.928	24380.13	3.940	205.303
19.090	177.22	54.01	509.619	24581.16	4.136	199.311
22.593	193.33	58.13	606.185	24953.17	4.483	184.554
26.097	211.67	62.29	731.152	25360.28	4.895	169.772
30.238	217.22	67.24	762.280	25490.15	5.082	169.950
34.381	233.89	72.20	690.558	25844.20	5.508	159.843
38.524	235.00	77.18	886.162	25880.71	5.615	163.988
43.305	248.89	82.92	999.211	26168.78	6.020	157.668
48.087	251.67	88.65	1008.361	26239.77	6.186	160.965
52.869	253.89	94.35	1011.590	26300.63	6.341	164.855

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI (1957)	KUNII (1960)	WILLIAMS (1962)	KRUPICZKA (1957)	SPECCHIA BALDI (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.3082 0.1955 0.2124 0.1809 0.3633

PSEUDOHOMOGENEOUS PECLET NUMBER
 2845.3 4404.3 4128.8 4846.9 2350.6 2414.1

AVERAGE EXPERIMENTAL NUSSELT NUMBER
 19.023 29.981 27.604 32.405 15.715 15.140

TEST NUMBER BC-1-3
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 2.54000 2.47904 0.300
 PARTICLE SIZE RANGE (MICRONS)
 590-840

EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID
 (W) (CM/S) (G/CM**3) FRACTION
 1025.80 2.44 1.485 0.372

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS PARTICLE PARTICLE HEAT HEAT TRANSFER
 CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
 (W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
 0.02780 1.0875 0.8307 24109.40 226.88

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES
 AXIAL WALL PARTICLE RADIATIVE CONVECTIVE RADIATIVE CONVECTIVE
 POSITION TEMPERATURE TEMPERATURE TEMPERATURE HEAT FLUX HEAT FLUX H T COEFF H T COEFF
 (CM) (C) (C) (C) (W/M**2) (W/M**2) (W/M**2K) (W/M**2K)
 0. 79.44 33.33 113.845 21205.65 2.469 459.368
 2.225 99.44 36.08 175.850 21714.18 2.744 342.711
 4.769 125.00 39.31 267.753 22339.56 3.125 260.688
 7.314 144.44 42.80 351.400 22801.77 3.450 223.888
 10.178 151.11 46.34 377.316 22982.71 3.601 219.173
 13.043 173.33 50.12 494.725 23467.07 4.015 190.464
 15.765 174.44 53.74 493.007 23499.83 4.084 194.692
 19.092 183.89 58.16 542.223 23714.33 4.313 188.617
 22.595 201.11 62.85 649.742 24086.90 4.699 174.210
 26.099 219.44 67.69 779.437 24467.15 5.133 161.124
 30.241 226.67 73.23 824.349 24622.81 5.373 160.475
 34.384 241.67 78.88 942.371 24920.78 5.789 153.092
 38.528 245.56 84.54 961.865 25009.01 5.974 155.324
 43.310 258.89 91.07 1073.616 25266.20 6.398 150.557
 48.093 262.78 97.07 1092.064 25355.24 6.611 153.496
 52.876 265.00 104.07 1092.457 25416.27 6.788 157.935

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII (1967) BALDI
 (1957) (1960) (1962) SICARDI
 (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.3121 0.1981 0.2151 0.1832 0.3780 0.3680
 PSEUDOHOMOGENEOUS PECLET NUMBER
 2385 3762.1 3464.9 4067.6 1972.1 2025.3
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 18.021 28.389 26.147 30.695 14.882 15.284

TEST NUMBER BC-1-4

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

2.54000 2.47904 0.300

PARTICLE SIZE RANGE (MICRONS)

690-840

EXPERIMENTAL VARIABLES

POWER (W) VELOCITY (CM/S) DENSITY (G/CM³) VOID FRACTION

1073.50 1.81 1.485 0.372

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS CONDUCTIVITY (W/MK) PARTICLE CONDUCTIVITY (W/MK) PARTICLE SPECIFIC HEAT (WS/GK) HEAT FLUX (W/M²) HEAT TRANSFER COEFFICIENT (W/M²K)

0.02879 1.1143 0.8488 24938.02 200.20

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM) WALL TEMPERATURE (C) PARTICLE TEMPERATURE (C) RADIATIVE HEAT FLUX (W/M²) CONVECTIVE HEAT FLUX (W/M²) RADIATIVE H T COEFF (W/M²K) CONVECTIVE H T COEFF (W/M²K)

0.	83.89	32.78	128.572	21439.55	2.516	419.469
2.226	111.67	36.54	218.523	22137.17	2.309	294.654
4.770	138.89	40.95	327.634	22797.31	3.346	232.782
7.316	166.11	45.49	462.163	23429.64	3.831	194.236
10.181	173.89	50.63	496.910	23613.51	4.032	191.603
13.047	199.44	55.86	655.232	24172.05	4.563	168.348
15.770	203.89	60.85	675.419	24276.31	4.722	169.723
19.099	216.67	66.96	758.534	24550.58	5.067	163.992
22.604	236.11	73.43	907.091	24944.60	5.576	153.339
26.111	257.78	79.98	1097.296	25357.84	6.172	142.624
30.256	265.00	87.76	1148.785	25507.07	6.481	143.909
34.402	266.67	95.55	1369.142	25887.77	7.164	135.455
38.549	290.00	103.35	1381.953	25967.28	7.404	139.126
43.335	307.22	112.34	1569.005	26256.60	8.051	134.730
48.122	313.33	121.32	1615.807	26378.58	8.415	137.377
52.910	311.67	130.20	1554.066	26394.31	8.564	145.453

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI	KUNII	WILLHITE	KRUPICZKA	SPECCHIA	SICARDI
(1957)	SMITH (1960)	KUNII (1962)	(1967)	BALDI (1980)	SICARDI (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.3213 0.2041 0.2215 0.1887 0.3894 0.3792

PSEUDOHOMOGENEOUS PECLET NUMBER

1783.9 2726.0 2558.5 3003.5 1455.2 1494.5

AVERAGE EXPERIMENTAL NUSSELT NUMBER

15.448 24.312 22.407 26.304 12.745 13.089

TEST NUMBER BC-2-1
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 2.54000 2.47904 0.300
 PARTICLE SIZE RANGE (MICRONS)
 590-840
 EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID
 (W) (CM/S) (G/CM**3) FRACTION
 1422.50 3.49 1.485 0.372
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS PARTICLE PARTICLE HEAT HEAT TRANSFER
 CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
 (W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
 0.02761 1.0820 0.8269 33459.54 255.53
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES
 AXIAL WALL PARTICLE RADIATIVE CONVECTIVE RADIATIVE CONVECTIVE
 POSITION TEMPERATURE TEMPERATURE TEMPERATURE H T COEFF H T COEFF
 (CM) (C) (C) (W/M**2) (W/M**2) (W/M**2K) (W/M**2K)
 0. 90.00 31.67 150.338 29029.16 2.577 497.643
 2.226 114.44 34.31 233.995 29875.18 2.920 372.835
 4.770 141.67 37.43 348.556 30792.77 3.344 295.400
 7.316 164.44 40.62 463.086 31539.28 3.740 254.702
 10.181 167.78 44.24 474.672 31653.50 3.842 256.224
 13.047 192.78 47.90 626.684 32443.41 4.326 223.936
 15.769 193.33 51.41 622.454 32468.54 4.386 228.768
 19.098 204.44 55.69 692.474 32816.20 4.655 220.607
 22.602 222.78 60.24 826.413 33370.18 5.084 209.307
 26.106 245.00 64.86 1013.486 34014.85 5.626 188.821
 30.252 252.22 70.35 1069.020 34229.13 5.878 188.208
 34.397 271.11 75.88 1251.816 34750.86 6.412 177.996
 38.543 273.89 81.41 1265.263 34839.87 6.579 181.010
 43.328 288.89 87.80 1421.926 35242.29 7.071 175.257
 48.113 293.89 94.19 1462.546 35387.45 7.324 177.201
 52.899 292.78 100.52 1426.536 35382.19 7.420 184.040
 DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII BALDI SICCARDI
 (1957) (1960) SMITH (1962) SICCARDI (1960)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.3102 0.1969 0.2138 0.1821 0.3756 0.3657
 PSEUDOHOMOGENEOUS PECLET NUMBER
 3422.5 5392.9 4966.2 5829.9 2826.9 2903.3
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 20.419 32.175 29.629 34.782 16.865 17.321

TEST NUMBER BC-2-1				LOCAL NUSSELL NUMBER PROFILES			
YAGI AND KUNII (1957)				YAGI AND KUNII (1957)			
N D	POSITION	THEORETICAL FLAT	THEORETICAL PARABOLIC	N D	POSITION	THEORETICAL FLAT	THEORETICAL PARABOLIC
39	0.00026	814	27.360	39	0.00026	814	27.360
223	0.00056	656	14.644	223	0.00056	656	14.644
200	0.00086	404	13.000	200	0.00086	404	13.000
200	0.00119	327	11.762	200	0.00119	327	11.762
0.00119	16	376	10.978	0.00119	16	376	10.978
0.00224	17	685	9.620	0.00224	17	685	9.620
0.00305	16	464	8.724	0.00305	16	464	8.724
0.00305	15	148	8.324	0.00305	15	148	8.324
0.00450	14	181	7.735	0.00450	14	181	7.735
0.00506	14	229	7.468	0.00506	14	229	7.468
0.00562	14	278	7.239	0.00562	14	278	7.239
0.00617	14	328	7.039	0.00617	14	328	7.039
0.00617	14	373	6.860	0.00617	14	373	6.860
0.00617	14	417	6.699	0.00617	14	417	6.699
0.00617	14	461	6.548	0.00617	14	461	6.548
0.00617	14	505	6.407	0.00617	14	505	6.407
0.00617	14	549	6.276	0.00617	14	549	6.276
0.00617	14	593	6.155	0.00617	14	593	6.155
0.00617	14	637	6.044	0.00617	14	637	6.044
0.00617	14	681	5.942	0.00617	14	681	5.942
0.00617	14	725	5.849	0.00617	14	725	5.849
0.00617	14	769	5.766	0.00617	14	769	5.766
0.00617	14	813	5.692	0.00617	14	813	5.692
0.00617	14	857	5.627	0.00617	14	857	5.627
0.00617	14	901	5.571	0.00617	14	901	5.571
0.00617	14	945	5.524	0.00617	14	945	5.524
0.00617	14	989	5.486	0.00617	14	989	5.486
0.00617	14	1033	5.457	0.00617	14	1033	5.457
0.00617	14	1077	5.436	0.00617	14	1077	5.436
0.00617	14	1121	5.422	0.00617	14	1121	5.422
0.00617	14	1165	5.414	0.00617	14	1165	5.414
0.00617	14	1209	5.412	0.00617	14	1209	5.412
0.00617	14	1253	5.416	0.00617	14	1253	5.416
0.00617	14	1297	5.426	0.00617	14	1297	5.426
0.00617	14	1341	5.441	0.00617	14	1341	5.441
0.00617	14	1385	5.461	0.00617	14	1385	5.461
0.00617	14	1429	5.486	0.00617	14	1429	5.486
0.00617	14	1473	5.516	0.00617	14	1473	5.516
0.00617	14	1517	5.551	0.00617	14	1517	5.551
0.00617	14	1561	5.591	0.00617	14	1561	5.591
0.00617	14	1605	5.636	0.00617	14	1605	5.636
0.00617	14	1649	5.686	0.00617	14	1649	5.686
0.00617	14	1693	5.741	0.00617	14	1693	5.741
0.00617	14	1737					

TEST NUMBER BC-2-2
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 2.54000 2.47804 0.300
 PARTICLE SIZE RANGE (MICRONS)
 590-840
 EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID
 (W) (CM/S) (G/CM**3) FRACTION
 1443.00 2.80 1.485 0.372
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS PARTICLE HEAT TRANSFER
 CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
 (W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
 0.02834 1.1032 0.8413 33738.95 242.92
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES
 AXIAL WALL PARTICLE RADIATIVE CONVECTIVE RADIATIVE CONVECTIVE
 POSITION TEMPERATURE TEMPERATURE TEMPERATURE HEAT FLUX HEAT FLUX H T COEFF H T COEFF
 (CM) (C) (C) (C) (W/M**2) (W/M**2) (W/M**2K) (W/M**2K)
 0. 92.78 33.33 156.311 28666.93 2.630 485.612
 2.226 121.11 36.61 256.706 29833.88 3.038 353.078
 4.771 151.11 40.48 390.082 30826.70 3.526 278.645
 7.317 176.11 44.45 524.680 31627.50 3.985 240.218
 10.183 182.22 48.96 653.382 31627.02 4.153 238.835
 13.049 208.69 53.53 731.428 32542.84 4.708 210.107
 15.773 211.11 57.90 737.968 32718.97 4.817 213.551
 19.102 223.89 63.24 828.013 33103.87 5.154 206.065
 22.608 243.89 68.91 931.951 33681.80 5.668 192.485
 26.115 267.22 74.67 1212.723 34324.19 6.298 176.256
 30.261 276.11 81.51 1291.104 34573.97 6.635 177.668
 34.408 296.67 88.39 1516.869 35105.65 7.283 168.551
 38.556 299.44 95.27 1529.451 35195.27 7.491 172.379
 43.343 317.78 103.21 1749.336 35649.03 8.153 166.141
 48.131 323.89 111.15 1807.315 35815.24 8.495 168.352
 52.919 321.67 119.01 1743.398 35797.65 8.603 176.646
 DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAOI KUNII WILLHITE KRUPICZKA SPECCHIA
 KUNII SMITH KUNII BALDI
 (1957) (1960) SMITH (1967) SICARDI
 (1962) (1960)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.3175 0.2016 0.2188 0.1864 0.3847 0.3746
 PSEUDOHOMOGENEOUS PECLET NUMBER
 2727.5 4294.4 3956.8 4645.0 2251.1 2311.9
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 18.969 29.865 27.517 32.303 15.656 16.078

TEST NUMBER BC-2-3
EXPERIMENTAL DATA
TUBE CHARACTERISTICS
OD (CM) ID (CM) EMISSIVITY
2.54000 2.47904 0.300
PARTICLE SIZE RANGE (MICRONS)
590-840

EXPERIMENTAL VARIABLES
POWER VELOCITY DENSITY VOID
(W) (CM/S) (G/CM³) FRACTION
1402.90 2.21 1.485 0.372

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
GAS PARTICLE PARTICLE HEAT HEAT
CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX TRANSFER
(W/MK) (W/MK) (WS/GK) (W/M²) COEFFICIENT
0.02903 1.1231 0.8546 32555.84 223.62

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES						
AXIAL POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M ²)	CONVECTIVE HEAT FLUX (W/M ²)	RADIATIVE H.T. COEFF (W/M ² *2K)	CONVECTIVE H.T. COEFF (W/M ² *2K)
0	94.44	33.89	160.856	27539.71	2.656	454.784
2.226	126.67	37.85	278.056	28578.03	3.131	321.752
4.771	158.39	42.52	424.579	29562.78	3.666	255.258
7.318	186.11	47.32	582.671	30393.47	4.198	216.986
10.184	194.44	52.78	626.971	30645.15	4.426	216.329
13.051	223.89	58.31	840.608	31474.88	5.077	190.095
15.776	227.78	63.62	860.217	31592.79	5.240	192.450
19.106	242.22	70.10	972.928	31990.28	5.653	185.858
22.613	263.33	76.98	1164.285	32542.94	6.248	174.627
26.121	287.22	83.94	1413.949	33132.80	6.956	162.990
30.269	297.76	92.22	1518.393	33398.49	7.387	162.478
34.417	319.44	100.53	1782.758	33892.32	8.144	154.820
38.567	325.56	108.85	1840.654	34047.90	8.493	157.117
43.356	343.33	118.44	2076.542	34432.04	9.233	153.105
48.147	350.56	128.02	2153.874	34606.19	9.679	155.509
52.937	346.67	137.49	2046.152	34578.53	9.782	165.310

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI	KUNII	WILLHITE	KRUPICZKA	SPECCHIA
KUNII	SMITH	KUNII	(1967)	BALDI
(1957)	(1960)	SMITH	(1962)	SICARDI
				(1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)				
0.3243	0.2061	0.2236	0.1905	0.3829
PSEUDOHOMOGENEOUS PECLET NUMBER				
2147.9	3379.4	3115.3	3657.1	1771.6
AVERAGE EXPERIMENTAL NUSSELT NUMBER				
17.095	26.896	24.794	29.106	14.100
				14.480

[illegible]

TEST NUMBER BC-3-2

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

2.54000 2.47904 0.300

PARTICLE SIZE RANGE (MICRONS)

590-840

EXPERIMENTAL VARIABLES

POWER VELOCITY DENSITY

(W) (CM/S) (G/CM³)

869.40 2.44 1.485

VOID

FRACTION

0.372

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE

CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT

(W/MK) (W/MK) (WS/GK)

0.02711 1.0879 0.3171

HEAT FLUX

(W/M²)

20528.45

HEAT TRANSFER

COEFFICIENT

(W/M²K)

221.81

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL WALL PARTICLE RADIATIVE CONVECTIVE RADIATIVE CONVECTIVE

POSITION TEMPERATURE TEMPERATURE HEAT FLUX HEAT FLUX H T COEFF H T COEFF

(CM) (C) (C) (W/M²) (W/M²) (W/M²K) (W/M²K)

0. 67.78 28.89 89.031 18277.97 2.289

2.225 87.22 31.28 142.063 18705.75 2.539

4.768 108.89 34.07 212.743 19169.53 2.843

7.312 127.78 36.92 284.856 19562.25 3.135

10.175 130.56 40.15 390.657 19824.81 3.214

13.039 150.56 43.41 380.876 20025.36 3.555

15.760 151.67 46.53 379.811 20053.66 3.613

19.085 159.44 50.34 413.207 20210.91 3.787

22.587 175.00 54.37 494.915 20509.65 4.103

26.089 191.11 58.46 589.977 20807.97 4.447

30.229 196.11 63.30 612.500 20907.37 4.612

34.370 211.11 68.16 711.187 21174.02 4.975

38.512 213.33 73.03 715.065 21224.20 5.097

43.291 224.44 78.64 789.620 21419.75 5.416

48.070 226.67 84.24 791.411 21471.94 5.557

52.850 226.67 89.79 773.587 21489.76 5.652

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILHITE KRUPICZKA SPECCHIA

KUNII SMITH KUNII BALDI

(1957) (1960) SMITH SICARDI

(1962) (1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.3054 0.1937 0.2104 0.1792 0.3695 0.3598

PSEUDOHOMOGENEOUS PECLET NUMBER

2402.3 3787.4 3486.4 4092.7 1905.3 2038.9

AVERAGE EXPERIMENTAL NUSSELT NUMBER

18.008 28.391 26.134 30.679 14.082 15.284

TEST NUMBER BC-3-3

EXPERIMENTAL DATA

TUBE CHARACTERISTICS

OD (CM) ID (CM) EMISSIVITY

2.54000 2.47904 0.900

PARTICLE SIZE RANGE (MICRONS)

590-840

EXPERIMENTAL VARIABLES

POWER (W) VELOCITY (CM/S) DENSITY (G/CM**3) VOID FRACTION

886.20 1.95 1.485 0.372

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT HEAT TRANSFER
CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
(W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)

0.02772 1.0854 0.8292 20802.91 205.39

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

POSITION (CM)	WALL TEMPERATURE (C)	PARTICLE TEMPERATURE (C)	RADIATIVE HEAT FLUX (W/M**2)	CONVECTIVE HEAT FLUX (W/M**2)	RADIATIVE H T COEFF (W/M**2K)	CONVECTIVE H T COEFF (W/M**2K)
0.	69.44	29.44	92.545	18259.17	2.314	456.479
2.225	93.89	32.43	161.835	18792.18	2.633	305.760
4.769	118.33	35.94	246.509	19308.07	2.992	234.343
7.313	138.33	39.53	328.051	19716.60	3.324	199.544
10.177	143.33	43.59	343.714	19823.27	3.446	198.745
13.041	165.00	47.69	450.769	20245.48	3.843	172.564
15.763	166.67	51.61	451.394	20285.51	3.923	176.316
19.089	176.67	55.41	500.328	20480.33	4.160	170.299
22.592	192.78	61.48	593.816	20778.84	4.523	158.258
26.095	211.11	66.61	715.387	21102.60	4.951	146.040
30.237	217.22	72.70	747.115	21219.06	5.170	146.826
34.379	233.89	76.81	871.333	21498.42	5.619	138.629
38.523	237.78	84.92	807.760	21576.03	5.808	141.155
43.304	249.44	91.97	975.510	21770.15	6.195	138.241
48.086	254.44	98.99	1001.061	21865.20	6.440	140.657
52.868	252.22	105.96	953.443	21859.27	6.519	149.449

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI KUNII WILLHITE KRUPICZKA SPECCHIA
KUNII SMITH UNIL (1967) BALDI
(1957) (1960) SMITH (1980) SICARDI
(1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.3114 0.1976 0.2146 0.1828 0.3770 0.3671

PSEUDOHOMOGENEOUS PECLET NUMBER

1912.1 3012.5 2774.4 3257.0 1579.1 1621.8

AVERAGE EXPERIMENTAL NUSSELT NUMBER

16.352 25.762 23.726 27.852 13.504 13.869

TEST NUMBER BC-3-4
EXPERIMENTAL DATA

TUBE CHARACTERISTICS
OD (CM) ID (CM) EMISSIVITY
2.84000 2.47904 0.300
PARTICLE SIZE RANGE (MICRONS)
690-840

EXPERIMENTAL VARIABLES
POWER VELOCITY DENSITY VOID
(W) (CM/S) (G/CM³) FRACTION
802.90 1.42 1.465 0.372

AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA

GAS PARTICLE PARTICLE HEAT HEAT
CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX
(W/MK) (W/MK) (WS/GK) (W/M²)
0.02670 1.1134 0.8482 20985.27
HEAT TRANSFER COEFFICIENT (W/M²°K) 185.78

AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES

AXIAL POSITION (CM)	WALL TEMPERATURE (°C)	PARTICLE TEMPERATURE (°C)	RADIATIVE HEAT FLUX (W/M ²)	CONVECTIVE HEAT FLUX (W/M ²)	RADIATIVE H.T. COEFF (W/M ² °K)	CONVECTIVE H.T. COEFF (W/M ² °K)
0.	74.44	28.89	107.706	18125.89	2.364	397.885
2.225	103.33	32.97	194.111	18741.40	2.759	266.347
4.769	130.50	37.76	295.545	19299.18	3.185	207.984
7.315	154.44	42.67	403.083	19768.38	3.605	176.801
10.170	162.22	46.24	439.621	19925.23	3.804	174.816
13.044	186.67	53.67	571.119	20375.62	4.301	153.431
15.767	189.44	52.24	576.610	20436.82	4.429	156.961
19.095	202.78	65.81	654.212	20679.02	4.778	150.972
22.599	221.11	72.76	778.638	20993.27	5.250	141.508
26.105	241.67	79.78	939.679	21323.31	5.805	131.716
30.249	248.89	88.10	982.783	21432.38	6.112	133.420
34.394	266.67	96.43	1137.698	21720.61	6.683	127.587
38.539	271.67	104.74	1162.656	21814.49	6.965	130.887
43.324	286.67	114.32	1299.446	22033.76	7.540	127.844
48.109	293.69	123.67	1348.584	22155.52	7.932	130.316
52.695	299.44	133.32	1251.512	22147.55	8.076	141.855

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI	KUNII	WILLHITE	KRUPICZKA	SPECCHIA
KUNII	SMITH	KUNII	(1967)	BALDI
(1957)	(1960)	SMITH	(1962)	SICARDI
			(1980)	(1980)

THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)

0.3210	0.2040	0.2213	0.1885	0.3691	0.3708
PSEUDOHOMOGENEOUS	PECLET NUMBER	2359.5	1143.2	1174.1	

1385.6	2180.8	2009.9	2359.5	1143.2	1174.1
AVERAGE EXPERIMENTAL	NUSELT NUMBER	24.431	11.838	12.157	

14.348	22.581	20.812	24.431	11.838	12.157

TEST NUMBER 8C-3-5
 EXPERIMENTAL DATA
 TUBE CHARACTERISTICS
 OD (CM) ID (CM) EMISSIVITY
 2.54000 2.47904 0.300
 PARTICLE SIZE RANGE (MICRONS)
 590-840
 EXPERIMENTAL VARIABLES
 POWER VELOCITY DENSITY VOID
 (W) (CM/S) (G/CM**3) FRACTION
 938.70 0.94 1.485 0.372
 AVERAGE PHYSICAL PROPERTIES AND HEAT TRANSFER DATA
 GAS PARTICLE PARTICLE HEAT HEAT TRANSFER
 CONDUCTIVITY CONDUCTIVITY SPECIFIC HEAT FLUX COEFFICIENT
 (W/MK) (W/MK) (WS/GK) (W/M**2) (W/M**2K)
 0.03067 1.1705 0.8850 21395.03 165.73
 AXIAL TEMPERATURE, HEAT FLUX, AND LOCAL HEAT TRANSFER COEFFICIENT PROFILES
 POSITION WALL PARTICLE RADIATIVE CONVECTIVE RADIATIVE CONVECTIVE
 (CM) TEMPERATURE TEMPERATURE TEMPERATURE HEAT FLUX HEAT FLUX H T COEFF H T COEFF
 (C) (C) (C) (W/M**2) (W/M**2) (W/M**2K) (W/M**2K)
 0 82.22 29.44 129.845 18064.80 2.460 342.280
 2.226 119.44 35.63 251.743 18834.83 3.004 224.725
 4.771 151.67 42.93 387.756 19467.73 3.566 179.032
 7.317 180.56 50.40 539.314 20009.01 4.144 163.685
 10.183 191.67 58.68 592.734 20213.12 4.484 152.224
 13.050 221.67 67.44 798.222 20717.35 5.176 134.329
 15.774 228.33 75.62 831.833 20841.10 5.437 136.459
 19.105 245.56 85.60 958.529 21120.31 5.992 132.039
 22.812 265.06 96.15 1126.697 21422.41 6.651 126.434
 26.120 290.00 106.77 1359.259 21753.02 7.473 118.720
 30.268 301.67 119.35 1467.133 21928.07 8.047 120.274
 34.417 324.44 131.93 1727.655 22109.23 8.974 115.311
 38.567 332.78 144.49 1792.331 22328.68 9.519 118.590
 43.357 351.11 158.93 2009.413 22537.94 10.456 117.276
 48.149 361.67 173.33 2106.520 22635.84 11.185 120.453
 52.940 351.67 187.60 1844.059 22716.20 11.233 138.371
 DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAOI KUNIT WILLHITE KRUPICZKA SPECCHIA
 KUNIT SMITH KUNIT BALDI
 (1957) (1960) SMITH (1967) SICARDI
 (1962) (1980)
 THEORETICAL STATIC EFFECTIVE THERMAL CONDUCTIVITIES (W/MK)
 0.3405 0.2167 0.2348 0.2001 0.4134 0.4025
 PSEUDOHOMOGENEOUS PECLET NUMBER
 899.1 1412.3 1303.4 1530.0 740.5 760.4
 AVERAGE EXPERIMENTAL NUSSELT NUMBER
 12.066 18.556 17.494 20.536 9.939 10.206

RADIAL EXIT TEMPERATURE PROFILES

TEST NUMBER POSITION	AA-S-6 TEMPERATURE (C)	AA-S-7 TEMPERATURE (C)	AA-S-8 TEMPERATURE (C)	AA-S-1 TEMPERATURE (C)	AA-S-2 TEMPERATURE (C)	AA-S-3 TEMPERATURE (C)	AA-S-4 TEMPERATURE (C)
1-000	92.8	100.6	105.6	81.7	85.0	88.0	88.0
0-921	93.3	100.6	105.6	81.7	85.0	88.0	88.0
0-821	93.3	100.6	105.6	81.7	85.0	88.0	88.0
0-737	101.1	102.0	107.0	81.7	85.0	88.0	88.0
0-691	101.1	102.0	107.0	81.7	85.0	88.0	88.0
0-555	101.1	102.0	107.0	81.7	85.0	88.0	88.0
0-469	101.1	102.0	107.0	81.7	85.0	88.0	88.0
0-383	101.1	102.0	107.0	81.7	85.0	88.0	88.0
0-297	101.1	102.0	107.0	81.7	85.0	88.0	88.0
0-211	101.1	102.0	107.0	81.7	85.0	88.0	88.0
0-125	101.1	102.0	107.0	81.7	85.0	88.0	88.0
0-039	101.1	102.0	107.0	81.7	85.0	88.0	88.0

TEST NUMBER POSITION	AA-S-5 TEMPERATURE (C)	AA-S-6 TEMPERATURE (C)	AA-S-7 TEMPERATURE (C)	AA-S-8 TEMPERATURE (C)	AB-1-1 TEMPERATURE (C)	AB-1-2 TEMPERATURE (C)	AB-1-3 TEMPERATURE (C)
1-000	97.7	102.0	108.0	108.0	88.0	88.0	88.0
0-921	97.7	102.0	108.0	108.0	88.0	88.0	88.0
0-821	97.7	102.0	108.0	108.0	88.0	88.0	88.0
0-737	112.0	112.0	112.0	112.0	88.0	88.0	88.0
0-691	112.0	112.0	112.0	112.0	88.0	88.0	88.0
0-555	112.0	112.0	112.0	112.0	88.0	88.0	88.0
0-469	112.0	112.0	112.0	112.0	88.0	88.0	88.0
0-383	112.0	112.0	112.0	112.0	88.0	88.0	88.0
0-297	112.0	112.0	112.0	112.0	88.0	88.0	88.0
0-211	112.0	112.0	112.0	112.0	88.0	88.0	88.0
0-125	112.0	112.0	112.0	112.0	88.0	88.0	88.0
0-039	112.0	112.0	112.0	112.0	88.0	88.0	88.0

APPENDIX 5

STATIONARY BED EXPERIMENTAL DATA AND CALCULATIONS

Immediately following is the program used to make all calculations for the stationary particle bed experiment. The bulk of this appendix is then a listing of all experimental data and the solutions to these calculations for each of the twenty-eight experiments.

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      INTEGER TEST
      DIMENSION TWALL(14), TBEDB(4), TBEDL(4), TBEDF(4), TBEDR(4), TWALLO(7),
      2AXPOS(4), AXPOSW(7), TPROBU(30), TPROBL(30), THETA(30), RADNON(30),
      3THETAT(30), EFCON(6), RADPOS(30), THETAC(14), THEOT(30), CHDTH(8),
      4CORTMP(8,30)
      CALL DROPPFILE(0)
      CALL LINK("UNITS=(D,OPEN),UNIT6=(S,CREATE,TEXT)///")
C****
C0000 TWALL(1)=INNER WALL AXIAL TEMPERATURE PROFILE (C), TBEDB(1)=
C0000 BACK BED AXIAL TEMPERATURE PROFILE (C), TBEDL(1)=LEFT BED AXIAL
C0000 TEMPERATURE PROFILE (C), TBEDF(1)=FRONT BED AXIAL TEMPERATURE
C0000 PROFILE (C), TBEDR(1)=RIGHT BED AXIAL TEMPERATURE PROFILE (C),
C**** TWALLO(1)=OUTER WALL AXIAL TEMPERATURE PROFILE (C).
      READ(5,10) TEST
      10 FORMAT(A6)
      READ(5,20)(TWALL(1),I=1,4)
      READ(5,20)(TBEDB(1),I=1,4)
      READ(5,20)(TBEDL(1),I=1,4)
      READ(5,20)(TBEDF(1),I=1,4)
      READ(5,20)(TBEDR(1),I=1,4)
      20 FORMAT(4(F6.1))
      20 READ(5,30)(TWALLO(1),I=1,7)
      30 FORMAT(7(F6.1))
C****
C0000 AXPOS(1)=AXIAL POSITIONS OF THE INNER WALL AND STATIONARY BED
C0000 THERMOCOUPLES (CM), AXPOSW(1)=AXIAL POSITIONS OF THE OUTER WALL
C0000 THERMOCOUPLES (CM), BOTH OF THESE ARE FROM THE BOTTOM OF THE
C**** HEATED SECTION.
      AXPOS(1)=25.0825
      AXPOS(2)=18.0975
      AXPOS(3)=11.1125
      AXPOS(4)=4.1275
      AXPOSW(1)=5.82875
      AXPOSW(2)=23.33625
      AXPOSW(3)=19.84375
      AXPOSW(4)=16.35125
      AXPOSW(5)=9.36625
      AXPOSW(6)=5.87375
      AXPOSW(7)=2.38125
C****
C0000 VOUT=OUTER AIR VELOCITY (CM/S), VIN=INNER AIR VELOCITY (CM/S),
C0000 Q=POWER (W), TAMB=AMBIENT TEMPERATURE (C), TSHRC=SHROUD TEMPERATURE
C0000 (C), TINRI=INNER AIR INLET TEMPERATURE (C), TINRE=INNER AIR
C0000 EXIT TEMPERATURE (C), TOUTRI=OUTER AIR INLET TEMPERATURE (C),
C0000 SIZEMN=MINIMUM PARTICLE SIZE (MICRON), SIZEMX=MAXIMUM PARTICLE
C**** SIZE (MICRON), VOID=VOID FRACTION.
      READ(5,40) VOUT,VIN,Q,TAMB,TSHRD,TINRI,TINRE,TOUTRI,SIZEMN,SIZEMX,
      2VOID
      40 FORMAT(F4.0,2(F6.1),3(F5.1),F6.1,F5.1,2(F5.0),F6.3)
C****
C0000 TPROBU(1)=TEMPERATURE OBTAINED BY THE MICROMETER PROBE LOCATED
C0000 AT AN AXIAL POSITION OF 18.0975 CM (C), TPROBL(1)=TEMPERATURE
C0000 OBTAINED BY THE MICROMETER PROBE LOCATED AT AN AXIAL POSITION
C0000 OF 4.1275 CM (C), THETAC(1)=CURVE FITTED NONDIMENSIONAL
C0000 TEMPERATURE OBTAINED FROM THE DATA OF THE MICROMETER PROBE LOCATED
C**** AT AN AXIAL POSITION OF 18.0975 CM.

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      READ(5,50)(TPROBU(I),I=1,15)
      READ(5,50)(TPROBU(I),I=16,30)
      READ(5,50)(TPROBL(I),I=1,15)
      READ(5,50)(TPROBL(I),I=16,30)
50  FORMAT(15(F5.0))
      READ(5,50)(THETAC(I),I=1,14)
60  FORMAT(14(F5.3))
C****
C**** RADPOS(1)=RADIAL POSITIONS OF THE MICROMETER MOUNTED THERMOCOUPLE
      PROBE (IN). ALL OF THESE ARE FROM THE OUTER WALL OF THE INNER TUBE.
C****
      RADPOS(1)=0.000
      RADPOS(2)=0.005
      RADPOS(3)=0.010
      RADPOS(4)=0.015
      RADPOS(5)=0.020
      RADPOS(6)=0.025
      RADPOS(7)=0.030
      RADPOS(8)=0.035
      RADPOS(9)=0.040
      RADPOS(10)=0.045
      RADPOS(11)=0.050
      RADPOS(12)=0.075
      RADPOS(13)=0.100
      RADPOS(14)=0.125
      RADPOS(15)=0.150
      RADPOS(16)=0.200
      RADPOS(17)=0.250
      RADPOS(18)=0.300
      RADPOS(19)=0.350
      RADPOS(20)=0.400
      RADPOS(21)=0.450
      RADPOS(22)=0.500
      RADPOS(23)=0.550
      RADPOS(24)=0.600
      RADPOS(25)=0.625
      RADPOS(26)=0.650
      RADPOS(27)=0.675
      RADPOS(28)=0.700
      RADPOS(29)=0.725
      RADPOS(30)=0.750
C****
C**** CALL GRADNT TO CALCULATE THE AVERAGE AXIAL TEMPERATURE GRADIENT
      IN THE VICINITY OF THE UPPER MICROMETER PROBE (C/CM).
C****
C**** CALL GRADNT(TBEDB,TBEDL,TBEDF,TBEDR,AXPOS,GRAD)
C****
C**** CALL REYNLD TO CALCULATE THE MODIFIED REYNOLDS NUMBER AND
      PHYSICAL PROPERTIES FOR THE PACKED BED ALONG WITH THE
      REYNOLDS NUMBER IN THE INNER TUBE.
C****
C**** CALL REYNLD(VOUT,VIN,TINRI,TINRE,RE,SIZEMN,SIZEMX,REM,CONDO,
      2VISCO,CONDP,SPCHIO,RHO0,TBEDB,TBEDL,TBEDF,TBEDR)
C****
C**** CALL SEVERAL SUBROUTINES TO CALCULATE THE STATIC EFFECTIVE
      THERMAL CONDUCTIVITY FROM VARIOUS MODELS.
C****
      CALL YK57(VOID,CONDP,CONDO,EFCON)
      CALL KS60(VOID,CONDP,CONDO,EFCON)
      CALL WKS62(VOID,CONDP,CONDO,EFCON)

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CALL K67(VOID,CONDP,CONDO,EFCON)
CALL S8580(VOID,CONDP,CONDO,EFCON)
CALL S580(VOID,CONDP,CONDO,EFCON)
C****
C C C CALL SEVERAL SUBROUTINES TO CALCULATE THE EFFECTIVE THERMAL
C C C CONDUCTIVITY FROM VARIOUS CORRELATIONS.
C****
CALL BIOS49(CNDTH,REM,CONDO)
CALL S869(CNDTH,REM,SPCHTO,VISCO,CONDO)
CALL Q356(CNDTH,REM)
CALL P155(CNDTH,REM)
CALL CH51(CNDTH,REM)
CALL CH52(CNDTH,REM,CONDO)
CALL C137(CNDTH,REM)
CALL PLY60(CNDTH,REM,SPCHTO,VISCO,CONDO)
C****
C C C CALL PROFILE TO CALCULATE THE NONDIMENSIONAL EXPERIMENTAL
C C C TEMPERATURE PROFILE.
C****
CALL PROFILE(RADNON,RADPOS,THETA,T,PROBU)
C****
C C C CALL CONDOC TO CALCULATE THE EFFECTIVE THERMAL CONDUCTIVITY AND
C C C THE NONDIMENSIONAL THEORETICAL TEMPERATURE PROFILE (WHICH IS
C C C BASED UPON THE EXPERIMENTAL EFFECTIVE THERMAL CONDUCTIVITY).
C****
CALL CONDOC(THETA,THETA,GRAD,RADNON,EFCON,RHOO,VOUT,SPCHTO,
2TPROBU,THEOT,CNDEF,CNDTH,CORTMP)
C****
C C C CONVERT RADIAL POSITIONS TO CM.
C****
DO 70 I=1,30
RADPOS(I)=2.54*RADPOS(I)
C****
C C C NONDIMENSIONALIZE THE EFFECTIVE THERMAL CONDUCTIVITY.
C****
X=(CNDEF/CONDO
MIPART=INT(SIZEM)
MXIPART=INT(SIZEMX)
WRITE(6,100) TEST
100 FORMAT(1H1/////////11X,"TEST NUMBER ",A6)
WRITE(6,110)
110 FORMAT(11X,"EXPERIMENTAL VARIABLES")
WRITE(6,120)
120 FORMAT(11X,"INNER",8X,"OUTER",8X,"POWER",5X,"PARTICLE")
WRITE(6,130)
130 FORMAT(11X,"VELOCITY",5X,"VELOCITY",5X,"(W)",7X,"SIZE RANGE")
WRITE(6,140)
140 FORMAT(11X,"(CM/S)",7X,"(CM/S)",17X,"(MICRONS)")
WRITE(6,150)
150 FORMAT(11X,"F5.0,8X,F4.0,9X,F5.0,6X,I3,"-",13)
WRITE(6,160)
160 FORMAT(11X,"EXPERIMENTAL DATA")
WRITE(6,170)
170 FORMAT(11X,"INSIDE",7X,"OUTSIDE",6X,"AXIAL",7X,"GAS",11X,
2"GAS",11X,"SPECIFIC",5X,"VOID",9X,"REYNOLDS")
WRITE(6,180)
180 FORMAT(11X,"DIAMETER",5X,"DIAMETER",5X,"HEIGHT",6X,"DENSITY",7X,
2"VISCOSITY",5X,"HEAT",5X,"FRACTION",5X,"NUMBER")
WRITE(6,190)

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190 FORMAT(11X,"(CM)",9X,"(CM)",9X,"(M)",9X,"(G/CM**3)",5X,"(G/CM**3)",
27X,"(WS/GK)"),
WRITE(6,200) RHOO,VISCO,SPCHTO,VOID,RE
200 FORMAT(11X,"1.27",9X,"0.019",8X,"0.2921",5X,2(F10.7,4X),F8.4,5X,
2F6.3,7X,F2.1)
WRITE(6,220)
220 FORMAT(11X,"TERMINAL TEMPERATURES (C)")
WRITE(6,230)
230 FORMAT(11X,"INNER",5X,"INNER",5X,"OUTER",5X,"AMBIENT",5X
2,"SHROUD")
WRITE(6,240)
240 FORMAT(11X,"INLET",5X,"EXIT",6X,"INLET")
WRITE(6,250) TINRI,TINRE,TOURI,TAMB,TSHRD
250 FORMAT(11X,F5.1,5X,F6.1,4X,F5.1,5X,F5.1,7X,F5.1)
WRITE(6,260)
260 FORMAT(11X,"STATIONARY PROBE TEMPERATURE PROFILES (C)",17X,
2,"WALL TEMPERATURE PROFILES (C)")
WRITE(6,270)
270 FORMAT(11X,"AXIAL",8X,"RADIAL POSITION FROM INNER WALL (CM)",9X,
2"AXIAL",8X,"OUTER",6X,"AXIAL",8X,"INNER")
WRITE(6,280)
280 FORMAT(11X,"POSITION",5X,"0.15875",4X,"0.635",6X,"1.27",7X,
2"1.5875",6X,"POSITION",5X,"WALL",7X,"POSITION",5X,"WALL")
WRITE(6,290)
290 FORMAT(11X,"(CM)",54X,"(CM)",20X,"(CM)")
DO 300 I=1,4
WRITE(6,295) AXPOS(I),TBEDR(I),TBEDF(I),TBEDL(I),TBEDB(I),
2AXPOSW(I),TVALLO(I),AXPOS(I),TWALL(I)
295 FORMAT(11X,F6.2,2X,4(5X,F6.1),6X,F6.2,7X,F6.1,5X,F6.2,7X,F6.1)
300 CONTINUE
DO 370 I=5,7
WRITE(6,360) AXPOSW(I),TVALLO(I)
360 FORMAT(69X,F6.2,7X,F6.1)
370 CONTINUE
WRITE(6,400)
400 FORMAT(11X,"MOVEABLE PROBE TEMPERATURE PROFILES (C)",17X,
2"NONDIMENSIONAL PROBE TEMPERATURE PROFILES")
WRITE(6,410)
410 FORMAT(11X,"RADIAL",8X,"AXIAL POSITION (CM)",25X,"N D",9X,
2"AXIAL POSITION (CM)")
WRITE(6,420)
420 FORMAT(11X,"POSITION",5X,"4.1275",9X,"18.0975",8X,"18.0975",
26X,"RADIAL",7X,"18.0975",8X,"18.0975")
WRITE(6,430)
430 FORMAT(11X,"(CM)",8X,2(" (EXPERIMENT)",3X)," (THEORY)",6X,"POSITION"
2,4X," (EXPERIMENT)",3X," (THEORY)")
DO 445 I=1,30
WRITE(6,440) RADPOS(I),TPROB(I),TPROBU(I),THEOT(I),RADNON(I),
2THETA(I),THETA(I)
440 FORMAT(11X,F6.3,6X,2(F5.0,10X),F5.0,9X,F6.3,6X,2(F6.3,9X))
445 CONTINUE
WRITE(6,447) TEST
447 FORMAT(11X,"TEST NUMBER ",A6)
WRITE(6,450)
450 FORMAT(11X,"DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AU
2THORS")
WRITE(6,490)
490 FORMAT(11X,"YAGI",6X,"KUNIT",5X,"WILLHITE",4X,"KRUPICZKA",4X,
2"SPECCHIA",4X,"SPECCHIA")
WRITE(6,500)

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500 FORMAT(1X,"KUNIT",5X,"SMITH",5X,"KUNIT",7X,"(1967)",7X,"BALDI"
2 7X,"SICARDI")
510 WRITE(6,510)
510 FORMAT(1X,"(1957)",4X,"(1960)",4X,"SMITH",20X,"SICARDI",5X,
2 WRITE(6,520)
520 FORMAT(1X,20X,"(1962)",19X,"(1960)")
530 WRITE(6,530) THEORETICAL STATIC EFFECTIVE CONDUCTIVITY (W/MK)
530 WRITE(6,540) (ECON(I),I=1,6)
540 FORMAT(1X,2(F7.4,3X),F7.4,5X,F7.4,6X,2(F7.4,5X))
550 WRITE(6,550)
550 FORMAT(1X,20X,"DATA BASED UPON CORRELATIONS PRESENTED BY THE FOLLOWING
2 CONTINUE")
560 WRITE(6,560)
560 FORMAT(1X,"BUNNELL",4X,"SCHERTZ",5X,"QUINTON",4X,"PLAUTZ",7X,
2 "ROBERLY",5X,"CAMPSBELL",6X,"CALDERBANK",4X,"PHILLIPS")
570 FORMAT(1X,"IRVIN",6X,"BISCHOFF",4X,"STORROW",4X,"JOHNSTONE",4X,
2 "MARSHALL",4X,"MUNTINGTON",4X,"POGORSKI",6X,"LEAVITT")
580 WRITE(6,580) "OLSON",5X,"(1969)",5X,"(1956)",5X,"(1955)",7X,"(1951)"
2 6X,"(1952)",8X,"(1957)",8X,"YOUNG")
590 FORMAT(1X,"SMITH",92X,"(1960)")
590 WRITE(6,590)
600 FORMAT(1X,"(1949)")
610 WRITE(6,610)
610 FORMAT(1X,"EFFECTIVE CONDUCTIVITY (W/MK)")
620 WRITE(6,620) "CROTH(I)=1"
620 FORMAT(1X,F7.4,4X,F7.4,5X,F7.4,4X,F7.4,6X,F7.4,5X,2(F7.4,7X),F7.4
2)
630 WRITE(6,630)
630 FORMAT(1X,"RADIAL TEMPERATURE PROFILES (C) AT AXIAL POSITION OF 1
2 CM")
640 WRITE(6,640) (CORTMP(I,J),I=1,8)
640 FORMAT(1X,F5.0,6X,F5.0,6X,F5.0,6X,F5.0,6X,F5.0,6X,F5.0,6X,F5.0
2)
645 CONTINUE
650 WRITE(6,650)
650 FORMAT(1X,"EXPERIMENTAL RESULTS")
660 FORMAT(1X,"MODIFIED",5X,"PARTICLE",9X,"GAS",14X,"EFFECTIVE",8X,
2 "NONDIMENSIONAL")
670 WRITE(6,670)
670 WRITE(6,680) "REYNOLDS",315X,"CONDUCTIVITY",5X,"EFFECTIVE")
680 FORMAT(1X,"NUMBER",7X,3(" (W/MK)",11X),"CONDUCTIVITY")
690 WRITE(6,690) REM,CONDP,CNDEF,XX
690 FORMAT(1X,F7.3,6X,F7.4,10X,F8.3,16X,F8.4,11X,F4.1)
2 STOP
END

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SUBROUTINE GRADNT(TBEDB,TBEDL,TBEDF,TBEDR,AXPOS,GRAD)
DIMENSION TBEDB(4),TBEDL(4),TBEDF(4),TBEDR(4),AXPOS(4)
C****
C**** CALCULATE THE AVERAGE AXIAL TEMPERATURE GRADIENT FOR THE
C**** UPPER MICROMETER PROBE (C/CM) BASED UPON THE TEMPERATURES
C**** OBTAINED BY THE STATIONARY PROBES IMMEDIATELY ABOVE AND BELOW.
C****
GRAD=(TBEDB(2)-TBEDB(3)+TBEDL(2)-TBEDL(3)+TBEDF(2)-TBEDF(3))/
2*(3*(AXPOS(2)-AXPOS(3)))
RETURN
END

SUBROUTINE REYNLDIVOUT(VIN,TINRI,TINRE,RE,SIZEMN,SIZEMX,REM,
2CONDP,VISCO,CONDP,SPCHTO,RHOI,TBEDB,TBEDL,TBEDF,TBEDR)
DIMENSION TBEDB(4),TBEDL(4),TBEDF(4),TBEDR(4)
C****
C**** COMPUTE THE INNER AND OUTER AIR DENSITIES EVALUATED AT ROOM
C**** TEMPERATURE WHICH IS WHERE THE ROTAMETER WAS CALIBRATED
C****
RHOI=0.001293/(1.+0.00367*21)
RHOI=RHOI
C****
C**** COMPUTE REYNOLDS NUMBER IN INNER TUBE.
C****
TBAR=0.5*(TINRI+TINRE)
VISC=(4.023E-06)*((TBAR+273.1)**0.675)
RE=1.1684*VIN*RHOI/VISC
C****
C**** COMPUTE THE PACKED BED PHYSICAL PROPERTIES AND THE MODIFIED
C**** REYNOLDS NUMBER.
C****
TBARO=(TBEDB(2)+TBEDL(2)+TBEDF(2))/3.
VISCO=(4.023E-06)*((TBARO+273.1)**0.675)
DIAP=(0.5E-04)*(SIZEMN+SIZEMX)
REM=DIAP*VOUT*RHOI/VISCO
SPCHTO=1.0447-(3.1597E-04)*((TBARO+273.1)+(7.0791E-07)*((TBARO+273.1)
2**2)-(2.7034E-10)*((TBARO+273.1)**3)
CONDO=(1.475E-04)*((TBARO+273.1)**0.898)
CONDP=(2.1E-03)*((TBARO+273.1)+0.37
RETURN
END

SUBROUTINE YK57(VOID,CONDP,CONDO,EFCON)
DIMENSION EFCON(6)
C****
C**** CALCULATION OF THE STATIC EFFECTIVE THERMAL CONDUCTIVITY (W/MK),
C**** ACCORDING TO METHOD OF YAOI-KUNII (1957) WITH BETA=GAMMA=1.
C****
EFCON(1)=(1.-VOID)*CONDO/((CONDO/CONDP)+0.0*(VOID/0.2)**1.79)
RETURN
END

```

```

SUBROUTINE KS60(VOID,CONDP,CONDG,EFCON)
DIMENSION EFCON(6)
C****
C    CALCULATION OF THE STATIC EFFECTIVE THERMAL CONDUCTIVITY (W/MK).
C    ACCORDING TO THE METHOD OF KUNIT-SMITH (1960) WITH BETA=1 AND
C    GAMMA=2/3.
C****
X=CONDP/CONDG
PHI1=(0.240/X**0.213)+0.0029
PHI2=0.0922/(X**0.255)
PHI=PHI2+((PHI1-PHI2)*(VOID-0.260))/0.218
EFCON(2)=(VOID*(1.-VOID)/(PHI+2./3.*X))*CONDG
RETURN
END

SUBROUTINE WK62(VOID,CONDP,CONDG,EFCON)
DIMENSION EFCON(6)
C****
C    CALCULATION OF THE STATIC EFFECTIVE THERMAL CONDUCTIVITY (W/MK).
C    ACCORDING TO THE METHOD OF WILLHITE-KUNIT-SMITH (1962).
C****
X=CONDP/CONDG
Y=(15.03-25.26*VOID)/(1.91-1.91*VOID)
E1=1.-1./Y
T1=((1.-1./X)**2)/(2.*Y)
T2=X*(X-1.)*SQRT(E1)
T3=(1.-1./X)*(1.-SQRT(E1))
ALPHA=T1/(ALOG(T2)-T3)
EFCON(3)=(1.+(1.-VOID)*(1.-1./X)+2.*((1.-1./X)**2)*(1.-VOID)/
2*(3.*ALPHA))*CONDG
RETURN
END

SUBROUTINE K67(VOID,CONDP,CONDG,EFCON)
DIMENSION EFCON(6)
C****
C    CALCULATION OF THE STATIC EFFECTIVE THERMAL CONDUCTIVITY (W/MK).
C    ACCORDING TO THE METHOD OF KRUPICZKA (1967).
C****
A=0.280-0.757*ALOG10(VOID)
B=-0.057
X=CONDP/CONDG
E=A+B*ALOG10(X)
EFCON(4)=(X**E)*CONDG
RETURN
END

SUBROUTINE SBS60(VOID,CONDP,CONDG,EFCON)
DIMENSION EFCON(6)
C****
C    CALCULATION OF THE STATIC EFFECTIVE THERMAL CONDUCTIVITY (W/MK).
C    USING THE KUNIT-SMITH (1960) MODEL WITH THE CORRELATION FOR PHI
C    GIVEN BY SPECCHIA-BALDI-SICARDI (1980).
C****
X=CONDG/CONDP
PHI=0.220*(VOID**2)
EFCON(5)=(VOID*(1.-VOID)/(2.*X/3.*PHI))*CONDG
RETURN
END

```

```

SUBROUTINE SS80(VOID,CONDP,CONDG,EFCON)
DIMENSION EFCON(6)
C****
C  CALCULATION OF THE STATIC EFFECTIVE THERMAL CONDUCTIVITY (W/MK),
C  ACCORDING TO THE METHOD OF SPECCHIA-SICARDI (1980).
C****
      X=CONDG/CONDP
      PHI=0.13D*(VOID**1.44)
      EFCON(6)=((VOID/1.5)+(1.-VOID))/(2.*X/3.+PHI)*CONDG
      RETURN
      END

SUBROUTINE BIGS49(CNDTH,REM,CONDO)
DIMENSION CNDTH(8)
C****
C  CALCULATION OF THE EFFECTIVE CONDUCTIVITY (W/MK), ACCORDING TO THE
C  CORRELATION OF BUNNELL-IRVIN-OLSON-SMITH (1949).
C****
      CNDTH(1)=(5.+0.061*REM)*CONDO
      RETURN
      END

SUBROUTINE SB69(CNDTH,REM,SPCHTO,VISCO,CONDO)
DIMENSION CNDTH(8)
C****
C  CALCULATION OF THE EFFECTIVE CONDUCTIVITY (W/MK), ACCORDING TO THE
C  CORRELATION OF SCHERTZ-BISCHOFF (1969).
C****
      CNDTH(2)=7.*CONDO+5.5*REM*SPCHTO*VISCO
      RETURN
      END

SUBROUTINE DS56(CNDTH,REM)
DIMENSION CNDTH(8)
C****
C  CALCULATION OF THE EFFECTIVE CONDUCTIVITY (W/MK), ACCORDING TO THE
C  CORRELATION OF QUINTON-STORROW (1956).
C****
      CNDTH(3)=0.0415+0.00019*REM
      RETURN
      END

SUBROUTINE PJ55(CNDTH,REM)
DIMENSION CNDTH(8)
C****
C  CALCULATION OF THE EFFECTIVE CONDUCTIVITY (W/MK), ACCORDING TO THE
C  CORRELATION OF PLAUTZ-JOHNSTONE (1955).
C****
      CNDTH(4)=0.76+0.00223*REM
      RETURN
      END

```

```

SUBROUTINE CM51(CNDTH,REM)
DIMENSION CNDTH(8)
C****
C**** CALCULATION OF THE EFFECTIVE CONDUCTIVITY (W/MK), ACCORDING TO THE
CORRELATION OF COBERLY-MARSHALL (1951).
C****
      PI=4.*ATAN(1.)
      CNDTH(5)=0.31+0.017*REM*SQRT(PI)
      RETURN
      END

SUBROUTINE CH52(CNDTH,REM,CONDO)
DIMENSION CNDTH(8)
C****
C**** CALCULATION OF THE EFFECTIVE CONDUCTIVITY (W/MK), ACCORDING TO THE
CORRELATION OF CAMPBELL-HUNTINGTON (1952).
C****
      CNDTH(6)=(10.+0.267*REM/6.)*CONDO
      RETURN
      END

SUBROUTINE CP57(CNDTH,REM)
DIMENSION CNDTH(8)
C****
C**** CALCULATION OF THE EFFECTIVE CONDUCTIVITY (W/MK), ACCORDING TO THE
CORRELATION OF CALDERBANK-POGORSKI (1957).
C****
      PI=4.*ATAN(1.)
      CNDTH(7)=0.35+0.0016*REM*SQRT(PI)
      RETURN
      END

SUBROUTINE PLY60(CNDTH,REM,SPCHTO,VISCO,CONDO)
DIMENSION CNDTH(8)
C****
C**** CALCULATION OF THE EFFECTIVE CONDUCTIVITY (W/MK), ACCORDING TO THE
CORRELATION OF PHILLIPS-LEAVITT-YOON (1960).
C****
      CNDTH(8)=0.14+0.65*CONDO*REM*SPCHTO/VISCO/0.091
      RETURN
      END

SUBROUTINE PROFLE(RADNON,RADPOS,THETA,TPROBU)
DIMENSION RADNON(30),RADPOS(30),THETA(30),TPROBU(30)
C****
C**** CALCULATE THE EXPERIMENTAL NONDIMENSIONAL RADIAL POSITIONS
AND TEMPERATURE PROFILE.
C****
      DO 10 I=1,30
      RADNON(I)=(RADPOS(I)+0.250)/0.988
      THETA(I)=(TPROBU(I)-TPROBU(1))/(TPROBU(30)-TPROBU(1))
      RETURN
      END

```

```

SUBROUTINE CONDUCT(THETAC,THETAT,GRAD,RADNON,EFCON,RHOO,VOUT,SPCHTO
2,TPROBU,THEOT,CNDEF,CNDTH,CORTMP)
DIMENSION TPROBU(30),THETAT(30),RADNON(30),EFCON(8),RADNOT(14),
2THETAC(14),THETA(14),THEOT(30),ERROR(500),CORGRD(8),
3CNDTH(8),THETA(8,30),CORTMP(8,30)
C****
C**** DEFINE THE NONDIMENSIONAL POSITIONS TO BE STUDIED.
RADNOT(1)=RADNON(11)
RADNOT(2)=RADNON(13)
RADNOT(3)=RADNON(15)
RADNOT(4)=RADNON(16)
RADNOT(5)=RADNON(17)
RADNOT(6)=RADNON(18)
RADNOT(7)=RADNON(19)
RADNOT(8)=RADNON(20)
RADNOT(9)=RADNON(21)
RADNOT(10)=RADNON(22)
RADNOT(11)=RADNON(23)
RADNOT(12)=RADNON(24)
RADNOT(13)=RADNON(26)
RADNOT(14)=RADNON(28)
C****
C**** AS A FIRST ITERATION, TAKE THE EFFECTIVE THERMAL CONDUCTIVITY
C**** TO BE EQUAL TO THE STATIC EFFECTIVE THERMAL CONDUCTIVITY PREDICTED
C**** BY KRUPICZKA (1967).
CNDEF=EFCON(4)
ZETA1=ALOG(0.253)
ZETA2=1.-((0.253)**2)
C****
C**** CALCULATE THE NONDIMENSIONAL AXIAL TEMPERATURE GRADIENT IN THE
C**** VICINITY OF THE MICROKETER PROBE LOCATED AT AN AXIAL POSITION
C**** OF 18.0975 CM.
DO 150 J=1,500
GRDNON=(629.769*SPCHTO+RHOO*VOUT*GRAD)/
2(CNDEF*(TPROBU(30)-TPROBU(1)))
C****
C**** COMPUTE THE NONDIMENSIONAL THEORETICAL TEMPERATURE PROFILE BASED
C**** UPON THE ASSUMED EFFECTIVE THERMAL CONDUCTIVITY.
DO 50 I=1,14
50 THETA(I)=1.-0.25*GRDNON*(1.-(RADNOT(I)**2))
2-(1.-0.25*GRDNON*ZETA2)*ALOG(RADNOT(I))/ZETA1
C****
C**** COMPUTE THE ERROR BETWEEN THE CURVE FITTED EXPERIMENTAL AND
C**** THEORETICAL PROFILES.
ERROR(J)=0.
DO 100 I=1,14
ERR=ABS(THETAC(I)-THETA(I))
100 ERROR(J)=ERROR(J)+ERR**2
150 CNDEF=1.01*CNDEF
C****
C**** COMPUTE THE MINIMUM ERROR.
J=1
DO 200 I=2,500
IF(ERROR(I).LT.ERROR(J)) J=I
200

```

```

200 CONTINUE
N=J-1
C****
C    CALCULATE THE NONDIMENSIONAL THEORETICAL TEMPERATURE
C    PROFILE BASED ON THE ERROR MINIMIZED EFFECTIVE THERMAL
C    CONDUCTIVITY.
C****
      CNDEF=(1.01**N)*EFCON(4)
      GRDNON=(629.769*SPCHTO*RHOQ*VOUT*GRAD)/
      2*(CNDEF*(TPROBU(30)-TPROBU(1)))
      THETAT(1)=0
      THETAT(30)=1
      DO 300 I=2,29
300  THETAT(I)=1.-0.25*GRDNON*(1.-(RADNON(I)**2))
      2*(1.-0.25*GRDNON*ZETA2)*ALOG(RADNON(I))/ZETA1
C****
C    COMPUTE THE ERROR MINIMIZED THEORETICAL TEMPERATURE PROFILE (C)
C****
      DO 350 I=1,30
      THEOT(I)=THETAT(I)*(TPROBU(30)-TPROBU(1))+TPROBU(1)
350  CONTINUE
C****
C    CALCULATE THE TEMPERATURE PROFILE PREDICTED BY USING THE
C    CORRELATIONS FOR THE EFFECTIVE CONDUCTIVITY PRESENTED BY THE
C    VARIOUS AUTHORS MENTIONED ABOVE.
C****
      DO 360 I=1,8
      CORGRD(I)=(629.769*SPCHTO*RHOQ*VOUT*GRAD)/
      2*(CNDEF*(TPROBU(30)-TPROBU(1)))
      THETA(I,1)=0
      THETA(I,30)=1
      DO 360 J=2,29
360  THETA(I,J)=1.-0.25*CORGRD(I)*(1.-(RADNON(J)**2))
      2*(1.-0.25*CORGRD(I)*ZETA2)*ALOG(RADNON(J))/ZETA1
      DO 370 J=1,30
370  CORTMP(I,J)=THETA(I,J)*(TPROBU(30)-TPROBU(1))+TPROBU(1)
380 CONTINUE
      RETURN
      END

```


TEST NUMBER AA-2-1

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 KUNII SMITH KUNII WILLHITE KRUPICZKA SPECCHIA SPECCHIA
 (1957) (1960) (1962) (1967) (1980) (1980) (1980)

THEORETICAL STATIC EFFECTIVE CONDUCTIVITY (W/MK)
 0.3325 0.2080 0.2450 0.2067 0.3951 0.4001

DATA BASED UPON CORRELATIONS PRESENTED BY THE FOLLOWING AUTHORS
 DUNNELL SCHERTZ QUINTON PLAUTZ COBERLY CAMPBELL
 IRVIN BISCHOFF STORROW JOHNSTONE MARSHALL HUNTINGTON
 OLSON (1969) (1966) (1955) (1951) (1952)

CALDERBANK
 FOGORSKI
 (1957)

PHILLIPS
 LEAVITT
 YOUNG
 (1960)

EFFECTIVE CONDUCTIVITY (W/MK)
 0.1878 0.2613 0.0417 0.7622 0.3401 0.3728
 RADIAL TEMPERATURE PROFILES (C) AT AXIAL POSITION OF 18.0975 CM

180.	180.	180.	180.	180.	180.	180.	180.
180.	180.	177.	180.	180.	180.	180.	180.
180.	180.	174.	181.	180.	180.	180.	179.
179.	180.	171.	181.	180.	180.	180.	179.
179.	180.	169.	181.	181.	181.	181.	179.
179.	180.	166.	182.	181.	181.	181.	179.
179.	180.	163.	182.	181.	181.	181.	178.
179.	180.	161.	182.	181.	181.	181.	178.
178.	180.	158.	183.	181.	181.	181.	178.
178.	180.	156.	183.	181.	182.	181.	178.
178.	180.	154.	183.	181.	182.	181.	177.
178.	180.	144.	183.	182.	183.	182.	177.
177.	181.	135.	187.	183.	183.	183.	176.
177.	181.	126.	188.	184.	184.	184.	176.
177.	182.	122.	189.	185.	185.	185.	175.
176.	183.	113.	192.	186.	187.	187.	176.
176.	185.	108.	195.	188.	189.	189.	177.
181.	187.	107.	197.	191.	192.	191.	179.
184.	190.	110.	200.	193.	194.	194.	181.
187.	192.	115.	202.	196.	197.	196.	184.
190.	196.	123.	205.	199.	200.	199.	188.
194.	199.	134.	207.	202.	203.	202.	192.
199.	203.	146.	209.	205.	206.	205.	197.
203.	207.	163.	212.	208.	209.	209.	202.
206.	209.	172.	213.	210.	211.	210.	205.
209.	211.	182.	214.	212.	212.	212.	208.
211.	213.	192.	216.	214.	214.	214.	211.
214.	215.	202.	217.	216.	216.	216.	214.
217.	218.	213.	218.	218.	218.	218.	217.
219.	219.	219.	219.	219.	219.	219.	219.

EXPERIMENTAL RESULTS
 MODIFIED PARTICLE
 REYNOLDS CONDUCTIVITY
 NUMBER (W/MK)
 0.999 1.3602

GAS
 CONDUCTIVITY
 (W/MK)
 0.03712

EFFECTIVE
 CONDUCTIVITY
 (W/MK)
 1.3690

NONDIMENSIONAL
 EFFECTIVE
 CONDUCTIVITY
 36.9

TEST NUMBER AA-2-2
EXPERIMENTAL VARIABLES

INNER VELOCITY (CM/S)
200.
EXPERIMENTAL DATA
INSIDE DIAMETER (CM)
1.27
OUTER VELOCITY (CM/S)
20.
OUTSIDE DIAMETER (CM)
5.019

POWER (W)
123.

PARTICLE SIZE RANGE (MICRONS)
177-250

GAS DENSITY (G/CM³)
0.002246
GAS VISCOSITY (G/CM²)
0.0002346

SPECIFIC HEAT (WS/GK)
1.0159

VOID FRACTION
0.419

REYNOLDS NUMBER
1403.1

TERMINAL TEMPERATURES (C)
INNER INNER OUTER
28.0 77.8 25.0

AMBIENT
32.6

SIROUD
42.1

STATIONARY PROBE TEMPERATURE PROFILES (C)
AXIAL POSITION (CM) RADIAL POSITION FROM INNER WALL (CM)
0.15875 0.635 1.27 1.5875
25.08 149.1 157.7 178.7 184.4
18.10 113.5 122.6 144.5 153.0
11.11 88.0 91.9 106.1 118.5
4.13 52.0 57.2 70.2 82.1

WALL TEMPERATURE PROFILES (C)
AXIAL POSITION (CM) OUTER WALL AXIAL POSITION (CM) INNER WALL
25.83 231.4 25.08 137.6
23.34 192.4 18.10 112.7
19.84 173.8 11.11 87.8
16.35 145.3 4.13 65.8
9.37 107.6
5.87 93.0
2.38 72.0

MOVEABLE PROBE TEMPERATURE PROFILES (C)
RADIAL POSITION (CM) AXIAL POSITION (CM) 18.0975 (EXPERIMENT) 18.0975 (THEORY)
0. 54. 112. 112.
0.013 34. 112. 112.
0.023 54. 112. 112.
0.036 53. 113. 113.
0.051 53. 113. 113.
0.063 53. 113. 113.
0.076 53. 114. 114.
0.089 53. 114. 114.
0.102 53. 115. 115.
0.114 53. 115. 115.
0.127 32. 113. 113.
0.191 32. 114. 116.
0.254 31. 115. 116.
0.318 31. 116. 119.
0.381 31. 116. 120.
0.508 32. 121. 123.
0.635 32. 124. 126.
0.762 57. 124. 129.
0.889 39. 132. 133.
1.016 63. 137. 136.
1.143 67. 141. 140.
1.270 71. 146. 143.
1.397 76. 150. 147.
1.524 81. 154. 151.
1.658 84. 156. 153.
1.785 86. 158. 155.
1.911 88. 160. 157.
1.778 89. 161. 160.
1.842 89. 162. 162.
1.875 89. 163. 163.

NONDIMENSIONAL PROBE TEMPERATURE PROFILES
N D AXIAL POSITION (CM) 18.0975 (EXPERIMENT) 18.0975 (THEORY)
0.253 0. 0.006
0.263 0. 0.011
0.268 0. 0.017
0.273 0. 0.023
0.278 0. 0.028
0.283 0. 0.034
0.288 0. 0.040
0.294 0. 0.045
0.299 0. 0.051
0.304 0.020 0.056
0.329 0.039 0.084
0.354 0.059 0.111
0.380 0.078 0.139
0.405 0.118 0.167
0.435 0.176 0.223
0.506 0.235 0.281
0.557 0.314 0.342
0.607 0.392 0.405
0.658 0.490 0.471
0.709 0.569 0.540
0.758 0.567 0.611
0.810 0.745 0.687
0.860 0.824 0.765
0.896 0.863 0.806
0.911 0.892 0.847
0.936 0.931 0.889
0.962 0.951 0.933
0.987 0.980 0.977
1.000 1.000 1.000

TEST NUMBER AA-2-2

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPIC2KA SPECCHIA SPECCHIA
 KUNII SMITH KUNII (1967) BALDI SICARDI
 (1957) (1960) SMITH (1980) SICARDI (1980)

THEORETICAL STATIC EFFECTIVE CONDUCTIVITY (W/MK)
 0.2982 0.1861 0.2196 0.1853 0.3534 0.3580
 DATA BASED UPON CORRELATIONS PRESENTED BY THE FOLLOWING AUTHORS
 BUNWELL SCHERTZ QUINTON PLAUTZ COBERLY CAMPBELL
 IRVIN BISCHOFF STORRON JOHNSTONE MARSHALL HUNTINGTON
 OLSON (1969) (1956) (1955) (1951) (1952)
 SMITH (1949)

CALDERBANK
 POGORSKI
 (1957)

PHILLIPS
 LEAVITT
 YOUNG
 (1960)

EFFECTIVE CONDUCTIVITY (W/MK)		0.1692 0.2336 0.0419		0.7649 0.3758 0.3328		0.3562 0.1671	
RADIAL TEMPERATURE PROFILES (C) AT		AXIAL POSITION OF		18.0975 CM			
112.	112.	112.	112.	112.	112.	112.	112.
112.	112.	108.	112.	112.	112.	111.	111.
111.	112.	104.	113.	112.	112.	111.	111.
111.	112.	100.	113.	113.	112.	111.	111.
110.	111.	96.	114.	113.	112.	110.	110.
110.	111.	92.	114.	113.	113.	110.	110.
109.	111.	89.	115.	113.	113.	109.	109.
109.	111.	85.	115.	113.	113.	109.	109.
109.	111.	82.	116.	114.	113.	109.	109.
108.	111.	78.	116.	114.	113.	108.	108.
108.	111.	75.	116.	114.	113.	108.	108.
107.	111.	61.	118.	115.	114.	106.	106.
106.	111.	49.	120.	116.	115.	105.	105.
105.	111.	38.	122.	117.	115.	105.	105.
105.	111.	30.	124.	118.	117.	104.	104.
105.	111.	17.	127.	121.	119.	103.	103.
106.	113.	11.	131.	124.	122.	103.	103.
109.	118.	9.	134.	127.	125.	103.	103.
112.	121.	12.	137.	130.	128.	111.	111.
116.	129.	20.	140.	133.	131.	113.	113.
121.	134.	31.	144.	137.	135.	115.	115.
126.	139.	46.	147.	141.	139.	126.	126.
133.	144.	64.	150.	145.	144.	132.	132.
140.	148.	86.	154.	149.	148.	140.	140.
144.	151.	98.	155.	152.	151.	143.	143.
148.	154.	111.	157.	154.	153.	147.	147.
152.	158.	125.	159.	157.	156.	152.	152.
156.	161.	139.	160.	159.	159.	156.	156.
161.	163.	155.	162.	162.	162.	161.	161.
163.	163.	163.	163.	163.	163.	163.	163.

EXPERIMENTAL RESULTS
 MODIFIED PARTICLE
 REYNOLDS CONDUCTIVITY
 NUMBER (W/MK)
 2.185 1.2374

GAS
 CONDUCTIVITY
 (W/MK)
 0.03296

EFFECTIVE
 CONDUCTIVITY
 (W/MK)
 0.4674

NONDIMENSIONAL
 EFFECTIVE
 CONDUCTIVITY
 14.2

TEST NUMBER AA-2-3

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNITA WILLHITE KRUPICZKA SPECCHIA SPECCHIA
 KUNITA SMITH KUNITA (1967) BALDI SICARDI
 (1957) (1960) SMITH (1962) SICARDI (1980)

THEORETICAL STATIC EFFECTIVE CONDUCTIVITY (W/MK)
 0.2797 0.1442 0.2059 0.1737 0.3308 0.3351

DATA BASED UPON CORRELATIONS PRESENTED BY THE FOLLOWING AUTHORS
 BUNNELL SCHERTZ QUINTON PLAUTZ COBERLY CAMPBELL
 IRVIN BISCHOFF STORROW JOHNSTONE MARSHALL HUNTINGTON
 OLSON (1969) (1956) (1955) (1951) (1952)

CALDERBANK
 POGORSKI
 (1957)

PHILLIPS
 LEAVITT
 YOOH
 (1960)

EFFECTIVE CONDUCTIVITY (W/MK)

0.1800 0.2192 0.0422 0.7677 0.4142 0.3117 0.3598 0.1685

RADIAL TEMPERATURE PROFILES (C) AT AXIAL POSITION OF 18.0975 CM							
72.	72.	72.	72.	72.	72.	72.	72.
71.	72.	67.	73.	72.	72.	72.	71.
71.	72.	62.	73.	73.	72.	72.	71.
70.	71.	58.	74.	73.	72.	73.	70.
69.	71.	53.	74.	73.	72.	73.	70.
69.	71.	49.	75.	73.	72.	73.	69.
68.	71.	44.	75.	74.	73.	73.	69.
68.	71.	40.	76.	74.	73.	73.	68.
67.	70.	36.	76.	74.	73.	74.	68.
67.	70.	32.	77.	74.	73.	74.	68.
66.	70.	29.	77.	75.	73.	74.	67.
65.	70.	12.	80.	76.	74.	75.	65.
63.	69.	-3.	82.	78.	75.	76.	64.
62.	70.	-15.	84.	79.	76.	77.	63.
62.	70.	-25.	86.	81.	77.	79.	63.
62.	71.	-40.	90.	84.	79.	82.	63.
63.	74.	-47.	94.	87.	82.	85.	63.
63.	77.	-49.	98.	91.	85.	88.	63.
69.	80.	-45.	102.	94.	89.	92.	71.
74.	85.	-37.	105.	98.	93.	96.	76.
80.	90.	-24.	109.	103.	98.	100.	82.
87.	96.	-6.	113.	107.	103.	105.	88.
95.	102.	16.	117.	112.	108.	110.	96.
103.	109.	41.	121.	117.	114.	116.	104.
108.	113.	56.	123.	119.	117.	118.	109.
113.	117.	71.	125.	122.	120.	121.	114.
118.	121.	87.	127.	125.	123.	124.	119.
123.	125.	104.	129.	128.	127.	127.	124.
129.	130.	122.	131.	130.	130.	130.	129.
132.	132.	132.	132.	132.	132.	132.	132.

EXPERIMENTAL RESULTS

MODIFIED PARTICLE
 REYNOLDS CONDUCTIVITY
 NUMBER (W/MK)
 3.457 1.1715

GAS
 CONDUCTIVITY
 (W/MK)
 0.03070

EFFECTIVE
 CONDUCTIVITY
 (W/MK)
 0.4559

HONDIMENSIONAL
 EFFECTIVE
 CONDUCTIVITY
 14.9

TEST NUMBER AA-5-1

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI	KUNII	WILLHITE	KRUPICZKA	SPECCHIA	SPECCHIA
(1957)	(1960)	(1962)	(1967)	(1980)	(1980)

THEORETICAL STATIC EFFECTIVE CONDUCTIVITY (W/MK)

0.3213	0.2008	0.2367	0.1997	0.3815	0.3863
--------	--------	--------	--------	--------	--------

DATA BASED UPON CORRELATIONS PRESENTED BY THE FOLLOWING AUTHORS

BUNNELL	SCHERTZ	QUINTON	FLAHERTY	COBERLY	CAMPBELL
IRVIN	BISCHOFF	STORROW	JOHNSTONE	MARSHALL	HUNTINGTON
OLSON	(1969)	(1956)	(1955)	(1951)	(1952)

CALDERBANK
POGORSKI
(1957)

PHILLIPS
LEAVITT
YOUNG
(1960)

EFFECTIVE CONDUCTIVITY (W/MK)

0.1810	0.2518	0.0417	0.7623	0.3410	0.3592	0.3529	0.1661
--------	--------	--------	--------	--------	--------	--------	--------

RADIAL TEMPERATURE PROFILES (C) AT AXIAL POSITION OF 18.0975 CM

140.	140.	140.	140.	140.	140.	140.	140.
140.	140.	138.	141.	141.	141.	141.	140.
140.	141.	136.	141.	141.	141.	141.	140.
141.	141.	134.	142.	142.	142.	142.	140.
141.	142.	132.	143.	142.	142.	142.	141.
141.	142.	130.	144.	143.	143.	143.	141.
141.	142.	129.	144.	143.	143.	143.	141.
142.	143.	127.	145.	144.	144.	144.	141.
142.	143.	126.	146.	144.	144.	144.	141.
142.	144.	124.	146.	145.	145.	145.	142.
142.	144.	122.	147.	145.	145.	145.	142.
144.	146.	116.	150.	147.	148.	148.	143.
145.	148.	110.	153.	150.	150.	150.	144.
146.	150.	106.	155.	152.	152.	152.	145.
146.	151.	102.	158.	154.	154.	154.	146.
151.	155.	98.	163.	158.	158.	158.	149.
154.	159.	95.	167.	162.	163.	163.	152.
158.	163.	98.	171.	166.	167.	166.	156.
162.	167.	101.	175.	170.	170.	170.	160.
166.	171.	108.	179.	174.	174.	174.	164.
170.	175.	116.	183.	178.	178.	178.	169.
175.	179.	126.	186.	182.	182.	182.	174.
180.	184.	139.	190.	186.	186.	186.	179.
185.	188.	153.	193.	190.	190.	190.	185.
189.	191.	161.	196.	192.	192.	192.	188.
191.	193.	169.	198.	194.	194.	194.	191.
194.	196.	178.	198.	196.	197.	197.	194.
197.	198.	187.	200.	199.	199.	199.	197.
200.	201.	197.	201.	201.	201.	201.	200.
202.	202.	202.	202.	202.	202.	202.	202.

EXPERIMENTAL RESULTS
MODIFIED PARTICLE
REYNOLDS CONDUCTIVITY
NUMBER (W/MK)
1.027 1.3199

GAS
CONDUCTIVITY
(W/MK)
0.03576

EFFECTIVE
CONDUCTIVITY
(W/MK)

NONDIMENSIONAL
EFFECTIVE
CONDUCTIVITY

TEST NUMBER AA-5-2

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI	KUNITI	WILLHITE	KRUPICZKA	SPECCHIA	SPECCHIA
KUNITI	SMITH	KUNITI	(1967)	BALDI	SICARDI
(1967)	(1960)	SMITH	(1962)	SICARDI	(1960)

THEORETICAL STATIC EFFECTIVE CONDUCTIVITY (W/MK)

0.2979	0.1858	0.2194	0.1851	0.3531	0.3676
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DATA BASED UPON CORRELATIONS PRESENTED BY THE FOLLOWING AUTHORS

BUNNELL	SCHERTZ	QUINTON	PLAUTZ	COBERLY	CAMPBELL
IRVIN	BISCHOFF	STORROW	JOHNSTONE	MARSHALL	HUNTINGTON
OLSON	(1969)	(1956)	(1955)	(1951)	(1952)

CALDERBANK
POGORSKI
(1957)

PHILLIPS
LEAVITT
YOON
(1960)

EFFECTIVE CONDUCTIVITY (W/MK)

0.1690	0.2333	0.0419	0.7649	0.3759	0.3325
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RADIAL TEMPERATURE PROFILES (C) AT AXIAL POSITION OF 18.0975 CM

99.	99.	99.	99.	99.	99.
98.	99.	92.	100.	100.	100.
98.	99.	88.	101.	100.	100.
98.	99.	84.	102.	101.	100.
98.	99.	81.	102.	101.	101.
98.	99.	78.	103.	101.	101.
98.	100.	75.	103.	102.	101.
97.	100.	72.	104.	102.	102.
97.	100.	69.	105.	102.	102.
97.	100.	66.	105.	103.	102.
97.	101.	63.	108.	105.	104.
96.	101.	42.	110.	106.	105.
97.	102.	33.	113.	108.	107.
97.	103.	26.	115.	110.	109.
98.	106.	15.	120.	114.	112.
101.	109.	10.	124.	117.	116.
104.	113.	10.	128.	121.	119.
108.	117.	13.	132.	125.	123.
113.	121.	21.	136.	129.	127.
118.	126.	33.	140.	134.	132.
124.	131.	48.	144.	138.	137.
131.	137.	66.	148.	143.	141.
138.	143.	87.	151.	148.	147.
142.	146.	99.	153.	150.	149.
146.	149.	112.	157.	154.	153.
151.	153.	125.	157.	155.	155.
155.	156.	139.	159.	158.	158.
160.	160.	154.	161.	160.	161.
162.	162.	162.	162.	162.	162.

EXPERIMENTAL RESULTS
MODIFIED PARTICLE
REYNOLDS CONDUCTIVITY
NUMBER (W/MK)
2.187 1.2365

GAS
CONDUCTIVITY
(W/MK)
0.03293

EFFECTIVE
CONDUCTIVITY
(W/MK)
0.6816

NONDIMENSIONAL
EFFECTIVE
CONDUCTIVITY
20.7

TEST NUMBER AA-5-3

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA SPECCHIA
 KUNII SMITH KUNII BALDI SICARDI SICARDI
 (1957) (1960) SMITH (1962) (1980) (1980)

THEORETICAL STATIC EFFECTIVE CONDUCTIVITY (W/MK)
 0.2800 0.1744 0.2062 0.1739 0.3313 0.3356

DATA BASED UPON CORRELATIONS PRESENTED BY THE FOLLOWING AUTHORS
 BUNNELL SCHERTZ QUINTON PLAUTZ COBERLY CAMPBELL
 IRVIN BISCHOFF STORROW JOHNSTONE MARSHALL HUNTINGTON
 OLSON (1969) (1956) (1955) (1951) (1952)

CALDERBANK
 POGORSKI
 (1957)

PHILLIPS
 LEAVITT
 YOON
 (1960)

EFFECTIVE CONDUCTIVITY (W/MK)

0.1602 0.2195 0.0422 0.7677 0.4141 0.3121 0.3598 0.1685

RADIAL TEMPERATURE PROFILES (C) AT AXIAL POSITION OF 18.0975 CM

67.	67.	67.	67.	67.	67.	67.	67.
66.	67.	62.	68.	67.	67.	67.	66.
66.	67.	57.	68.	68.	67.	67.	66.
65.	66.	53.	69.	68.	67.	68.	65.
65.	66.	48.	69.	68.	68.	68.	65.
64.	66.	44.	70.	69.	68.	68.	65.
64.	66.	39.	71.	69.	68.	68.	64.
63.	66.	35.	71.	69.	68.	69.	64.
63.	66.	31.	72.	70.	68.	69.	63.
62.	66.	27.	72.	70.	68.	69.	63.
62.	66.	24.	73.	70.	69.	70.	63.
63.	65.	6.	75.	72.	70.	71.	61.
59.	63.	-8.	78.	74.	71.	72.	60.
58.	66.	-20.	80.	75.	72.	74.	60.
58.	66.	-30.	83.	77.	73.	75.	59.
58.	69.	-44.	87.	81.	76.	78.	60.
60.	71.	-52.	91.	84.	79.	82.	62.
63.	74.	-53.	96.	88.	83.	86.	65.
67.	78.	-50.	100.	92.	87.	90.	69.
72.	83.	-41.	104.	97.	92.	94.	74.
78.	88.	-27.	108.	101.	98.	99.	80.
85.	94.	-9.	112.	106.	102.	104.	87.
93.	101.	13.	116.	111.	107.	109.	95.
102.	109.	40.	120.	116.	113.	115.	104.
107.	117.	50.	124.	121.	118.	119.	108.
112.	116.	70.	124.	122.	120.	121.	113.
118.	121.	86.	127.	125.	123.	124.	118.
123.	125.	104.	129.	127.	127.	127.	124.
129.	130.	122.	130.	130.	130.	130.	129.
132.	132.	132.	132.	132.	132.	132.	132.

EXPERIMENTAL RESULTS
 MODIFIED PARTICLE
 REYNOLDS CONDUCTIVITY
 NUMBER (W/MK)
 3.453 1.1727

GAS
 CONDUCTIVITY
 (W/MK)
 0.03074

EFFECTIVE
 CONDUCTIVITY
 (W/MK)
 0.4657

NONDIMENSIONAL
 EFFECTIVE
 CONDUCTIVITY
 15.1

TEST NUMBER BA-2-1

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA SPECCHIA
 KUNII SMITH KUNII (1967) BALDI SICARDI
 (1957) (1960) SMITH (1980) (1980)

THEORETICAL STATIC EFFECTIVE CONDUCTIVITY (W/MK)
 0.3472 0.2185 0.2481 0.2093 0.4172 0.4141

DATA BASED UPON CORRELATIONS PRESENTED BY THE FOLLOWING AUTHORS

BURNELL SCHERTZ QUINTON PLAUTZ COBERLY CAMPBELL CALDERBANK PHILLIPS
 IRVIN BISCHOFF STORROW JOHNSTONE HARSHALL HUNTINGTON POGORSKI LEAVITT
 OLSON (1969) (1956) (1955) (1951) (1952) (1957) YOUNG
 SMITH (1949)

EFFECTIVE CONDUCTIVITY (W/MK)

0.1796 0.2475 0.0420 0.7655 0.3846 0.3525 0.3570 0.1695

RADIAL TEMPERATURE PROFILES (C) AT AXIAL POSITION OF 18.0975 CM

139.	139.	139.	139.	139.	139.	139.	139.
139.	139.	137.	139.	139.	139.	139.	139.
139.	139.	135.	140.	140.	139.	139.	139.
139.	139.	132.	140.	140.	140.	140.	139.
139.	139.	130.	141.	140.	140.	140.	139.
139.	140.	128.	141.	140.	140.	140.	138.
139.	140.	126.	141.	141.	140.	140.	138.
139.	140.	123.	142.	141.	141.	141.	138.
139.	140.	123.	142.	141.	141.	141.	138.
138.	140.	121.	143.	141.	141.	141.	138.
138.	140.	119.	143.	142.	141.	141.	138.
138.	141.	112.	145.	143.	142.	143.	138.
139.	141.	105.	146.	144.	144.	144.	138.
139.	142.	100.	148.	145.	145.	145.	138.
139.	143.	95.	150.	146.	146.	146.	139.
141.	145.	89.	152.	149.	148.	148.	140.
142.	147.	86.	155.	151.	151.	151.	141.
144.	149.	85.	158.	154.	153.	153.	143.
147.	152.	84.	160.	156.	155.	156.	145.
150.	154.	80.	163.	159.	158.	158.	149.
153.	157.	101.	165.	162.	161.	161.	152.
157.	161.	110.	168.	164.	164.	164.	155.
161.	164.	121.	170.	167.	167.	167.	160.
165.	168.	134.	172.	170.	170.	170.	164.
167.	170.	141.	174.	172.	171.	171.	167.
170.	172.	149.	175.	173.	173.	173.	169.
172.	174.	157.	176.	175.	175.	175.	172.
175.	176.	165.	177.	176.	176.	176.	175.
178.	178.	174.	178.	178.	178.	178.	178.
179.	179.	179.	179.	179.	179.	179.	179.

EXPERIMENTAL RESULTS

MODIFIED PARTICLE
 REYNOLDS CONDUCTIVITY
 NUMBER (W/MK)
 2.477 1.2936

GAS
 CONDUCTIVITY
 (W/MK)
 0.03487

EFFECTIVE
 CONDUCTIVITY
 (W/MK)
 1.1703

NONDIMENSIONAL
 EFFECTIVE
 CONDUCTIVITY
 33.6

TEST NUMBER DA-2-2

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI	KUNITI	WILLHITE	KRUPICZKA	SPECCHIA	SPECCHIA
(1957)	(1960)	(1960)	(1967)	BALDI	SICARDI
				(1960)	(1960)

THEORETICAL STATIC EFFECTIVE CONDUCTIVITY (W/MK)

0.3271	0.2056	0.2337	0.1971	0.3925	0.3897
DATA BASED UPON CORRELATIONS PRESENTED BY THE FOLLOWING AUTHORS					
BUNNELL	SCHERTZ	QUINTON	PLAUTZ	COBERLY	CAMPBELL
IRVIN	BISCHOFF	STORROW	JOINSTONE	MARSHALL	HUNTINGTON
OLSON	(1969)	(1956)	(1955)	(1951)	(1952)
SMITH					
(1949)					

CALDERBANK
POGORSKI
(1957)

PHILLIPS
LEAVITT
YOON
(1960)

EFFECTIVE CONDUCTIVITY (W/MK)						
0.1736	0.2353	0.0425	0.7716	0.4668	0.3341	0.3648
RADIAL TEMPERATURE PROFILES (C) AT AXIAL POSITION OF 18.0975 CM						
101.	101.	101.	101.	101.	101.	101.
101.	101.	97.	101.	101.	101.	101.
100.	101.	93.	102.	102.	101.	100.
100.	101.	89.	102.	102.	101.	100.
99.	101.	85.	103.	102.	102.	99.
99.	100.	82.	103.	103.	102.	99.
99.	100.	78.	104.	103.	102.	99.
98.	100.	75.	104.	103.	102.	98.
98.	100.	71.	105.	103.	102.	98.
98.	100.	68.	105.	104.	102.	98.
97.	100.	65.	106.	104.	102.	97.
96.	100.	61.	106.	105.	103.	96.
95.	100.	59.	110.	107.	104.	96.
95.	101.	29.	112.	108.	105.	95.
95.	101.	20.	113.	110.	106.	95.
95.	103.	8.	117.	119.	109.	95.
97.	105.	2.	120.	116.	111.	97.
99.	107.	1.	124.	119.	114.	99.
102.	111.	4.	127.	122.	116.	102.
106.	114.	11.	130.	126.	119.	107.
111.	119.	22.	133.	129.	123.	111.
117.	124.	37.	137.	133.	129.	117.
120.	129.	55.	140.	137.	134.	123.
130.	136.	77.	143.	141.	136.	130.
134.	139.	89.	145.	143.	141.	134.
138.	141.	102.	147.	145.	143.	138.
142.	144.	115.	149.	147.	146.	142.
146.	148.	130.	150.	148.	148.	146.
151.	151.	145.	152.	152.	152.	151.
153.	153.	153.	153.	153.	153.	153.

EXPERIMENTAL RESULTS

MODIFIED PARTICLE
REYNOLDS
NUMBER

GAS
CONDUCTIVITY
(W/MK)

EFFECTIVE
CONDUCTIVITY
(W/MK)

NONDIMENSIONAL
EFFECTIVE
CONDUCTIVITY

5.204

1.2285

0.03265

0.4923

15.1

TEST NUMBER BA-2-3									
EXPERIMENTAL VARIABLES									
VELOCITY (CM/S)	VELOCITY (CM/S)	POWER (W)	PARTICLE SIZE RANGE (MICRONS)	GAS VISCOSITY (G/CMS)	SPECIFIC HEAT (W/SGK)	VOID FRACTION	REYNOLDS NUMBER		
200	104.		420-530	0.0002195	1.0114	0.395	1436.5		
EXPERIMENTAL DATA									
DIAMETER (CM)	DIAMETER (CM)	AXIAL HEIGHT (M)	DENSITY (G/CM ³)						
0.019	0.019	0.2921	0.0012005						
TEMPERATURE PROFILES (C)									
INNER	INNER	OUTER	SHROUD						
27.8	27.8	32.0	39.6						
WALL TEMPERATURE PROFILES (C)									
AXIAL POSITION	AXIAL POSITION	AXIAL POSITION	AXIAL POSITION	AXIAL POSITION	AXIAL POSITION	AXIAL POSITION	AXIAL POSITION	AXIAL POSITION	AXIAL POSITION
0.15875	0.15875	0.635	1.27	1.5875	1.5875	1.5875	1.5875	1.5875	1.5875
93.2	93.2	95.0	120.9	127.7	127.7	127.7	127.7	127.7	127.7
53.0	53.0	59.8	79.5	115.6	115.6	115.6	115.6	115.6	115.6
35.5	35.5	38.6	50.3	74.0	74.0	74.0	74.0	74.0	74.0
NONDIMENSIONAL PROBE TEMPERATURE PROFILES									
AXIAL POSITION	AXIAL POSITION	AXIAL POSITION	AXIAL POSITION	AXIAL POSITION	AXIAL POSITION	AXIAL POSITION	AXIAL POSITION	AXIAL POSITION	AXIAL POSITION
0.15875	0.15875	0.635	1.27	1.5875	1.5875	1.5875	1.5875	1.5875	1.5875
93.2	93.2	95.0	120.9	127.7	127.7	127.7	127.7	127.7	127.7
53.0	53.0	59.8	79.5	115.6	115.6	115.6	115.6	115.6	115.6
35.5	35.5	38.6	50.3	74.0	74.0	74.0	74.0	74.0	74.0

TEST NUMBER BA-2-3

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUMI WILLHITE KRUPICZKA SPECCHIA SPECCHIA
 KUMI SMITH KUMI BALDI SICARDI
 (1957) (1960) SMITH (1962) (1980) (1980)

THEORETICAL STATIC EFFECTIVE CONDUCTIVITY (W/MK)
 0.0046 0.1911 0.2176 0.1834 0.3648 0.3622

DATA BASED UPON CORRELATIONS PRESENTED BY THE FOLLOWING AUTHORS
 BUNNELL SCHIERTZ QUINTON PLAUTZ COBERLY CAMPBELL
 IRVIN BISCHOFF STORROW JOHNSTONE MARSHALL HUNTINGTON
 OLSON (1959) (1956) (1953) (1951) (1952)
 SMITH (1949)

CALDERBANK
 FOGDRSKI
 (1957)

PHILLIPS
 LEAVITT
 YOON
 (1960)

EFFECTIVE CONDUCTIVITY (W/MK)
 0.1661 0.2213 0.0431

RADIAL TEMPERATURE PROFILES (C) AT AXIAL POSITION OF 18.0975 CM
 0.7785 0.5597 0.3128

0.3735

0.1798

67.	67.	67.	67.	67.	67.	67.
67.	67.	63.	68.	67.	67.	67.
66.	67.	59.	68.	68.	67.	66.
66.	67.	55.	69.	68.	67.	66.
65.	67.	52.	69.	68.	68.	66.
65.	66.	48.	70.	69.	68.	65.
65.	66.	45.	70.	69.	68.	65.
64.	66.	42.	71.	70.	68.	65.
64.	66.	38.	71.	70.	68.	65.
64.	66.	35.	72.	71.	68.	64.
63.	66.	32.	72.	71.	69.	64.
62.	66.	19.	74.	73.	69.	63.
62.	66.	7.	76.	75.	70.	63.
61.	67.	-2.	79.	77.	71.	63.
61.	67.	-10.	81.	78.	73.	63.
61.	69.	-21.	84.	82.	75.	64.
63.	71.	-27.	88.	85.	78.	66.
66.	74.	-28.	92.	89.	81.	68.
69.	77.	-25.	95.	92.	85.	72.
73.	81.	-18.	98.	96.	89.	76.
78.	86.	-7.	102.	99.	92.	81.
84.	91.	8.	105.	103.	97.	86.
91.	97.	26.	109.	107.	102.	93.
98.	103.	47.	112.	111.	107.	100.
102.	106.	59.	114.	113.	109.	103.
106.	109.	72.	118.	115.	112.	107.
110.	113.	85.	117.	117.	115.	111.
115.	116.	99.	119.	119.	118.	115.
120.	120.	114.	121.	121.	121.	120.
122.	122.	122.	122.	122.	122.	122.

EXPERIMENTAL RESULTS
 MODIFIED PARTICLE
 REYNOLDS CONDUCTIVITY
 NUMBER (W/MK)
 8.286 1.1560

GAS
 CONDUCTIVITY
 (W/MK)
 0.03017

EFFECTIVE
 CONDUCTIVITY
 (W/MK)
 0.4816

NONDIMENSIONAL
 EFFECTIVE
 CONDUCTIVITY
 16.0

TEST NUMBER BA-5-1

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA SPECCHIA
 KUNII SMITH KUNII BALDI SICARDI
 (1957) (1960) SMITH (1967) (1980) (1980)

THEORETICAL STATIC EFFECTIVE CONDUCTIVITY (W/MK)
 0.3307 0.2079 0.2363 0.1993 0.3969 0.3940
 DATA BASED UPON CORRELATIONS PRESENTED BY THE FOLLOWING AUTHORS
 BUNNELL SCHERTZ QUINTON PLAUTZ COBERLY CAMPBELL
 IRVIN BISCHOFF STORROW JOHNSTONE MARSHALL HUNTINGTON
 OLSON (1963) (1956) (1955) (1951) (1952)
 SMITH (1949)

EFFECTIVE CONDUCTIVITY (W/MK)
 0.1704 0.2347 0.0420 0.7658 0.3877 0.3343 0.3573 0.1683
 RADIAL TEMPERATURE PROFILES (C) AT AXIAL POSITION OF 18.0975 CM

103.	103.	103.	103.	103.	103.	103.	103.
103.	103.	101.	104.	104.	104.	104.	103.
103.	104.	100.	104.	104.	104.	104.	103.
104.	104.	99.	105.	105.	105.	105.	104.
104.	105.	97.	106.	105.	105.	105.	104.
104.	105.	96.	106.	105.	105.	106.	104.
104.	105.	95.	107.	106.	106.	106.	104.
105.	106.	94.	107.	107.	106.	107.	105.
105.	106.	92.	108.	107.	107.	107.	105.
105.	106.	91.	109.	108.	107.	107.	105.
105.	107.	90.	109.	108.	108.	108.	105.
107.	108.	85.	112.	110.	110.	110.	106.
108.	110.	81.	115.	113.	112.	112.	108.
109.	112.	78.	117.	115.	114.	114.	109.
110.	114.	76.	119.	117.	116.	116.	110.
113.	117.	73.	124.	121.	120.	120.	113.
116.	120.	72.	126.	124.	123.	124.	116.
119.	124.	73.	131.	126.	127.	127.	119.
127.	131.	72.	135.	131.	130.	131.	123.
131.	134.	69.	138.	135.	134.	134.	126.
135.	138.	69.	141.	138.	137.	138.	130.
135.	138.	67.	144.	142.	141.	141.	135.
144.	142.	107.	147.	145.	144.	145.	139.
144.	142.	119.	150.	148.	148.	148.	144.
146.	148.	125.	152.	150.	150.	150.	146.
149.	150.	132.	153.	152.	151.	152.	149.
151.	152.	139.	154.	154.	153.	153.	151.
156.	156.	145.	156.	157.	156.	156.	157.
157.	157.	154.	157.	157.	157.	157.	157.
158.	158.	158.	158.	158.	158.	158.	158.

EXPERIMENTAL RESULTS	GAS	EFFECTIVE	NONDIMENSIONAL
MODIFIED PARTICLE	CONDUCTIVITY	CONDUCTIVITY	EFFECTIVE
REYNOLDS	(W/MK)	(W/MK)	CONDUCTIVITY
NUMBER			
2.579	1.2400	0.03305	50.2

TEST NUMBER BA-8-2									
EXPERIMENTAL VARIABLES									
INNER VELOCITY (CM/S)	OUTER VELOCITY (CM/S)	DATA INSIDE DUCT (CM)	DATA OUTSIDE DUCT (CM)	POWER (W)	PARTICLE SIZE (MICRONS)	GAS VISCOSITY (G/CM ² S)	SPECIFIC HEAT (W/CM ² S)	VOID FRACTION	REYNOLDS NUMBER
500	20	1.27	5.019	104	420-590	0.002310	1.0147	0.395	3565.6
TEMPERATURE PROFILES (C)									
INNER	OUTER	INNER	OUTER	AXIAL POSITION (CM)	AXIAL POSITION (CM)	AXIAL POSITION (CM)	AXIAL POSITION (CM)	AXIAL POSITION (CM)	AXIAL POSITION (CM)
27.1	27.7	32.7	32.7	1.27	1.27	1.27	1.27	1.27	1.27
STATIONARY PROBE TEMPERATURE PROFILES (C)									
INNER	OUTER	INNER	OUTER	AXIAL POSITION (CM)	AXIAL POSITION (CM)	AXIAL POSITION (CM)	AXIAL POSITION (CM)	AXIAL POSITION (CM)	AXIAL POSITION (CM)
25.08	13.3	136.0	136.0	1.27	1.27	1.27	1.27	1.27	1.27
16.10	106.5	106.5	106.5	1.27	1.27	1.27	1.27	1.27	1.27
11.11	84.0	84.0	84.0	1.27	1.27	1.27	1.27	1.27	1.27
4.13	53.2	53.2	53.2	1.27	1.27	1.27	1.27	1.27	1.27
NONDIMENSIONAL PROBE TEMPERATURE PROFILES									
INNER	OUTER	INNER	OUTER	AXIAL POSITION (CM)	AXIAL POSITION (CM)	AXIAL POSITION (CM)	AXIAL POSITION (CM)	AXIAL POSITION (CM)	AXIAL POSITION (CM)
0.013	0.025	0.025	0.025	1.27	1.27	1.27	1.27	1.27	1.27
0.035	0.051	0.051	0.051	1.27	1.27	1.27	1.27	1.27	1.27
0.051	0.069	0.069	0.069	1.27	1.27	1.27	1.27	1.27	1.27
0.069	0.087	0.087	0.087	1.27	1.27	1.27	1.27	1.27	1.27
0.087	0.104	0.104	0.104	1.27	1.27	1.27	1.27	1.27	1.27
0.104	0.121	0.121	0.121	1.27	1.27	1.27	1.27	1.27	1.27
0.121	0.138	0.138	0.138	1.27	1.27	1.27	1.27	1.27	1.27
0.138	0.155	0.155	0.155	1.27	1.27	1.27	1.27	1.27	1.27
0.155	0.172	0.172	0.172	1.27	1.27	1.27	1.27	1.27	1.27
0.172	0.189	0.189	0.189	1.27	1.27	1.27	1.27	1.27	1.27
0.189	0.206	0.206	0.206	1.27	1.27	1.27	1.27	1.27	1.27
0.206	0.223	0.223	0.223	1.27	1.27	1.27	1.27	1.27	1.27
0.223	0.240	0.240	0.240	1.27	1.27	1.27	1.27	1.27	1.27
0.240	0.257	0.257	0.257	1.27	1.27	1.27	1.27	1.27	1.27
0.257	0.274	0.274	0.274	1.27	1.27	1.27	1.27	1.27	1.27
0.274	0.291	0.291	0.291	1.27	1.27	1.27	1.27	1.27	1.27
0.291	0.308	0.308	0.308	1.27	1.27	1.27	1.27	1.27	1.27
0.308	0.325	0.325	0.325	1.27	1.27	1.27	1.27	1.27	1.27
0.325	0.342	0.342	0.342	1.27	1.27	1.27	1.27	1.27	1.27
0.342	0.359	0.359	0.359	1.27	1.27	1.27	1.27	1.27	1.27
0.359	0.376	0.376	0.376	1.27	1.27	1.27	1.27	1.27	1.27
0.376	0.393	0.393	0.393	1.27	1.27	1.27	1.27	1.27	1.27
0.393	0.410	0.410	0.410	1.27	1.27	1.27	1.27	1.27	1.27
0.410	0.427	0.427	0.427	1.27	1.27	1.27	1.27	1.27	1.27
0.427	0.444	0.444	0.444	1.27	1.27	1.27	1.27	1.27	1.27
0.444	0.461	0.461	0.461	1.27	1.27	1.27	1.27	1.27	1.27
0.461	0.478	0.478	0.478	1.27	1.27	1.27	1.27	1.27	1.27
0.478	0.495	0.495	0.495	1.27	1.27	1.27	1.27	1.27	1.27
0.495	0.512	0.512	0.512	1.27	1.27	1.27	1.27	1.27	1.27
0.512	0.529	0.529	0.529	1.27	1.27	1.27	1.27	1.27	1.27
0.529	0.546	0.546	0.546	1.27	1.27	1.27	1.27	1.27	1.27
0.546	0.563	0.563	0.563	1.27	1.27	1.27	1.27	1.27	1.27
0.563	0.580	0.580	0.580	1.27	1.27	1.27	1.27	1.27	1.27
0.580	0.597	0.597	0.597	1.27	1.27	1.27	1.27	1.27	1.27
0.597	0.614	0.614	0.614	1.27	1.27	1.27	1.27	1.27	1.27
0.614	0.631	0.631	0.631	1.27	1.27	1.27	1.27	1.27	1.27
0.631	0.648	0.648	0.648	1.27	1.27	1.27	1.27	1.27	1.27
0.648	0.665	0.665	0.665	1.27	1.27	1.27	1.27	1.27	1.27
0.665	0.682	0.682	0.682	1.27	1.27	1.27	1.27	1.27	1.27
0.682	0.699	0.699	0.699	1.27	1.27	1.27	1.27	1.27	1.27
0.699	0.716	0.716	0.716	1.27	1.27	1.27	1.27	1.27	1.27
0.716	0.733	0.733	0.733	1.27	1.27	1.27	1.27	1.27	1.27
0.733	0.750	0.750	0.750	1.27	1.27	1.27	1.27	1.27	1.27
0.750	0.767	0.767	0.767	1.27	1.27	1.27	1.27	1.27	1.27
0.767	0.784	0.784	0.784	1.27	1.27	1.27	1.27	1.27	1.27
0.784	0.801	0.801	0.801	1.27	1.27	1.27	1.27	1.27	1.27
0.801	0.818	0.818	0.818	1.27	1.27	1.27	1.27	1.27	1.27
0.818	0.835	0.835	0.835	1.27	1.27	1.27	1.27	1.27	1.27
0.835	0.852	0.852	0.852	1.27	1.27	1.27	1.27	1.27	1.27
0.852	0.869	0.869	0.869	1.27	1.27	1.27	1.27	1.27	1.27
0.869	0.886	0.886	0.886	1.27	1.27	1.27	1.27	1.27	1.27
0.886	0.903	0.903	0.903	1.27	1.27	1.27	1.27	1.27	1.27
0.903	0.920	0.920	0.920	1.27	1.27	1.27	1.27	1.27	1.27
0.920	0.937	0.937	0.937	1.27	1.27	1.27	1.27	1.27	1.27
0.937	0.954	0.954	0.954	1.27	1.27	1.27	1.27	1.27	1.27
0.954	0.971	0.971	0.971	1.27	1.27	1.27	1.27	1.27	1.27
0.971	0.988	0.988	0.988	1.27	1.27	1.27	1.27	1.27	1.27
0.988	1.005	1.005	1.005	1.27	1.27	1.27	1.27	1.27	1.27

TEST NUMBER BA-5-2

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI	KUNITI	WILLHITE	KRUPICZKA	SPECCHIA	SPECCHIA
KUNITI	SHITH	KUNITI	(1957)	BALDI	SICARDI
(1957)	(1950)	(1952)		SICARDI	(1980)

THEORETICAL STATIC EFFECTIVE CONDUCTIVITY (W/MK)

0.3237	0.2034	0.2313	0.1950	0.3883	0.3855
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DATA BASED UPON CORRELATIONS PRESENTED BY THE FOLLOWING AUTHORS

BUNNELL	SCHERTZ	QUINTON	COBERLY	CAMPBELL	CALDERBANK	PHILLIPS
IRVIN	BISCHOFF	STORROW	JOHNSTONE	MARSHALL	HUNTINGTON	LEAVITT
OLSON	(1969)	(1956)	(1955)	(1951)	(1952)	YOON
SMITH						(1960)
(1949)						

EFFECTIVE CONDUCTIVITY (W/MK)	0.1717	0.2327	0.0425	0.7717	0.4682	0.3303	0.3649	0.1745
RADIAL TEMPERATURE PROFILES (C) AT AXIAL POSITION OF	18.0975	CM						
88.	88.	88.	88.	88.	88.	88.	88.	88.
88.	88.	84.	89.	89.	88.	88.	88.	88.
88.	88.	81.	89.	89.	89.	89.	88.	88.
88.	88.	78.	90.	90.	89.	89.	88.	88.
87.	88.	75.	91.	90.	89.	90.	87.	87.
87.	89.	72.	91.	90.	90.	90.	87.	87.
87.	89.	69.	92.	91.	90.	90.	87.	87.
87.	89.	66.	92.	91.	90.	91.	87.	87.
87.	89.	63.	93.	92.	91.	91.	87.	87.
87.	89.	60.	94.	92.	91.	91.	87.	87.
87.	89.	58.	94.	93.	91.	92.	87.	87.
87.	90.	46.	97.	95.	93.	94.	87.	87.
87.	91.	35.	100.	97.	95.	96.	87.	87.
87.	92.	28.	102.	99.	96.	97.	87.	87.
88.	93.	21.	105.	102.	98.	99.	88.	88.
89.	96.	12.	109.	106.	102.	103.	90.	90.
92.	99.	7.	114.	110.	105.	107.	92.	92.
95.	103.	7.	118.	114.	109.	111.	96.	96.
99.	107.	11.	122.	117.	113.	114.	100.	100.
104.	111.	18.	126.	122.	117.	119.	104.	104.
109.	116.	29.	129.	126.	122.	123.	109.	109.
115.	121.	42.	133.	130.	127.	125.	115.	115.
121.	127.	61.	137.	134.	131.	132.	122.	122.
126.	133.	81.	141.	138.	136.	137.	129.	129.
132.	136.	92.	142.	141.	139.	139.	132.	132.
136.	139.	104.	143.	143.	141.	142.	136.	136.
140.	142.	116.	146.	145.	144.	144.	140.	140.
144.	146.	130.	148.	147.	147.	147.	144.	144.
149.	149.	144.	150.	150.	150.	150.	149.	149.
151.	151.	151.	151.	151.	151.	151.	151.	151.

EXPERIMENTAL RESULTS	GAS	EFFECTIVE	NONDIMENSIONAL
MODIFIED	PARTICLE	CONDUCTIVITY	EFFECTIVE
REYNOLDS	CONDUCTIVITY	(W/MK)	CONDUCTIVITY
NUMBER	(W/MK)		
5.250	1.2175	0.03228	16.7

TEST NUMBER BA-6-3

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNITI WILLHITE KRUPICZKA SPECCHIA SPECCHIA
 KUNITI SMITH KUNITI (1967) BALDI SICARDI
 (1957) (1960) (1962) (1960) (1960)

THEORETICAL STATIC EFFECTIVE CONDUCTIVITY (W/MK)

0.3040 0.1907 0.2171 0.1831 0.3540 0.3814
 DATA BASED UPON CORRELATIONS PRESENTED BY THE FOLLOWING AUTHORS
 BUNNELL SCHERTZ QUINTON PLAUTZ COBERLY CAMPBELL
 IRVIN BISCHOFF STORROW JOHNSTONE MARSHALL HUNTINGTON
 OLSON (1969) (1956) (1955) (1951) (1952)
 SMITH (1949)

CALDERBANK
 FOGORSKI
 (1957)

PHILLIPS
 LEAVITT
 YOON
 (1960)

EFFECTIVE CONDUCTIVITY (W/MK)

0.1657 0.2208 0.0431 0.7785 0.5601 0.3121

RADIAL TEMPERATURE PROFILES (C) AT AXIAL POSITION OF 18.0975 CM

61.	61.	61.	61.	61.	61.
61.	61.	61.	62.	61.	61.
60.	61.	54.	62.	61.	62.
60.	61.	50.	63.	62.	62.
60.	61.	47.	63.	62.	62.
60.	61.	43.	64.	62.	63.
59.	61.	40.	65.	62.	63.
58.	61.	37.	65.	63.	63.
58.	61.	34.	66.	63.	64.
58.	61.	31.	66.	63.	64.
56.	61.	28.	67.	63.	64.
56.	61.	15.	69.	65.	66.
57.	62.	4.	72.	70.	68.
57.	63.	2.	74.	73.	69.
57.	64.	-12.	77.	75.	71.
59.	66.	-23.	81.	79.	72.
61.	68.	-26.	85.	83.	74.
61.	69.	-28.	86.	84.	78.
68.	76.	-25.	93.	90.	82.
72.	80.	-17.	97.	94.	86.
77.	85.	-6.	100.	98.	90.
90.	90.	27.	104.	102.	94.
90.	95.	48.	106.	105.	98.
98.	102.	60.	108.	107.	103.
102.	106.	72.	110.	109.	108.
106.	109.	85.	112.	112.	110.
110.	113.	99.	114.	114.	113.
115.	116.	114.	117.	117.	115.
120.	120.	121.	119.	117.	118.
122.	122.	122.	121.	120.	120.
			122.	122.	122.

EXPERIMENTAL
 MODIFIED
 REYNOLDS
 NUMBER
 8.300

RESULTS
 PARTICLE
 CONDUCTIVITY
 (W/MK)
 1.1539

GAS
 CONDUCTIVITY
 (W/MK)
 0.03010

EFFECTIVE
 CONDUCTIVITY
 (W/MK)
 0.4438

NONDIMENSIONAL
 EFFECTIVE
 CONDUCTIVITY
 14.7

TEST NUMBER 88-2-1
EXPERIMENTAL VARIABLES

INNER VELOCITY (CM/S)	OUTER VELOCITY (CM/S)	POWER (W)	PARTICLE SIZE RANGE (MICRONS)
200.	10.	160.	420-590

EXPERIMENTAL INSIDE DIAMETER (CM)	DATA OUTSIDE DIAMETER (CM)	AXIAL HEIGHT (M)	GAS DENSITY (G/CM ³)*3	GAS VISCOSITY (G/CM ² S)	SPECIFIC HEAT (J/GK)	VOID FRACTION	REYNOLDS NUMBER
1.27	5.019	0.2921	0.0012005	0.0002561	1.0246	0.395	1349.5

INNER INLET	INNER EXIT	OUTER INLET	AMBIENT	SHROUD
35.7	108.8	30.8	39.7	55.3

STATIONARY PROBE TEMPERATURE PROFILES (C)

AXIAL POSITION (CM)	RADIAL POSITION FROM INNER WALL (CM)	1.27	1.5875
25.08	0.15875	220.3	254.1
18.10	0.635	174.3	204.6
11.11	1.27	131.0	152.0
4.13	1.5875	79.5	98.3

WALL TEMPERATURE PROFILES (C)

AXIAL POSITION (CM)	OUTER WALL	AXIAL POSITION (CM)	INNER WALL
26.63	315.4	25.08	187.4
23.34	268.4	18.10	158.1
19.84	242.7	11.11	122.1
16.35	204.6	4.13	91.2
9.37	148.3		
5.87	126.5		
2.38	98.5		

MOVEABLE PROBE TEMPERATURE PROFILES (C)

RADIAL POSITION (CM)	AXIAL POSITION (CM)	18.0975 (EXPERIMENT)	18.0975 (THEORY)
0.013	71.	151.	151.
0.025	70.	151.	152.
0.038	70.	151.	152.
0.051	70.	152.	153.
0.063	69.	152.	153.
0.076	69.	152.	154.
0.089	69.	152.	155.
0.102	69.	153.	155.
0.114	68.	153.	156.
0.127	68.	154.	156.
0.140	68.	155.	157.
0.153	67.	157.	161.
0.166	67.	159.	163.
0.179	67.	161.	165.
0.192	65.	165.	169.
0.205	65.	166.	173.
0.218	71.	170.	177.
0.231	75.	176.	181.
0.244	80.	181.	185.
0.257	85.	186.	189.
0.270	91.	191.	194.
0.283	97.	196.	198.
0.296	102.	203.	202.
0.309	108.	208.	204.
0.322	110.	210.	207.
0.335	112.	211.	209.
0.348	114.	212.	211.
0.361	115.	213.	215.
0.374	115.	215.	215.

NONDIMENSIONAL PROBE TEMPERATURE PROFILES

N D RADIAL POSITION	AXIAL POSITION (CM)	18.0975 (EXPERIMENT)	18.0975 (THEORY)
0.253	0.	0.	0.008
0.258	0.	0.	0.016
0.263	0.	0.	0.024
0.268	0.016	0.016	0.032
0.273	0.016	0.016	0.040
0.278	0.016	0.016	0.048
0.283	0.016	0.016	0.055
0.288	0.031	0.031	0.063
0.294	0.031	0.031	0.071
0.299	0.047	0.047	0.078
0.304	0.063	0.063	0.114
0.309	0.094	0.094	0.149
0.314	0.125	0.125	0.183
0.319	0.156	0.156	0.217
0.324	0.234	0.234	0.281
0.329	0.297	0.297	0.345
0.334	0.391	0.391	0.408
0.339	0.469	0.469	0.471
0.344	0.547	0.547	0.535
0.349	0.625	0.625	0.599
0.354	0.703	0.703	0.665
0.359	0.813	0.813	0.732
0.364	0.891	0.891	0.801
0.369	0.922	0.922	0.836
0.374	0.936	0.936	0.871
0.379	0.953	0.953	0.907
0.384	0.969	0.969	0.944
0.389	1.000	1.000	0.981
0.394	1.000	1.000	1.000

TEST NUMBER 88-21					
DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS					
YAGI	KUNII	WILLHITE	KRUPICZKA	SPECCHIA	SPECCHIA
KUNII	SMITH	KUNII	(1967)	BALDI	SICARDI
(1957)	(1960)	SMITH		SICARDI	(1980)
		(1962)		(1980)	

DATA BASED UPON CORRELATIONS PRESENTED BY THE FOLLOWING AUTHORS					
BUNNELL	SCHERTZ	QUINTON	PLAUTZ	COBERLY	CAMPBELL
IRVIN	B. SCHOFF	STORROW	JOHNSTONE	MARSHALL	HUNTINGTON
OLSON	(1969)	(1956)	(1955)	(1951)	(1952)
SMITH					
(1949)					

**PHILLIPS
LEAVITT
YOON
(1960)**

EFFECTIVE CONDUCTIVITY (W/MK) 0.1905 0.2627 0.0419 0.7653 0.3813 0.3743
RADIAL TEMPERATURE PROFILES (C) AT AXIAL POSITION OF 18.0975 CM

151.	151.	151.	151.	151.	151.
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[illegible]

210. EXPERIMENTAL	210. RESULTS	2
MODIFIED	PARTICLE	
REYNOLDS	CONDUCTIVITY	
NUMBER	(W/MK)	
2.367	1.3578	

GAS
CONDUCTIVITY
(W/MK)
0.03704

EFFECTIVE
CONDUCTIVITY
(W/MK)
0.3638

NONDIMENSIONAL EFFECTIVE CONDUCTIVITY

TEST NUMBER 88-2-3
 DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNIT WILLHITE KRUPICZKA SPECCHIA SPECCHIA
 KUNIT SMITH KUNIT (1967) BALDI SICARDI
 (1957) (1960) (1962) (1980) (1980)

THEORETICAL STATIC EFFECTIVE CONDUCTIVITY (W/MK)
 0.3087 0.1937 0.2204 0.1859 0.3697 0.3671
 DATA BASED UPON CORRELATIONS PRESENTED BY THE FOLLOWING AUTHORS
 BUNNELL SCHERTZ QUINTON FLAUTZ COBERLY CAMPBELL
 IRVIN BISCHOFF STORROW JOHNSTONE MARSHALL HUNTINGTON
 OLSON (1969) (1956) (1955) (1951) (1952)
 SMITH (1949)

CALDERBANK
 POGORSKI
 (1957)

PHILLIPS
 LEAVITT
 YOON
 (1960)

EFFECTIVE CONDUCTIVITY (W/MK)
 0.1684 0.2244 0.0431 0.7783 0.5569 0.3173 0.3732 0.1801
 RADIAL TEMPERATURE PROFILES (C) AT AXIAL POSITION OF 18.0975 CM
 52. 52. 52. 52. 52. 52. 52. 52.
 52. 52. 52. 52. 52. 52. 52. 52.
 52. 52. 52. 52. 52. 52. 52. 52.
 51. 52. 48. 53. 53. 53. 53. 53.
 51. 53. 44. 54. 54. 54. 54. 54.
 51. 53. 40. 55. 55. 55. 55. 55.
 51. 53. 36. 56. 56. 56. 56. 56.
 51. 53. 32. 57. 57. 57. 57. 57.
 51. 53. 29. 58. 58. 58. 58. 58.
 51. 53. 26. 59. 59. 59. 59. 59.
 51. 53. 22. 60. 60. 60. 60. 60.
 51. 53. 19. 60. 60. 60. 60. 60.
 51. 53. 16. 60. 60. 60. 60. 60.
 51. 55. 12. 64. 64. 64. 64. 64.
 51. 56. -10. 66. 66. 66. 66. 66.
 52. 56. -20. 69. 69. 69. 69. 69.
 52. 56. -28. 74. 74. 74. 74. 74.
 52. 56. -39. 80. 80. 80. 80. 80.
 58. 67. -44. 86. 86. 86. 86. 86.
 63. 72. -44. 88. 88. 88. 88. 88.
 68. 77. -39. 96. 96. 96. 96. 96.
 71. 83. -29. 98. 98. 98. 98. 98.
 80. 89. -16. 106. 106. 106. 106. 106.
 88. 95. 2. 111. 111. 111. 111. 111.
 96. 103. 23. 116. 116. 116. 116. 116.
 100. 110. 23. 121. 121. 121. 121. 121.
 110. 114. 26. 123. 123. 123. 123. 123.
 115. 118. 26. 126. 126. 126. 126. 126.
 120. 123. 22. 128. 128. 128. 128. 128.
 125. 127. 108. 130. 130. 130. 130. 130.
 131. 132. 128. 133. 133. 133. 133. 133.
 134. 134. 134. 134. 134. 134. 134. 134.

EXPERIMENTAL RESULTS
 MODIFIED PARTICLE
 REYNOLDS CONDUCTIVITY
 NUMBER (W/MK)
 8.195 1.1689

GAS
 CONDUCTIVITY
 (W/MK)
 0.03061

EFFECTIVE
 CONDUCTIVITY
 (W/MK)
 0.2432

NONDIMENSIONAL
 EFFECTIVE
 CONDUCTIVITY
 7.9

TEST NUMBER BB-5-1									
EXPERIMENTAL VARIABLES									
INLET VELOCITY (CM/S)	OUTLET VELOCITY (CM/S)	POWER (W)	PARTICLE SIZE RANGE (MICRONS)	GAS DENSITY (G/CM ³)	GAS VISCOSITY (G/CM ² S)	SPECIFIC HEAT (W/GK)	VOID FRACTION	REYNOLDS NUMBER	
300	10	160	420-590	0.0012005	0.0002530	1.0231	0.395	3465.2	
EXPERIMENTAL DATA									
DIAMETER (CM)	AXIAL HEIGHT (CM)	AXIAL HEIGHT (CM)	DENSITY (G/CM ³)	SHROUD					
1.27	0.19	0.2921	0.0012005						
TEMPERATURE PROFILES (C)									
INLET	EXIT	INLET	EXIT	INLET	EXIT	INLET	EXIT	INLET	EXIT
39.3	84.4	30.9	40.3	53.5					
STATIONARY PROBE TEMPERATURE PROFILES (C)									
AXIAL POSITION (CM)	PROBE POSITION (CM)	PROBE POSITION (CM)	INNER WALL (CM)						
25.06	176.2	199.3	240.3						
19.10	132.5	161.8	197.3						
4.13	62.0	127.7	197.6						
WALL TEMPERATURE PROFILES (C)									
AXIAL POSITION (CM)	WALL POSITION (CM)	WALL POSITION (CM)	WALL POSITION (CM)						
25.06	83	26.34	302.7						
19.10	16.32	16.32	268.7						
4.13	9.37	9.37	193.9						
	2.87	2.87	142.0						
NONDIMENSIONAL PROBE TEMPERATURE PROFILES									
RADIAL POSITION (CM)	AXIAL POSITION (CM)	AXIAL POSITION (CM)	AXIAL POSITION (CM)						
0.013	4.1275	18.0975	18.0975						
0.025	2.4	12.2	12.2						
0.038	66.3	125.6	125.6						
0.051	66.3	125.6	125.6						
0.076	66.3	125.6	125.6						
0.089	66.3	125.6	125.6						
0.102	66.3	125.6	125.6						
0.114	66.3	125.6	125.6						
0.131	66.3	125.6	125.6						
0.254	66.3	125.6	125.6						
0.319	66.3	125.6	125.6						
0.635	66.3	125.6	125.6						
0.899	66.3	125.6	125.6						
1.016	66.3	125.6	125.6						
1.270	66.3	125.6	125.6						
1.397	66.3	125.6	125.6						
1.524	66.3	125.6	125.6						
1.715	66.3	125.6	125.6						
1.779	66.3	125.6	125.6						
1.842	66.3	125.6	125.6						

TEST NUMBER BB-5-1

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNITI WILLHITE KRUPICZKA SPECCHIA SPECCHIA
 KUNITI SMITH KUNITI BALDI SICARDI
 (1957) (1960) SMITH (1967) (1980) (1980)
 (1962)

THEORETICAL STATIC EFFECTIVE CONDUCTIVITY (W/MK) 0.3613 0.2277 0.2583 0.2179 0.4346 0.4314

DATA BASED UPON CORRELATIONS PRESENTED BY THE FOLLOWING AUTHORS
 BUNNELL SCHERTZ QUINTON PLAUTZ COBERLY CAMPBELL
 IRVIN BISCHOFF STORROW JOHNSTONE MARSHALL HUNTINGTON
 OLSON (1969) (1956) (1955) (1951) (1952)
 SMITH (1949)

CALDERBANK
 POGORSKI
 (1957)

PHILLIPS
 LEAVITT
 YOON
 (1960)

EFFECTIVE CONDUCTIVITY (W/MK)

0.1875 0.2584 0.0420

RADIAL TEMPERATURE PROFILES (C) AT AXIAL POSITION OF 18.0975 CM

0.3568

0.1705

123.	123.	123.	123.	123.	123.	123.
124.	124.	124.	124.	124.	124.	124.
124.	124.	119.	125.	125.	125.	125.
125.	125.	117.	126.	126.	126.	126.
125.	126.	116.	127.	126.	126.	126.
126.	126.	114.	128.	127.	127.	127.
126.	127.	112.	129.	128.	128.	128.
126.	128.	111.	130.	129.	129.	129.
127.	128.	109.	131.	130.	129.	129.
127.	129.	108.	132.	130.	130.	130.
128.	130.	106.	133.	131.	131.	131.
130.	133.	100.	137.	135.	135.	134.
133.	136.	95.	141.	138.	138.	134.
135.	139.	91.	145.	142.	141.	134.
138.	141.	88.	148.	145.	145.	136.
142.	147.	85.	155.	151.	150.	141.
147.	152.	85.	161.	157.	156.	146.
152.	158.	87.	167.	162.	161.	151.
158.	163.	93.	172.	167.	167.	156.
163.	168.	100.	177.	172.	172.	161.
169.	174.	110.	182.	178.	177.	167.
174.	179.	125.	186.	183.	182.	173.
181.	185.	136.	191.	188.	188.	180.
188.	190.	152.	195.	193.	193.	187.
191.	193.	161.	197.	195.	195.	190.
194.	196.	171.	200.	198.	198.	194.
198.	199.	180.	202.	200.	200.	197.
201.	202.	191.	204.	203.	203.	201.
205.	205.	201.	206.	206.	206.	205.
207.	207.	207.	207.	207.	207.	207.

EXPERIMENTAL RESULTS
 MODIFIED PARTICLE
 REYNOLDS CONDUCTIVITY
 NUMBER (W/MK)
 2.397 1.3398

GAS
 CONDUCTIVITY
 (W/MK)
 0.03643

EFFECTIVE
 CONDUCTIVITY
 (W/MK)
 0.5076

NONDIMENSIONAL
 EFFECTIVE
 CONDUCTIVITY
 13.9

TEST NUMBER BB-5-2
 DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNITI WILLHITE KRUPICZKA SPECCHIA SPECCHIA
 KUNITI SMITH KUNITI (1967) BALDI SICARDI
 (1957) (1960) SMITH (1962) (1980) (1980)

THEORETICAL STATIC EFFECTIVE CONDUCTIVITY (W/MK)
 0.3309 0.2081 0.2364 0.1994 0.3972 0.3943
 DATA BASED UPON CORRELATIONS PRESENTED BY THE FOLLOWING AUTHORS
 BUNNELL SCHERTZ QUINTON PLAUTZ COBERLY CAMPBELL
 IRVIN BISCHOFF STORROW JOHNSTONE MARSHALL HUNTINGTON
 OLSON (1969) (1956) (1955) (1951) (1952)
 SMITH (1948)

CALDERBANK
 POGORSKI
 (1957)

PHILLIPS
 LEAVITT
 YOON
 (1960)

EFFECTIVE CONDUCTIVITY (W/MK)						
0.1758	0.2383	0.0425	0.7715	0.4653	0.3383	0.3646
RADIAL TEMPERATURE PROFILES (C) AT AXIAL POSITION OF 18.0975 CM						
82.	82.	82.	82.	82.	82.	82.
82.	82.	78.	83.	83.	83.	83.
82.	83.	74.	84.	84.	83.	82.
82.	83.	71.	85.	84.	84.	82.
82.	84.	67.	85.	85.	85.	82.
82.	84.	64.	87.	86.	85.	82.
82.	84.	61.	88.	87.	86.	82.
83.	85.	57.	89.	88.	87.	83.
83.	85.	54.	90.	88.	87.	83.
83.	85.	51.	91.	89.	88.	83.
83.	86.	48.	91.	89.	89.	83.
84.	86.	36.	96.	93.	91.	84.
85.	90.	25.	100.	97.	94.	85.
86.	92.	16.	103.	100.	97.	86.
88.	94.	9.	107.	103.	101.	88.
91.	99.	-1.	114.	109.	105.	91.
95.	104.	-5.	120.	115.	111.	95.
100.	109.	-4.	126.	121.	116.	100.
102.	115.	-2.	132.	127.	122.	106.
112.	121.	11.	137.	132.	128.	112.
119.	127.	25.	143.	138.	134.	119.
127.	134.	40.	148.	144.	140.	127.
135.	141.	63.	153.	150.	146.	135.
143.	148.	86.	158.	155.	151.	143.
149.	153.	101.	161.	158.	156.	149.
154.	157.	116.	163.	161.	160.	154.
159.	161.	131.	166.	164.	163.	159.
164.	165.	146.	169.	167.	167.	164.
169.	170.	163.	171.	170.	170.	169.
172.	172.	172.	172.	172.	172.	172.

EXPERIMENTAL RESULTS

MODIFIED PARTICLE
 REYNOLDS CONDUCTIVITY
 NUMBER (W/MK)
 5.154 1.2408

GAS
 CONDUCTIVITY
 (W/MK)
 0.03307

EFFECTIVE
 CONDUCTIVITY
 (W/MK)
 0.3089

NONDIMENSIONAL
 EFFECTIVE
 CONDUCTIVITY
 9.3

TEST NUMBER BB-5-3

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNIT WILLHITE KRUPICZKA SPECCHIA SPECCHIA
 KUNIT SMITH KUNIT (1967) BALDI SICARDI
 (1957) (1960) SMITH (1980) (1980)

THEORETICAL STATIC EFFECTIVE CONDUCTIVITY (W/MK)
 0.3084 0.1935 0.2203 0.1817 0.3694 0.3668

DATA BASED UPON CORRELATIONS PRESENTED BY THE FOLLOWING AUTHORS
 BUNNELL SCHERTZ QUINTON PLAUTZ COBERLY CAMPBELL CALDERBANK PHILLIPS
 IRVIN BISCHOFF STORROW JOHNSTONE MARSHALL HUNTINGTON POGORSKI LEAVITT
 OLSON (1969) (1956) (1955) (1951) (1952) (1957) YOUNG
 SMITH (1960)

EFFECTIVE CONDUCTIVITY (W/MK)
 0.1582 0.2242 0.0431 0.7783 0.5571 0.3170 0.3733 0.1801
 RADIAL TEMPERATURE PROFILES (C) AT AXIAL POSITION OF 18.0975 CM
 52. 52. 52. 52. 52. 52. 52. 52.
 52. 52. 48. 53. 53. 52. 53. 52.
 52. 52. 44. 54. 53. 53. 53. 52.
 52. 52. 40. 55. 54. 53. 54. 52.
 51. 53. 37. 56. 55. 54. 55. 52.
 51. 53. 33. 56. 55. 54. 55. 52.
 51. 53. 30. 57. 56. 55. 55. 52.
 51. 53. 26. 58. 57. 55. 56. 52.
 51. 53. 23. 59. 56. 55. 56. 52.
 51. 53. 20. 59. 56. 55. 57. 52.
 51. 53. 17. 60. 56. 55. 57. 52.
 51. 53. 3. 64. 60. 59. 60. 52.
 51. 53. 36. 67. 65. 61. 62. 52.
 52. 53. 38. 70. 68. 63. 65. 53.
 52. 53. 39. 74. 71. 65. 67. 54.
 53. 53. 36. 79. 77. 70. 72. 57.
 53. 53. 41. 85. 82. 74. 77. 60.
 53. 53. 41. 90. 87. 79. 82. 65.
 53. 53. 36. 95. 92. 84. 87. 70.
 53. 53. 32. 100. 97. 89. 92. 75.
 53. 53. 27. 105. 102. 95. 97. 82.
 53. 53. 14. 110. 107. 101. 103. 89.
 53. 53. 3. 114. 112. 107. 109. 97.
 53. 53. 24. 119. 117. 113. 115. 105.
 53. 53. 48. 121. 120. 116. 118. 110.
 53. 53. 52. 124. 123. 120. 121. 114.
 53. 53. 76. 126. 125. 123. 124. 119.
 53. 53. 91. 128. 127. 127. 127. 124.
 53. 53. 106. 131. 130. 130. 130. 129.
 53. 53. 123. 132. 132. 132. 132. 132.

EXPERIMENTAL RESULTS
 MODIFIED PARTICLE
 REYNOLDS CONDUCTIVITY
 NUMBER (W/MK)
 8.200 1.1681
 GAS CONDUCTIVITY
 (W/MK)
 0.03058
 EFFECTIVE CONDUCTIVITY
 (W/MK)
 0.2479
 NONDIMENSIONAL
 EFFECTIVE CONDUCTIVITY
 8.1

TEST NUMBER CA-2-1									
DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS									
KUNZI	KUNZI	KUNZI	KUNZI	KUNZI	KUNZI	KUNZI	KUNZI	KUNZI	KUNZI
(1957)	(1957)	(1957)	(1957)	(1957)	(1957)	(1957)	(1957)	(1957)	(1957)
THEORETICAL STATIC EFFECTIVE CONDUCTIVITY (W/MK)	0.4230	0.4230	0.4230	0.4230	0.4230	0.4230	0.4230	0.4230	0.4230
DATA BASED UPON CORRELATION	0.4230	0.4230	0.4230	0.4230	0.4230	0.4230	0.4230	0.4230	0.4230
DINWELL	DINWELL	DINWELL	DINWELL	DINWELL	DINWELL	DINWELL	DINWELL	DINWELL	DINWELL
(1949)	(1949)	(1949)	(1949)	(1949)	(1949)	(1949)	(1949)	(1949)	(1949)
SCHEERITZ	SCHEERITZ	SCHEERITZ	SCHEERITZ	SCHEERITZ	SCHEERITZ	SCHEERITZ	SCHEERITZ	SCHEERITZ	SCHEERITZ
(1955)	(1955)	(1955)	(1955)	(1955)	(1955)	(1955)	(1955)	(1955)	(1955)
STORROW	STORROW	STORROW	STORROW	STORROW	STORROW	STORROW	STORROW	STORROW	STORROW
(1955)	(1955)	(1955)	(1955)	(1955)	(1955)	(1955)	(1955)	(1955)	(1955)
EFFECTIVE CONDUCTIVITY (W/MK)	0.4230	0.4230	0.4230	0.4230	0.4230	0.4230	0.4230	0.4230	0.4230
PODOLSKY	PODOLSKY	PODOLSKY	PODOLSKY	PODOLSKY	PODOLSKY	PODOLSKY	PODOLSKY	PODOLSKY	PODOLSKY
(1955)	(1955)	(1955)	(1955)	(1955)	(1955)	(1955)	(1955)	(1955)	(1955)
TEMPERATURE PROFILE	0.4230	0.4230	0.4230	0.4230	0.4230	0.4230	0.4230	0.4230	0.4230
AXIAL POSITION	0.4230	0.4230	0.4230	0.4230	0.4230	0.4230	0.4230	0.4230	0.4230
OF 19.0975 CM	0.4230	0.4230	0.4230	0.4230	0.4230	0.4230	0.4230	0.4230	0.4230
0.3589	0.3589	0.3589	0.3589	0.3589	0.3589	0.3589	0.3589	0.3589	0.3589
0.1760	0.1760	0.1760	0.1760	0.1760	0.1760	0.1760	0.1760	0.1760	0.1760
NONDIMENSIONAL	NONDIMENSIONAL	NONDIMENSIONAL	NONDIMENSIONAL	NONDIMENSIONAL	NONDIMENSIONAL	NONDIMENSIONAL	NONDIMENSIONAL	NONDIMENSIONAL	NONDIMENSIONAL
EFFECTIVE CONDUCTIVITY	EFFECTIVE CONDUCTIVITY	EFFECTIVE CONDUCTIVITY	EFFECTIVE CONDUCTIVITY	EFFECTIVE CONDUCTIVITY	EFFECTIVE CONDUCTIVITY	EFFECTIVE CONDUCTIVITY	EFFECTIVE CONDUCTIVITY	EFFECTIVE CONDUCTIVITY	EFFECTIVE CONDUCTIVITY
1.4565	1.4565	1.4565	1.4565	1.4565	1.4565	1.4565	1.4565	1.4565	1.4565
EXPERIMENTAL RESULTS	EXPERIMENTAL RESULTS	EXPERIMENTAL RESULTS	EXPERIMENTAL RESULTS	EXPERIMENTAL RESULTS	EXPERIMENTAL RESULTS	EXPERIMENTAL RESULTS	EXPERIMENTAL RESULTS	EXPERIMENTAL RESULTS	EXPERIMENTAL RESULTS
MODIFIED PARTICLE CONDUCTIVITY	MODIFIED PARTICLE CONDUCTIVITY	MODIFIED PARTICLE CONDUCTIVITY	MODIFIED PARTICLE CONDUCTIVITY	MODIFIED PARTICLE CONDUCTIVITY	MODIFIED PARTICLE CONDUCTIVITY	MODIFIED PARTICLE CONDUCTIVITY	MODIFIED PARTICLE CONDUCTIVITY	MODIFIED PARTICLE CONDUCTIVITY	MODIFIED PARTICLE CONDUCTIVITY
NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER	NUMBER
3.139	3.139	3.139	3.139	3.139	3.139	3.139	3.139	3.139	3.139

TEST NUMBER CA-2-2									
EXPERIMENTAL VARIABLES									
INNER VELOCITY (CM/S)	OUTER VELOCITY (CM/S)	POWER (W)	PARTICLE SIZE RANGE (UM)	AXIAL HEIGHT (CM)	GAS DENSITY (G/CM ³)	GAS VELOCITY (CM/S)	SPECIFIC HEAT (J/GK)	VOID FRACTION	REYNOLDS NUMBER
100	20	105.	590-840	0.2921	0.0012005	0.0002348	1.0160	0.365	1407.8
EXPERIMENTAL DATA									
DIAMETER (CM)	OUTSIDE DIAMETER (CM)	AXIAL HEIGHT (CM)	GAS DENSITY (G/CM ³)	SHROUD	WALL TEMPERATURE PROFILES (C)				
IN 27	OUTER IN 27	IN 27	OUTER IN 27	IN 27	AXIAL POSITION	OUTER WALL	AXIAL POSITION	INNER WALL	
STATIONARY PROBE POSITION	PROBE POSITION	PROBE POSITION	PROBE POSITION	PROBE POSITION	AXIAL POSITION	WALL	AXIAL POSITION	INNER WALL	
0.15875	0.15875	0.635	0.635	0.635	25.06	187.2	16.10	128.2	
16.10	145.4	159.2	173.2	181.2	25.06	187.2	16.10	128.2	
11.11	82.0	95.1	104.4	115.3	19.84	169.8	11.11	73.8	
4.13	52.0	57.5	65.2	73.4	2.37	89.5	4.13	54.7	
MOVABLE PROBE TEMPERATURE PROFILES (C)									
RADIAL POSITION (CM)	AXIAL POSITION (EXPERIMENT)	AXIAL POSITION (EXPERIMENT)	AXIAL POSITION (EXPERIMENT)	AXIAL POSITION (THEORY)	NONDIMENSIONAL PROBE TEMPERATURE PROFILES				
					RADIAL POSITION	AXIAL POSITION (EXPERIMENT)	AXIAL POSITION (THEORY)		
0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030
0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069	0.069
0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.089	0.089
0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114	0.114
0.147	0.147	0.147	0.147	0.147	0.147	0.147	0.147	0.147	0.147
0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.181
0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216	0.216
0.261	0.261	0.261	0.261	0.261	0.261	0.261	0.261	0.261	0.261
0.308	0.308	0.308	0.308	0.308	0.308	0.308	0.308	0.308	0.308
0.359	0.359	0.359	0.359	0.359	0.359	0.359	0.359	0.359	0.359
0.414	0.414	0.414	0.414	0.414	0.414	0.414	0.414	0.414	0.414
0.473	0.473	0.473	0.473	0.473	0.473	0.473	0.473	0.473	0.473
0.536	0.536	0.536	0.536	0.536	0.536	0.536	0.536	0.536	0.536
0.603	0.603	0.603	0.603	0.603	0.603	0.603	0.603	0.603	0.603
0.674	0.674	0.674	0.674	0.674	0.674	0.674	0.674	0.674	0.674
0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749
0.827	0.827	0.827	0.827	0.827	0.827	0.827	0.827	0.827	0.827
0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

TEST NUMBER CA-2-2

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNIT WILLHITE KRUPICZKA SPECCHIA SPECCHIA
 KUNIT SMITH KUNIT (1967) BALDI SICARDI
 (1957) (1960) (1962) (1980) (1980)

THEORETICAL STATIC EFFECTIVE CONDUCTIVITY (W/MK)
 0.3444 0.2177 0.2425 0.2052 0.4156 0.4092
 DATA BASED UPON CORRELATIONS PRESENTED BY THE FOLLOWING AUTHORS
 BUNNELL SCHERTZ QUINTON PLAUTZ COSERLY CAMPBELL
 IRVIN BISCHOFF STORROW JOHNSTONE MARSHALL HUNTINGTON
 OLSON (1969) (1956) (1955) (1951) (1952)
 SMITH (1949)

CALDERBANK
 POGORSKI
 (1957)

PHILLIPS
 LEAVITT
 YOON
 (1960)

EFFECTIVE CONDUCTIVITY (W/MK)			RADIAL TEMPERATURE PROFILES (C) AT AXIAL POSITION OF 18.0975 CM			EFFECTIVE CONDUCTIVITY (W/MK)		
0.1797	0.2406	0.0429	0.7763	0.5303	0.3407	0.3707	0.1806	
112.	112.	112.	112.	112.	112.	112.	112.	
111.	112.	108.	112.	112.	112.	112.	111.	
111.	112.	103.	113.	113.	112.	112.	110.	
110.	111.	99.	113.	113.	112.	112.	110.	
110.	111.	95.	114.	113.	112.	112.	110.	
110.	111.	92.	114.	113.	112.	112.	109.	
109.	111.	88.	114.	114.	112.	113.	109.	
109.	111.	84.	115.	114.	112.	113.	108.	
108.	111.	81.	115.	114.	112.	113.	108.	
108.	110.	77.	115.	114.	112.	113.	108.	
108.	110.	74.	116.	115.	113.	113.	108.	
106.	110.	59.	117.	116.	113.	114.	105.	
105.	110.	46.	119.	117.	114.	114.	105.	
104.	110.	36.	121.	118.	114.	115.	104.	
104.	110.	27.	122.	120.	115.	116.	104.	
104.	111.	14.	125.	120.	115.	116.	104.	
105.	112.	7.	128.	125.	119.	120.	105.	
107.	115.	5.	131.	128.	122.	123.	107.	
109.	118.	1.	134.	131.	125.	126.	110.	
118.	121.	26.	137.	134.	128.	129.	113.	
118.	125.	26.	140.	137.	131.	133.	118.	
123.	130.	41.	143.	140.	135.	136.	123.	
129.	135.	59.	146.	144.	139.	140.	129.	
136.	140.	81.	149.	147.	144.	145.	136.	
139.	143.	93.	151.	149.	146.	147.	139.	
143.	146.	106.	152.	151.	149.	151.	143.	
147.	149.	120.	154.	153.	151.	152.	147.	
151.	153.	134.	155.	155.	154.	154.	151.	
156.	156.	157.	157.	157.	157.	157.	156.	
159.	158.	158.	158.	158.	158.	158.	158.	

EXPERIMENTAL
 MODIFIED
 REYNOLDS
 NUMBER
 7.310

RESULTS
 PARTICLE
 CONDUCTIVITY
 (W/MK)
 1.2386

GAS
 CONDUCTIVITY
 (W/MK)
 0.03300

EFFECTIVE
 CONDUCTIVITY
 (W/MK)
 1.7084

NONDIMENSIONAL
 EFFECTIVE
 CONDUCTIVITY
 51.8

TEST NUMBER CA-2-3

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNITI WILLHITE KRUPICZKA SPECCHIA SPECCHIA
 KUNITI SMITH KUNITI BALDI SICARDI SICARDI
 (1957) (1960) SMITH (1957) (1980) (1980) (1980)

THEORETICAL STATIC EFFECTIVE CONDUCTIVITY (W/MK)
 0.3192 0.2013 0.2247 0.1901 0.3844 0.3785

DATA BASED UPON CORRELATIONS PRESENTED BY THE FOLLOWING AUTHORS
 BUNNELL SCHERTZ QUINTON PLAUTZ COBERLY CAMPBELL
 IRVIN BISCHOFF STORROW JOHNSTONE MARSHALL HUNTINGTON
 OLSON (1969) (1956) (1955) (1951) (1952)

CALDERBANK
 POGORSKI
 (1957)

PHILLIPS
 LEAVITT
 YOON
 (1960)

SMITH
 (1949)

EFFECTIVE CONDUCTIVITY (W/MK)

D.1732 0.2286 0.0437

0.7861

0.6621

0.3190

0.3831

0.1883

RADIAL TEMPERATURE PROFILES (C) AT AXIAL POSITION OF 18.0975 CM

74.	74.	74.	74.	74.	74.	74.
73.	74.	74.	74.	74.	74.	74.
73.	73.	65.	75.	75.	74.	73.
72.	73.	61.	75.	75.	74.	73.
72.	73.	57.	76.	76.	74.	72.
71.	73.	53.	76.	76.	74.	72.
71.	73.	49.	77.	76.	74.	71.
70.	72.	46.	77.	77.	74.	71.
70.	72.	42.	77.	77.	74.	71.
70.	72.	38.	78.	77.	74.	70.
69.	72.	35.	78.	78.	75.	70.
68.	71.	20.	80.	80.	75.	69.
66.	71.	7.	82.	81.	76.	68.
65.	71.	-4.	84.	83.	76.	67.
65.	71.	-13.	86.	85.	77.	60.
65.	72.	-26.	89.	88.	79.	62.
66.	74.	-33.	92.	91.	81.	65.
68.	77.	-35.	96.	94.	84.	67.
72.	80.	-32.	99.	97.	88.	71.
76.	84.	-25.	102.	101.	91.	74.
81.	88.	-13.	105.	104.	95.	78.
86.	93.	3.	109.	107.	99.	83.
93.	99.	12.	112.	111.	102.	89.
101.	105.	45.	115.	114.	109.	95.
105.	108.	57.	117.	116.	112.	102.
109.	112.	71.	119.	118.	115.	106.
113.	116.	85.	120.	119.	117.	110.
118.	119.	100.	122.	121.	119.	115.
122.	123.	124.	124.	124.	124.	123.
125.	125.	125.	125.	125.	125.	125.

EXPERIMENTAL RESULTS
 MODIFIED PARTICLE
 REYNOLDS CONDUCTIVITY
 NUMBER (W/MK)
 11.685 1.1605

GAS
 CONDUCTIVITY
 (W/MK)
 0.03032

EFFECTIVE
 CONDUCTIVITY
 (W/MK)
 0.7210

NONDIMENSIONAL
 EFFECTIVE
 CONDUCTIVITY
 23.8

TEST NUMBER CA-5-1

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI	KUNITI	WILLHITE	KRUPICZKA	SPECCHIA	SPECCHIA
KUNITI	SMITH	KUNITI	(1967)	BALDI	SICARDI
(1957)	(1960)	SMITH		SICARDI	(1980)
		(1962)		(1980)	

THEORETICAL STATIC EFFECTIVE CONDUCTIVITY (W/MK)

DATA BASED UPON CORRELATIONS PRESENTED BY THE FOLLOWING AUTHORS

BUNNELL	SCHERTZ	QUINTON	PLAUTZ	COBERLY	CAMPBELL
IRVIN	BISCHOFF	STORROW	JOHNSTONE	MARSHALL	HUNTINGTON
OLSON	(1969)	(1956)	(1955)	(1951)	(1952)
SMITH					
(1949)					

CALDERBANK
POGORSKI
(1957)

PHILLIPS
LEAVITT
YOUNG
(1960)

EFFECTIVE CONDUCTIVITY (W/MK)

0.1966	0.2694	0.0421	0.7674	0.4094	0.3836	0.3594	0.1743
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RADIAL TEMPERATURE PROFILES (C) AT		AXIAL POSITION OF		18.0975	CM		
166.	166.	166.	166.	166.	166.	166.	166.
166.	166.	166.	166.	166.	166.	166.	166.
166.	167.	161.	167.	167.	167.	167.	166.
166.	167.	158.	168.	168.	167.	167.	166.
166.	167.	156.	168.	168.	168.	168.	166.
166.	167.	154.	169.	168.	168.	168.	166.
166.	168.	151.	169.	169.	168.	168.	166.
167.	168.	149.	170.	169.	169.	169.	166.
167.	168.	147.	171.	169.	169.	169.	166.
167.	168.	145.	171.	170.	170.	169.	166.
167.	169.	143.	172.	170.	170.	170.	166.
167.	170.	134.	174.	172.	172.	172.	166.
168.	171.	127.	177.	174.	174.	173.	167.
169.	173.	121.	179.	176.	175.	175.	167.
170.	175.	116.	181.	178.	177.	177.	168.
172.	177.	109.	185.	181.	181.	180.	170.
175.	180.	106.	189.	185.	184.	183.	173.
178.	183.	106.	193.	188.	188.	187.	176.
181.	187.	110.	195.	192.	191.	190.	179.
185.	190.	116.	199.	195.	195.	194.	183.
190.	194.	125.	203.	199.	198.	198.	187.
194.	198.	136.	206.	202.	202.	201.	192.
199.	203.	150.	209.	206.	206.	205.	197.
204.	207.	167.	212.	210.	210.	209.	203.
207.	210.	175.	214.	212.	212.	211.	206.
210.	212.	184.	215.	214.	214.	213.	209.
213.	215.	194.	217.	216.	216.	215.	212.
216.	217.	204.	219.	218.	218.	218.	216.
219.	220.	215.	220.	220.	220.	220.	219.
221.	221.	221.	221.	221.	221.	221.	221.

EXPERIMENTAL RESULTS

MODIFIED PARTICLE
REYNOLDS CONDUCTIVITY
NUMBER (W/MK)
3.300 1.3805

GAS
CONDUCTIVITY
(W/MK)
0.03780

EFFECTIVE
CONDUCTIVITY
(W/MK) *

NONDIMENSIONAL
EFFECTIVE
CONDUCTIVITY *

TEST NUMBER CA-3-2									
EXPERIMENTAL VARIABLES									
INNER VELOCITY (CM/S)	OUTER VELOCITY (CM/S)	POWER (W)	PARTICLE SIZE RANGE (MICRONS)	AXIAL HEIGHT (CM)	GAS DENSITY (G/CM ³)	GAS VISCOSITY (G/CM-SEC)	SPECIFIC HEAT (CAL/GK)	VOID FRACTION	REYNOLDS NUMBER
100.0	108.0	108.0	590-840	0.2921	0.0012005	0.0002352	1.0161	0.385	3570.9
EXPERIMENTAL DATA									
INSIDE DIAMETER (CM)	OUTSIDE DIAMETER (CM)	AXIAL HEIGHT (CM)	GAS DENSITY (G/CM ³)	SHROUD					
0.019	0.019	0.2921	0.0012005	34.3					
TEMPERATURE PROFILES (C)									
INNER	OUTER	AXIAL	TEMPERATURE	PROFILES (C)					
27	27	27	27	27					
STATIONARY PROBE POSITION FROM INNER WALL (CM)									
0.15875	0.635	1.27	1.5675	1.86					
POSITION	AXIAL POSITION	WALL POSITION	INNER WALL	INNER WALL					
0.08	0.08	0.08	0.08	0.08					
18.10	114.3	129.7	173.5	181.1					
11.11	62.0	96.9	106.9	117.8					
4.13	53.0	59.9	67.8	75.8					
WALL TEMPERATURE PROFILES (C)									
AXIAL POSITION	OUTER WALL POSITION	INNER WALL POSITION	INNER WALL POSITION	INNER WALL POSITION					
0.08	0.08	0.08	0.08	0.08					
18.10	114.3	129.7	173.5	181.1					
11.11	62.0	96.9	106.9	117.8					
4.13	53.0	59.9	67.8	75.8					
MOVEABLE PROBE TEMPERATURE PROFILES (C)									
AXIAL POSITION	OUTER WALL POSITION	INNER WALL POSITION	INNER WALL POSITION	INNER WALL POSITION					
0.08	0.08	0.08	0.08	0.08					
18.10	114.3	129.7	173.5	181.1					
11.11	62.0	96.9	106.9	117.8					
4.13	53.0	59.9	67.8	75.8					

TEST NUMBER CA-5-2

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS

YAGI	KUNITI	WILLHITE	KRUPICZKA	SPECCHIA	SPECCHIA
KUNITI	SMITH	KUNITI	(1957)	BALDI	SICARDI
(1957)	(1960)	(1962)		(1980)	(1980)

THEORETICAL STATIC EFFECTIVE CONDUCTIVITY (W/MK)

0.3450	0.2181	0.2430	0.2056	0.4165	0.4100
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DATA BASED UPON CORRELATIONS PRESENTED BY THE FOLLOWING AUTHORS

BUNNELL	SCHERTZ	QUINTON	PLAUTZ	COBERLY	CAMPBELL	CALDERBANK	PHILLIPS
IRVIN	BISCHOFF	STORROW	JOHNSTONE	MARSHALL	HUNTINGTON	POGORSKI	LEAVITT
OLSON	(1969)	(1956)	(1955)	(1951)	(1952)	(1957)	YOON
SMITH							(1960)
(1949)							

EFFECTIVE CONDUCTIVITY (W/MK)

0.1801	0.2411	0.0429	0.7763	0.5299	0.3415	0.3707	0.1807
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RADIAL TEMPERATURE PROFILES (C) AT AXIAL POSITION OF 18.0975 CM

109.	109.	109.	109.	109.	109.	109.	109.
109.	109.	109.	109.	109.	109.	109.	109.
108.	109.	101.	110.	110.	109.	109.	108.
108.	109.	97.	110.	110.	109.	110.	108.
108.	109.	93.	111.	110.	110.	110.	108.
107.	109.	90.	111.	111.	110.	110.	107.
107.	109.	86.	112.	111.	110.	110.	107.
107.	108.	83.	112.	111.	110.	110.	107.
106.	108.	81.	113.	112.	110.	111.	106.
106.	108.	77.	113.	112.	110.	111.	106.
106.	108.	7.	114.	112.	111.	111.	106.
103.	108.	59.	116.	114.	111.	112.	105.
104.	109.	48.	118.	116.	112.	113.	104.
104.	109.	38.	120.	117.	113.	114.	104.
104.	109.	29.	121.	119.	115.	116.	104.
104.	11.	15.	125.	122.	117.	118.	104.
106.	113.	11.	128.	125.	120.	121.	106.
108.	116.	10.	132.	128.	123.	124.	108.
111.	123.	21.	138.	132.	126.	127.	112.
115.	123.	21.	138.	132.	126.	127.	112.
120.	127.	32.	142.	139.	133.	134.	120.
126.	132.	46.	145.	142.	137.	139.	126.
136.	137.	64.	148.	146.	142.	143.	132.
139.	143.	81.	151.	150.	147.	149.	139.
142.	146.	98.	153.	152.	149.	150.	142.
146.	149.	110.	155.	154.	152.	152.	146.
150.	152.	124.	157.	156.	154.	154.	150.
158.	156.	136.	160.	158.	157.	158.	158.
159.	159.	153.	160.	160.	160.	160.	159.
161.	161.	161.	161.	161.	161.	161.	161.

EXPERIMENTAL	RESULTS	GAS	EFFECTIVE	NONDIMENSIONAL
MODIFIED	PARTICLE	CONDUCTIVITY	CONDUCTIVITY	EFFECTIVE
REYNOLDS	CONDUCTIVITY	(W/MK)	(W/MK)	CONDUCTIVITY
NUMBER	(W/MK)			
7.298	1.2408	0.03307	4.6302	*

TEST NUMBER CA-5-3

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNIT WILLHITE KRUPICZKA SPECCHIA SPECCHIA
 KUNIT SMITH KUNIT (1967) BALDI SICARDI (1980)
 (1957) (1960) (1962) (1980)

THEORETICAL STATIC EFFECTIVE CONDUCTIVITY (W/MK)
 0.3186 0.2008 0.2242 0.1897 0.3837 0.3778
 DATA BASED UPON CORRELATIONS PRESENTED BY THE FOLLOWING AUTHORS
 BUNNELL SCHERTZ QUINTON PLAUTZ COBERLY CAMPBELL
 IRVIN BISCHOFF STORROW JOHNSTONE MARSHALL HUNTINGTON
 OLSON (1969) (1956) (1955) (1951) (1952)
 SMITH (1949)

CALDERBANK
 POGORSKI
 (1957)

PHILLIPS
 LEAVITT
 YOON
 (1960)

EFFECTIVE CONDUCTIVITY (W/MK)		EFFECTIVE CONDUCTIVITY (W/MK)		EFFECTIVE CONDUCTIVITY (W/MK)		EFFECTIVE CONDUCTIVITY (W/MK)	
0.1729	0.2261	0.0437	0.7851	0.6626	0.3184	0.3832	0.1883
RADIAL TEMPERATURE PROFILES (C) AT AXIAL POSITION OF 18.0975 CM							
67.	67.	67.	67.	67.	67.	67.	67.
66.	67.	63.	67.	67.	67.	67.	67.
66.	67.	59.	68.	68.	67.	67.	66.
66.	66.	55.	68.	68.	67.	68.	66.
65.	66.	51.	69.	69.	67.	68.	65.
65.	66.	47.	69.	69.	67.	68.	65.
64.	66.	43.	70.	70.	68.	68.	65.
64.	66.	40.	70.	70.	68.	68.	65.
64.	66.	36.	71.	70.	68.	69.	64.
63.	66.	33.	71.	71.	68.	69.	64.
63.	66.	30.	72.	71.	68.	69.	64.
61.	65.	15.	74.	73.	69.	70.	63.
60.	65.	3.	76.	75.	69.	71.	62.
60.	65.	-8.	78.	77.	70.	72.	62.
59.	65.	-17.	79.	78.	71.	74.	62.
60.	67.	-29.	83.	82.	73.	76.	62.
61.	69.	-35.	87.	85.	76.	79.	64.
63.	71.	-37.	90.	89.	79.	82.	66.
67.	75.	-34.	93.	92.	82.	85.	70.
71.	79.	-26.	97.	96.	89.	88.	74.
75.	83.	-15.	100.	99.	90.	93.	78.
82.	88.	0.	103.	102.	94.	97.	84.
88.	94.	19.	107.	106.	99.	101.	90.
95.	100.	42.	110.	109.	104.	106.	97.
100.	103.	64.	112.	111.	107.	108.	101.
104.	107.	67.	114.	113.	110.	111.	105.
108.	110.	81.	115.	115.	112.	113.	109.
113.	114.	96.	117.	117.	115.	116.	113.
117.	118.	112.	119.	119.	118.	119.	118.
120.	120.	120.	120.	120.	120.	120.	120.

EXPERIMENTAL RESULTS
 MODIFIED PARTICLE
 REYNOLDS CONDUCTIVITY
 NUMBER
 11.704 1.1587

GAS
 CONDUCTIVITY
 (W/MK)
 0.03026

EFFECTIVE
 CONDUCTIVITY
 (W/MK) *

NONDIMENSIONAL
 EFFECTIVE
 CONDUCTIVITY *

TEST NUMBER CB-2-2									
EXPERIMENTAL VARIABLES									
INNER VELOCITY (CM/S)	POWER (W)	PARTICLE SIZE RANGE (MICRONS)	GAS DENSITY (G/CM ³)		GAS VISCOSITY (G/CM ²)		SPECIFIC HEAT (W/GK)		REYNOLDS NUMBER
160.		590-840	0.0012005		0.0002624		1.0276		1354.7
OUTER VARIABLES									
INNER VELOCITY (CM/S)	AXIAL HEIGHT (CM)	AXIAL DIAMETER (CM)	GAS DENSITY (G/CM ³)		GAS VISCOSITY (G/CM ²)		VOID FRACTION		
160.	0.2921	0.0012005	0.0012005		0.0002624		0.385		
TEMPERATURE PROFILES (C)									
INNER INLET	INNER EXIT	OUTER INLET	OUTER EXIT	AMBIENT	SHROUD				
22.1	22.1	22.1	22.1	26.5	40.6				
STATIONARY PROBE POSITION (CM)									
INNER	OUTER	AXIAL POSITION (CM)	WALL POSITION (CM)	AXIAL POSITION (CM)	WALL POSITION (CM)				
25.08	244.1	272.3	274.8	1.5875	1.5875				
18.10	139.8	156.2	167.3						
4.13	182.6	91.9	101.9						
WALL TEMPERATURE PROFILES (C)									
INNER	OUTER	AXIAL POSITION (CM)	WALL POSITION (CM)	AXIAL POSITION (CM)	WALL POSITION (CM)				
329.2	329.2	3	3	28.08	182.2				
220.6	220.6	157.9	157.9	4.13	78.4				
NONDIMENSIONAL PROBE TEMPERATURE PROFILES									
RADIAL POSITION (CM)	AXIAL POSITION (CM)	AXIAL POSITION (CM)	AXIAL POSITION (CM)	AXIAL POSITION (CM)	AXIAL POSITION (CM)				
0.013	0.013	0.013	0.013	0.013	0.013				
0.025	0.025	0.025	0.025	0.025	0.025				
0.038	0.038	0.038	0.038	0.038	0.038				
0.061	0.061	0.061	0.061	0.061	0.061				
0.073	0.073	0.073	0.073	0.073	0.073				
0.089	0.089	0.089	0.089	0.089	0.089				
0.102	0.102	0.102	0.102	0.102	0.102				
0.124	0.124	0.124	0.124	0.124	0.124				
0.131	0.131	0.131	0.131	0.131	0.131				
0.2518	0.2518	0.2518	0.2518	0.2518	0.2518				
0.318	0.318	0.318	0.318	0.318	0.318				
0.625	0.625	0.625	0.625	0.625	0.625				
0.889	0.889	0.889	0.889	0.889	0.889				
1.016	1.016	1.016	1.016	1.016	1.016				
1.270	1.270	1.270	1.270	1.270	1.270				
1.397	1.397	1.397	1.397	1.397	1.397				
1.589	1.589	1.589	1.589	1.589	1.589				
1.715	1.715	1.715	1.715	1.715	1.715				
1.778	1.778	1.778	1.778	1.778	1.778				
1.875	1.875	1.875	1.875	1.875	1.875				

TEST NUMBER CB-2-3

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNITA WILLHITE KRUPICZKA SPECCHIA SPECCHIA
 KUNITA SMITH KUNITA (1967) BALDI SICARDI
 (1957) (1960) SMITH (1962) SICARDI (1960)

THEORETICAL STATIC EFFECTIVE CONDUCTIVITY (W/MK)
 0.3562 0.2254 0.2509 0.2123 0.4303 0.4237

DATA BASED UPON CORRELATIONS PRESENTED BY THE FOLLOWING AUTHORS
 BUNNELL SCHERTZ QUINTON PLAUTZ COBERLY CAMPBELL
 IRVIN BISCHOFF STORROW JOHNSTONE MARSHALL HUNTINGTON
 OLSON (1969) (1956) (1955) (1951) (1952)

CALDERBANK
 POGORSKI
 (1957)

PHILLIPS
 LEAVITT
 YOUNG
 (1960)

SMITH
 (1949)

EFFECTIVE CONDUCTIVITY (W/MK)

0.1236 0.2543 0.0435 0.7838 0.6312 0.3589 0.3802 0.1911

RADIAL TEMPERATURE PROFILES (C) AT AXIAL POSITION OF 18.0975 CM							
109.	109.	109.	109.	109.	109.	109.	109.
108.	109.	101.	110.	109.	109.	109.	108.
107.	108.	94.	110.	110.	109.	109.	107.
106.	108.	86.	111.	110.	109.	109.	106.
106.	107.	78.	111.	111.	109.	109.	105.
105.	107.	72.	112.	111.	109.	109.	105.
104.	107.	65.	113.	112.	109.	110.	104.
103.	106.	59.	113.	112.	109.	110.	103.
103.	106.	53.	114.	115.	109.	110.	103.
102.	106.	46.	114.	113.	109.	110.	102.
101.	106.	41.	115.	114.	110.	110.	101.
99.	105.	34.	117.	116.	110.	111.	99.
97.	104.	27.	120.	118.	111.	112.	97.
95.	104.	20.	123.	120.	112.	113.	95.
95.	104.	14.	125.	123.	113.	114.	94.
94.	106.	8.	130.	127.	116.	117.	94.
96.	108.	2.	132.	132.	120.	121.	95.
99.	112.	-5.	139.	136.	124.	125.	98.
104.	117.	-81.	144.	141.	129.	130.	103.
110.	122.	-69.	149.	146.	134.	135.	109.
118.	129.	-49.	154.	151.	140.	141.	117.
126.	137.	-29.	159.	156.	146.	148.	126.
136.	145.	9.	164.	161.	153.	155.	136.
148.	155.	48.	170.	168.	161.	162.	147.
154.	160.	70.	172.	171.	165.	166.	154.
160.	165.	93.	175.	174.	169.	170.	160.
167.	170.	117.	178.	177.	174.	174.	167.
174.	176.	143.	181.	180.	178.	178.	174.
181.	182.	170.	183.	183.	183.	183.	181.
185.	185.	185.	185.	185.	185.	185.	185.

EXPERIMENTAL
 MODIFIED
 REYNOLDS
 NUMBER
 10.660

RESULTS
 PARTICLE
 CONDUCTIVITY
 (W/MK)
 1.2757

GAS
 CONDUCTIVITY
 (W/MK)
 0.03426

EFFECTIVE
 CONDUCTIVITY
 (W/MK)
 0.6407

NONDIMENSIONAL
 EFFECTIVE
 CONDUCTIVITY
 18.7

TEST NUMBER CB-5-2

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA SPECCHIA
 KUNII SMITH KUNII (1967) BALDI SICARDI
 (1957) (1960) (1962) (1980) (1980)

THEORETICAL STATIC EFFECTIVE CONDUCTIVITY (W/MK)
 0.3797 0.2407 0.2675 0.2285 0.4594 0.4523
 DATA BASED UPON CORRELATIONS PRESENTED BY THE FOLLOWING AUTHORS
 BUNNELL SCHERTZ QUINTON FAULTZ COBERLY CARP BELL
 IRVIN BISCHOFF STORROW JOHNSTONE MARSHALL HUNT NGTON
 OLSON (1969) (1956) (1955) (1951) (1952)
 SMITH (1949)

CALDERBANK
 POGORSKI (1957)
 PHILLIPS
 LEAVITT
 YOON (1960)

EFFECTIVE CONDUCTIVITY (W/MK)		RADIAL TEMPERATURE PROFILES (C) AT AXIAL POSITION OF 18.0975 CM			
0.1989	0.2570	0.0428	0.7750	0.5131	0.3786
143.	143.	143.	143.	143.	143.
143.	143.	137.	144.	144.	143.
142.	143.	131.	144.	144.	142.
142.	143.	126.	145.	145.	144.
142.	143.	121.	146.	145.	144.
141.	143.	115.	147.	146.	144.
141.	143.	110.	147.	146.	143.
141.	143.	105.	148.	147.	143.
140.	143.	101.	149.	147.	143.
140.	143.	96.	149.	148.	143.
140.	143.	92.	150.	149.	146.
139.	144.	72.	153.	148.	146.
139.	145.	54.	156.	153.	149.
139.	146.	40.	159.	155.	151.
139.	147.	28.	162.	158.	153.
141.	150.	11.	167.	162.	157.
143.	153.	3.	172.	167.	161.
147.	157.	1.	177.	172.	166.
152.	162.	5.	182.	176.	171.
156.	166.	16.	187.	181.	176.
164.	174.	32.	191.	187.	182.
172.	180.	53.	196.	192.	187.
181.	188.	80.	201.	197.	193.
195.	195.	111.	206.	203.	200.
200.	200.	129.	209.	206.	203.
205.	204.	146.	211.	209.	207.
211.	208.	166.	212.	212.	210.
217.	213.	187.	216.	215.	214.
220.	218.	208.	219.	218.	218.
	220.	220.	220.	220.	220.

EXPERIMENTAL RESULTS	GAS	EFFECTIVE	NONDIMENSIONAL
MODIFIED REYNOLDS NUMBER	CONDUCTIVITY (W/MK)	CONDUCTIVITY (W/MK)	EFFECTIVE CONDUCTIVITY
6.741	0.03676	0.7777	21.2

TEST NUMBER CB-5-3

DATA BASED UPON THEORIES PRESENTED BY THE FOLLOWING AUTHORS
 YAGI KUNII WILLHITE KRUPICZKA SPECCHIA SPECCHIA
 KUNII SMITH KUNII BALDI SICARDI
 (1957) (1960) (1967) (1980) (1980)

THEORETICAL STATIC EFFECTIVE CONDUCTIVITY (W/MK)
 0.3505 0.2217 0.2469 0.2089 0.4232 0.4167
 DATA BASED UPON CORRELATIONS PRESENTED BY THE FOLLOWING AUTHORS
 BUNNELL SCHERTZ QUINTON PLAUTZ COBERLY CAMPBELL
 IRVIN BISCHOFF STORROW JOHNSTONE MARSHALL HUNTINGTON
 OLSON (1969) (1956) (1955) (1951) (1952)
 SMITH (1949)

EFFECTIVE CONDUCTIVITY (W/MK)	0.1904	0.2500	0.0436	0.7841	0.6356	0.3527	0.3806	0.1907
RADIAL TEMPERATURE PROFILES (C) AT AXIAL POSITION OF 18.0975 CM	110.	110.	110.	110.	110.	110.	110.	110.
109.	110.	103.	111.	110.	110.	110.	110.	109.
108.	109.	98.	111.	111.	110.	110.	110.	108.
108.	109.	89.	112.	111.	110.	110.	110.	108.
107.	109.	83.	112.	112.	110.	111.	111.	107.
106.	108.	77.	113.	112.	110.	111.	111.	106.
106.	108.	71.	114.	113.	110.	111.	111.	106.
105.	108.	65.	114.	113.	111.	111.	111.	105.
104.	108.	59.	115.	114.	111.	111.	111.	104.
104.	107.	53.	115.	114.	111.	111.	111.	104.
103.	107.	48.	116.	115.	111.	111.	111.	103.
101.	106.	24.	118.	117.	112.	112.	112.	101.
99.	106.	3.	121.	119.	112.	114.	114.	99.
98.	106.	-15.	123.	122.	113.	115.	115.	98.
97.	106.	-29.	126.	124.	115.	116.	116.	97.
97.	108.	-50.	131.	128.	118.	119.	119.	97.
99.	110.	-85.	135.	133.	121.	123.	123.	99.
102.	114.	-85.	140.	137.	125.	127.	127.	102.
107.	119.	-61.	144.	142.	130.	132.	132.	107.
113.	124.	-50.	149.	146.	135.	137.	137.	113.
120.	130.	-32.	154.	151.	140.	142.	142.	120.
128.	148.	-8.	159.	156.	147.	148.	148.	128.
138.	148.	22.	163.	160.	153.	155.	155.	138.
148.	155.	58.	168.	167.	161.	162.	162.	148.
154.	159.	77.	171.	170.	164.	165.	165.	154.
160.	164.	99.	174.	173.	168.	169.	169.	160.
165.	169.	123.	176.	175.	172.	173.	173.	165.
173.	179.	145.	179.	178.	173.	174.	174.	173.
179.	180.	170.	182.	181.	181.	181.	181.	179.
183.	183.	183.	183.	183.	183.	183.	183.	183.

EXPERIMENTAL MODIFIED REYNOLDS NUMBER	RESULTS PARTICLE CONDUCTIVITY (W/MK)	GAS CONDUCTIVITY (W/MK)	EFFECTIVE CONDUCTIVITY (W/MK)	NONDIMENSIONAL EFFECTIVE CONDUCTIVITY
10.805	1.2578	0.03365	1.0895	32.4