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**Revised Data Book for Evaluation of  
Combustion and Gasification Models**

**Final Report, Volume 3**

**K.R. Christensen  
M.W. Rasband  
L.D. Smoot**

October 1987

Work Performed Under Contract No.: DE-AC21-85MC22059

For  
U.S. Department of Energy  
Office of Fossil Energy  
Morgantown Energy Technology Center  
Morgantown, West Virginia

By  
Combustion Laboratory  
Chemical Engineering Department  
Brigham Young University  
Provo, Utah

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By  
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Chemical Engineering Department  
Brigham Young University  
Provo, Utah 84602

October 1987

## ABSTRACT

During the previous contract (DE-AC21-81MC16518) a major task was to identify, collect and publish detailed experimental data for evaluation of comprehensive gasification/combustion codes. A review of the literature was completed and prospective data were identified for inclusion in this data book in five categories of increasing complexity: 1) non-reacting, gaseous flows (58 cases); 2) non-reacting, particle-laden flows (43 cases); 3) gaseous combustion (34 cases); 4) pulverized coal combustion (57 cases); 5) entrained coal gasification (6 cases). Selection of these data was based on a set of criteria which included data completeness, availability of detailed, digital profiles for several properties (e.g., species concentrations, velocity, temperature) and data accuracy. From these 198 cases, which were referenced in the final report (Vol. III), the data base was reduced to a total of 35 sets of data from 8 laboratories, with at least 3 cases in each category above. For these 35 cases, the measured data, together with geometrical dimensions and test conditions were documented in a uniform tabular format. These data were also stored on a magnetic tape for distribution.

During this follow-on contract (DE-AC21-85MC22059), the accuracy of the data was checked and several additional corrections were made. The format for reporting the data (Appendix B) was simplified. Also, a review of additional data sets available from the Combustion Laboratory and other sources was completed. These included gasification profiles for four coal types at high pressure and with various injectors, and coal-water mixture profiles for high-rank and low-rank coals. From these additional data sets, two were added to the data book: One for gasification of Utah bituminous coal and high pressure and one for combustion of high-rank coal-water mixtures. Also recently reported data from Imperial College were received and an additional case was added to the data book. In all, 213 cases from 52 investigators at 18 laboratories were considered and 37 cases are included in this data book from 22 different investigations at 8 independent laboratories.



## FOREWORD

This report (Volume III) is the "Revised Data Book" which includes the several sets of data which were used to validate the two-dimensional code. Volume I of this three volume series of final reports provides a summary of technical accomplishments made during this twenty-six month study conducted for the Morgantown Energy Technology Center (METC) of the United States Department of Energy (DOE) under Contract No. DE-AC21-85MC22059. Volume II is a revised user's manual for the two-dimensional code (PCGC-2). The work period was from March 1, 1985 to April 30, 1987. Work was accomplished under the direction of Dr. L. Douglas Smoot, project director, Dr. Paul O. Hedman, principal investigator, and Drs. Angus U. Blackham and Philip J. Smith, senior investigators. Mr. Gary Friggens was the DOE technical project officer until the summer of 1986 when Mr. Leland E. Paulson became the technical project officer for DOE.

Graduate and undergraduate students who have contributed to the progress reported herein include Larry Baxter, Kevin Boyack, Blaine Brown, Bret Butler, Richard Cope, Jeffrey Lindsay, Kenneth Nichols, Michael Smith, and William Sowa. Michael R. King, Lynda Richmond, Marlyn Kyle, Shane Olsen, and Linda Ward have provided technician, typing, and drafting services. The National Science Foundation is also acknowledged for supporting a research assistant through a Graduate Fellowship.

## PREFACE

The data published in this data book were selected after careful consideration of many sets of data. In many instances, tabulated data were not yet available. For data taken from figures, extreme care was employed to ensure data accuracy. A computer tape containing tabulated data for the data cases in this data book is available upon request.

Errors in the data are discussed in this document. Neither Brigham Young University nor the U.S. Department of Energy claim responsibility for the accuracy of the data contained herein.

## DISCLAIMER

We were required to extract much of the enclosed data manually from literature sources. While reasonable care has been exerted, it is not likely that all of the data cases are free of error. We have continued to identify and correct such errors as we have made use of these data. We recommend that users of the data spot-check for general consistency against original sources, and more thoroughly compare to original sources where inconsistencies may appear to exist. We also invite users to forward confirmed errors to us in writing.

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## I. INTRODUCTION

### A. BACKGROUND

Since the shortages of the mid-70's, coal has been making a steadily increasing contribution to the world's energy needs. Today, the uses of coal include power generation, production of industrial heat and steam, and conversion to various gas and liquid products. Research on coal gasification, combustion and related fields has also increased dramatically in the last ten years. This interest is expected to be maintained, if not increased, through the next decade.

One aspect of coal-related research is the development, evaluation, and implementation of coal combustion and gasification computer models. With the recent increases in the capabilities of digital computers, solutions to complex problems (such as turbulent flows, multi-phase fluid mechanics, and coal reaction kinetics) are now possible. Models for pulverized coal reactors are still in the developmental stages (1). However, computer models have the potential to become valuable aids in optimizing and designing coal reactors. Also, our understanding of the controlling combustion and gasification processes can be increased through application of computer models. Before a model can be used with confidence, however, it must be evaluated through comparison with detailed data, as well as by other methods.

### B. OBJECTIVES

The purpose of this revised data book is to provide a single reference containing detailed experimental data for use in model evaluations. This book is not meant to be an exhaustive review of all data relating to coal combustion and gasification. Rather, it is a collection of selected data sets in each of several categories relating to coal combustion and gasification. An effort has been made to provide all of the information for each data set required to evaluate predictive models. Each data set included provides complete measurements of such properties as velocity, temperature, gas and solid concentrations, together with inlet conditions and geometrical specifications. An effort has been made to select data from several different laboratories. Extensive use of these data sets has been made by the BYU Combustion Laboratory in evaluating a generalized coal combustion and gasification code (PCGC-2). Use of the data by other investigators is also made possible through this publication.

### C. APPROACH

This document is a revised data book, based on an earlier data book publication (2). Various types of data that relate to coal gasification and combustion research were identified. Criteria were then established for data selection. Potential data sets were identified for possible inclusion in each data category. From the available data sets, selections were made according to the predetermined criteria. The selected data were then organized into tables in a uniform format and stored on magnetic computer tapes for distribution and application. The first data book (2) was reviewed in detail and errors were corrected. The format for data presentation was also evaluated. Twelve sets of new profiles obtained at this laboratory were reviewed and two

(one for high pressure gasification and one for combustion of a high rank coal-water slurry were added to the revised data book. Also, one subbituminous coal combustion profile from Imperial College was added.

## II. DATA CLASSIFICATION

### A. CATEGORY IDENTIFICATION

The data included in this book were selected because of their direct applicability to pulverized coal combustion and gasification modeling. The data were chosen for six categories of increasing complexity as shown in Figure 1, allowing independent analysis of different model components (eg. gas fluid mechanics, coal reaction processes).

The least complex category chosen is gaseous, non-reacting flow. This allows evaluation of the turbulent gas-phase fluid mechanics predictions. Next in complexity is the non-reacting, particle-laden, flow category, which provides a basis for evaluation of the turbulent dispersion of particles in the absence of chemical reactions. The third category gaseous combustion, adds complexities encountered with turbulent chemical reaction of gaseous species interacting with the gaseous fluid mechanics. Finally, the three most complex categories, coal combustion, coal gasification, and slurry combustion combine each of the previous categories with pulverized coal reactions.

Data on combustion of less complex liquid sprays may provide a useful addition for evaluation of codes developed for slurries. Such data would include problems concerned with liquid atomization and combustion. However, liquid fuel combustion data have not been included in this data book.

Recently, most of the emphasis in coal combustion has been in swirling flows. The use of swirling flow helps in stabilizing the flame and leads to higher coal burnout. For computer models, treatment of swirling flows adds another step in complexity. Data for both swirling and non-swirling flows in all categories except gasification have been included. Sloan, et al. (3) provided an extensive comparison and interpretation of measurements and model predictions for swirling flows.

Another important aspect of coal combustion and gasification is the formation of nitrogen and sulfur pollutants. Many codes currently under development, including the BYU Combustion Laboratory code (PCGC-2), contain subroutines for pollutant predictions (4). Pollutant concentration data are included for evaluation of those codes.

### B. SELECTION CRITERIA

The criteria that have been chosen for selecting data for code evaluation have been divided into two groups. The first group of criteria is concerned with the required and desired characteristics of each individual data set. The second group of criteria deals with the requirements necessary to sufficiently complete each category. Table 1 summarizes the selection criteria.

#### 1. Data Sets

Two firm requirements have been established for all data sets selected. First, each set must correspond to essentially axisymmetric, two-dimensional geometry. Second, the data must provide complete profile maps for selected

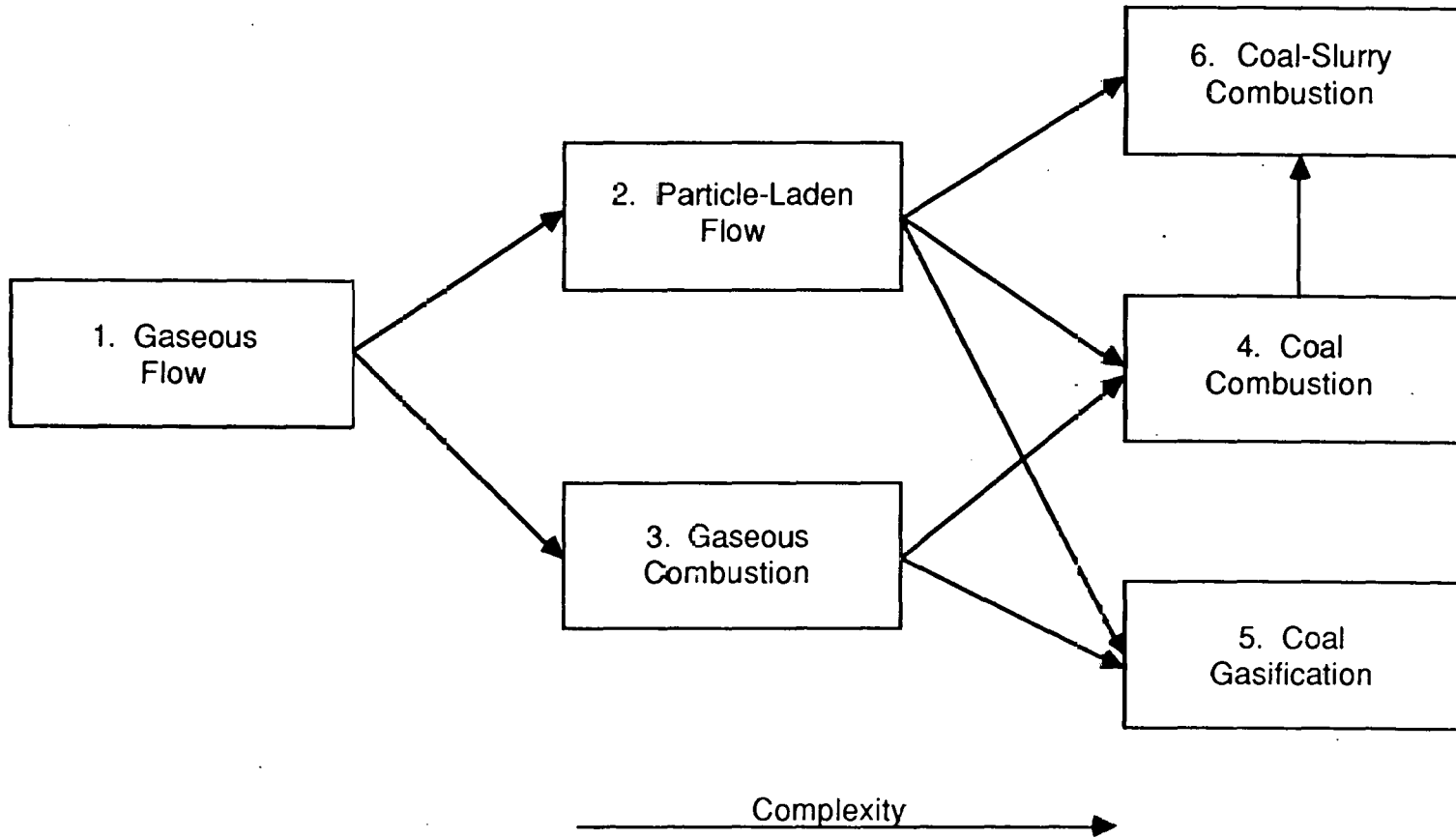


Figure 1. Relationships among the categories selected for combustion model evaluation.

TABLE 1

SELECTION CRITERIA

- I. Data Sets
  - A. Required
    - 1. Axial Axisymmetric Geometry
    - 2. Detailed Profile Data or Systematic Data\*
  - B. Desired
    - 1. Initial and Boundary Conditions
    - 2. Several Measured Variables
    - 3. Data Completeness
    - 4. Data Accuracy
    - 5. Tabular Form
  
- II. Data Categories
  - A. Various Facilities
  - B. Various Test Conditions
  - C. Multi-Category Studies
  - D. 4-5 Sets for each Category

\*Data where a key variable such as swirl number is systematically varied.



properties throughout the chamber. Several additional data characteristics have also been identified which are desirable. First, detailed initial and boundary conditions were sought, including initial turbulence conditions. Second, for a given test, measurements of several properties (eg. temperature, species concentrations, and char elemental composition) were desired. Finally, the most complete and accurate data available were sought. Data consistency, material balances, use by other investigators and reproducibility were among the criteria used in estimating accuracy.

A preference was also be given to those data sets in which the data were available in tabular form from the original investigator. This helps to insure that the data presented are consistent with the original measurements. It has been necessary to use some data which were only available in graphical form. In these cases care was taken to provide accurate extraction and interpolation.

## 2. Categories

For each data category, an attempt was made to identify four or five sets of data. Data sets were selected from different investigators and different facilities where possible. A range of test parameter values was sought in each category. Data sets that have been frequently used in the past for code evaluation were of particular interest. Also, data sets that are a part of a multi-category study were thought to be particularly useful. From these guidelines, a total of 35-45 different data sets among all five categories (for both swirling non-swirling flow) were sought. Such a data base was thought to be sufficient for comprehensive evaluation of a computer model.

### III. MEASUREMENT TECHNIQUES

Many techniques are available for use in combustion diagnostics. They can vary widely in complexity and accuracy. A brief description of some of the more popular techniques follows. Measurements in Flames (5) and Progress in Astronautics and Aeronautics (6,7) provide a more comprehensive review of experimental diagnostics for combusting systems.

#### A. INTRUSIVE PROBES

Historically, the most common technique used for making local composition, temperature, velocity, and turbulence measurements in combusting flows has been with intrusive probes (8). Probes have been used, and will continue to be used, because of their simplicity and relatively low cost. However, probes have some inherent disadvantages which must also be considered.

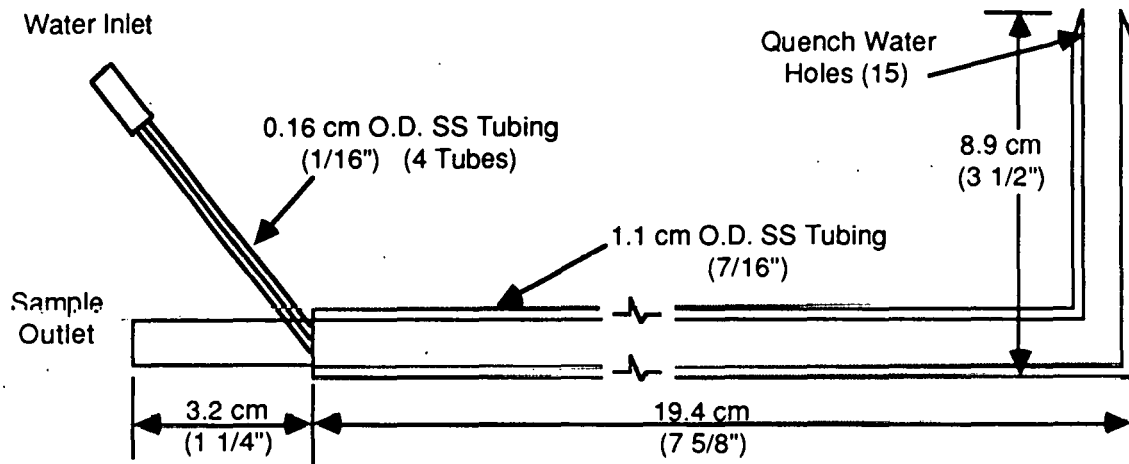
##### 1. Sampling with Probes

Isokinetic probes are commonly used for withdrawing samples from inside the reactor. Figure 2 illustrates an example of a water-quenched, isokinetic probe (9). This type of probe allows the direct quenching of the combustion products by water injected through small holes near the tip. Other types of quenching commonly used are sonic expansion and conductive cooling. A vacuum pump is attached at the end of the sampling system to help draw the combusting flow into the probe. The most important procedure in isokinetic probe sampling is to balance the pressure inside the probe with the local reactor pressure. The gas, liquid, and solid phases are separated external to the probe, as shown schematically in Figure 3 (10). The solid sample is filtered from the liquid, dried, and prepared for elemental analysis. The gas sample is analyzed through the use of gas chromatographs, chemiluminescent  $\text{NO}_x$  analyzers, infra-red  $\text{CO}_x$  analyzers, paramagnetic  $\text{O}_2$  analyzers, and other similar instruments.

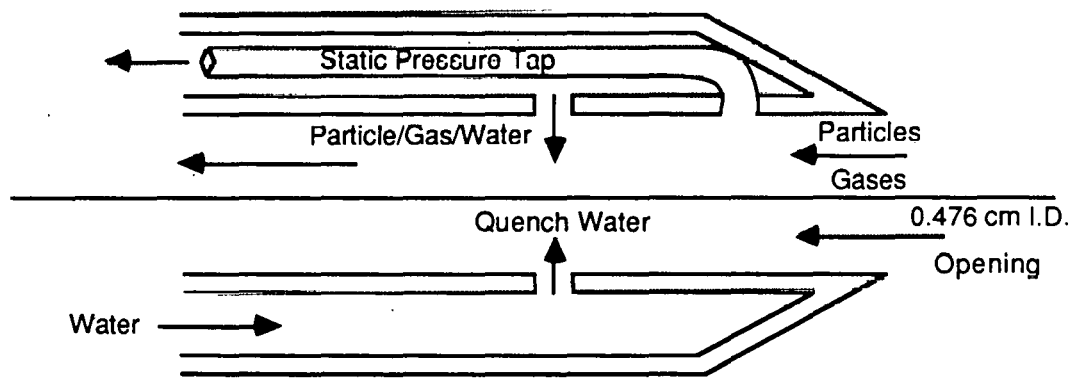
##### 2. Temperature Measurement

Several methods are available for measuring temperature (e.g., 11,12). Principal concerns for temperature measurements are the conductive and radiative heat losses from the probe to the cooler walls. The two most common probe techniques are fine-wire thermocouples and suction pyrometers. The advantages of fine-wire thermocouples are: 1) the flame disturbances can be minimized, and 2) the technique is simple and inexpensive. However, the fragility of thermocouple probes in turbulent particle-laden flames limits practical use.

Suction pyrometers partially resolve the radiation loss problems by shielding the thermocouple from its surroundings. A high suction velocity draws the gas over the protected thermocouple, insuring that the heat transfer is predominantly convective. However, the suction increases the flow field disturbance.



(a) Water quench probe



(b) Isokinetic probe tip

Figure 2. Water quenched isokinetic probe (9).

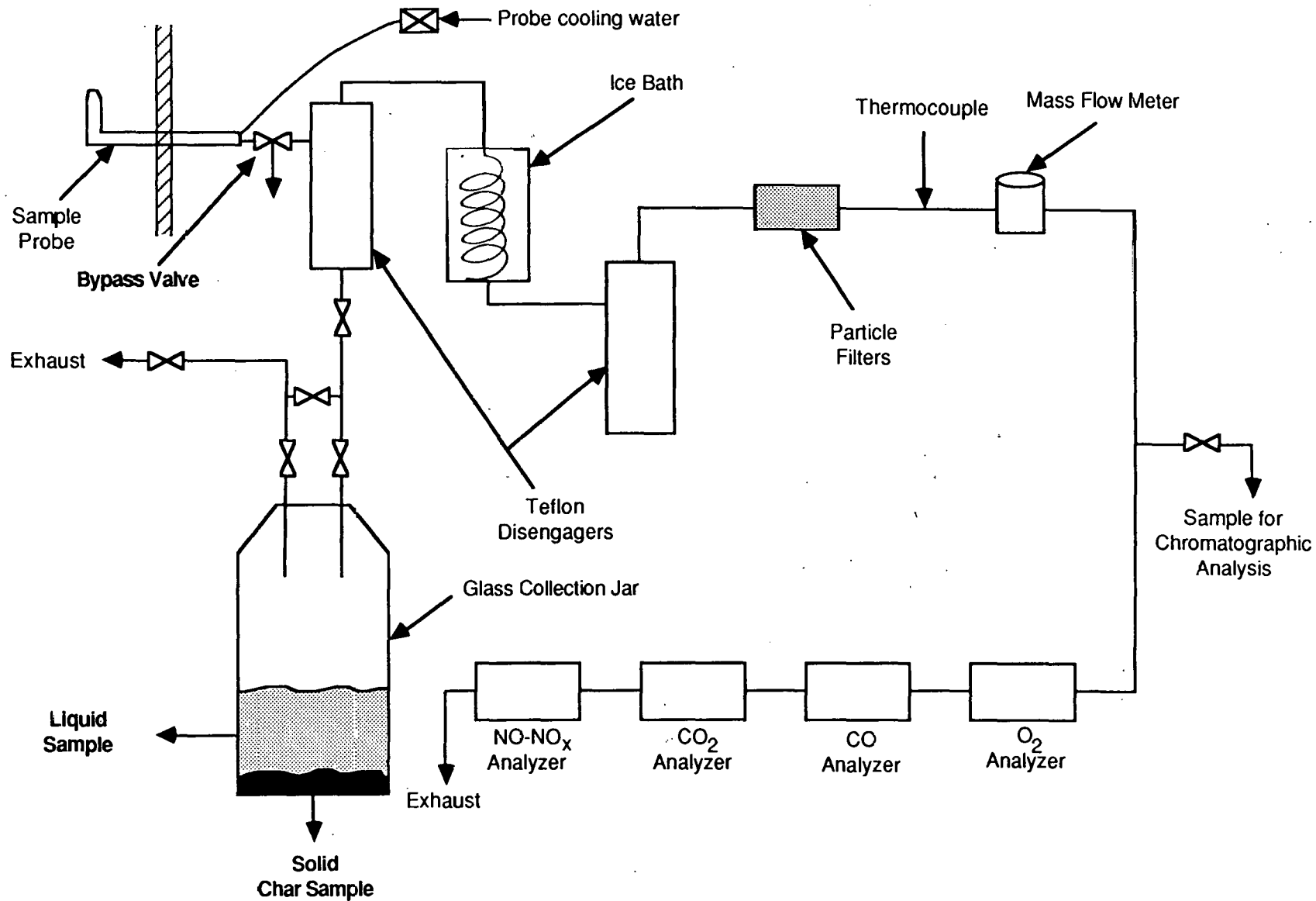


Figure 3. Schematic diagram of sampling system (10).

### 3. Gas Velocity

Local gas velocity is one of the important parameters which describes a flame. Because of its simplicity and reliability, the Pitot tube is widely used for measuring fluid velocity. Velocity is calculated from measured pressure differential and the density of the gas. At low velocities, the performance of Pitot tubes is questionable. In highly turbulent flows, poor frequency response and spatial resolution severely limit the usefulness of Pitot tubes. Particulates further complicate the use of this type of probe.

Hot wire anemometers were developed to measure velocity components in multi-dimensional flows. Velocities are calculated by measuring the heat loss from the wire to the gas stream. However, some characteristics of the hot wire anemometer render it useless in particle-laden and combusting flows; it is extremely fragile and cannot tolerate particle impact. It is also susceptible to damage from chemically active mediums or extreme temperatures common in combustion systems.

#### B. EFFECT OF PROBES ON FLOW SYSTEM

A principal concern with probe use is the disturbance caused in both the flow field and in the chemical and thermal properties of the sampled fluid. The interference with the flow field can be significant, especially in recirculation zones and swirling flows (8). Probes can also change the composition of the flow by acting as a fuel distributor, flame holder, or as a heat sink. These chemical and thermal disturbances will affect the homogeneous and heterogeneous rate processes, especially in the reacting zones of a flame (13). The disturbances caused by probes can be minimized in downstream regions of parallel injection flows, but cannot be ignored.

In turbulent flow systems where large velocity, concentration, and temperature gradients occur, significant experimental errors can occur due to spatial averaging (14). Wide probe openings yield insufficient resolution in such regions. The method of sampling can also affect the temporal averaging (8).

With such questions concerning intrusive probes, accuracy of the measurements must be considered when comparisons are made with model predictions. The experimental technique, thus has an important impact on how comparisons between experimental data and computer predictions are interpreted.

#### C. OPTICAL AND LASER MEASUREMENTS

Many optical techniques can be used in combustion diagnostics. However, this data book is only concerned with those techniques which can be used to make detailed local measurements. Current laser technology applied to combustion can provide these local measurements in some of the simpler flow fields.

The major advantage of laser techniques is that they do not significantly interfere with the flow field. Because laser beams can be focused down to very small diameters (0.05 mm or less), they also provide a high degree of spatial resolution. Pulsed lasers provide excellent temporal resolution as well, which is important in turbulent flows. However, laser techniques are relatively expensive and require a high degree of operator skill. Optical access

to the desired control volume is also essential. Further, application to highly loaded particle-laden flows is presently very limited due to light scattering.

Several laser spectroscopic methods have been used to provide measurements of concentration and temperature of particular species (15). The three most common techniques are: (1) spontaneous Raman scattering (SRS), (2) coherent anti-Stokes Raman scattering (CARS), and (3) laser-induced fluorescence (LIF). Each technique is based on the scattering, emittance, and/or absorption of a characteristic frequency of light by a particular molecule. The intensity of the scattered, emitted, or absorbed light can be related to the species concentration or temperature. Two-color optical pyrometry has also been used as a means of making local temperature measurements (16). The spatial and temporal resolution of this technique is presently poor.

Laser doppler anemometry (LDA or LDV) has recently become a popular technique for measuring velocity components in two-phase turbulent flows. Chigier (17) states that this technique has become the most accurate means of measuring velocity of fluids and particles. LDA also has the capability to measure negative velocities found in recirculation zones, and can be used in many various flow systems. However, use of this method in particle-laden flows is not well developed.

#### D. SWIRL

Swirling flow is usually imparted to a stream of fluid by one of three general methods (16); tangential entry, vanes, and moving blocks. These swirl generators allow variation in the degree of swirl induced to the flow.

The degree of swirl in a flow is often characterized by a non-dimensional swirl number,

$$S = \frac{G_{\phi}}{RG_x} \quad (1)$$

where  $G$  is the axial flux of the angular momentum,  $G$  is the axial flux of the axial momentum, and  $R$  is the radius of the orifice. This equation is derived from approximations made to the turbulent boundary layer equations (19). The equations which describe  $G_{\phi}$  and  $G_x$  can be written as:

$$G_{\phi} = \int_{r_1}^r 2r^2 \rho w u \, dr \quad \text{and} \quad (2)$$

$$G_x = \int_{r_1}^r 2[r \rho u u + r(p-p_0)] \, dr \quad (3)$$

However, approximations are often made to the  $G_x$  term in the form:

$$G_x = \int_{r_1}^r 2(r \rho u u - r \rho w w / 2) \, dr \quad \text{or} \quad (4)$$

$$G_x = \int_{r_1}^{r_2} r \rho u u \, dr. \quad (5)$$

Swirl numbers may be experimentally determined by use of a calibrator apparatus or may be calculated either from the swirl generator geometry or experimental velocity profiles via equations (1) through (5). Because the swirl number is an integrated or averaged value, the swirl number cannot be regarded, by itself, as sufficient to be representative of the inlet flow field. A particular swirl number may represent widely varying velocity profiles among the different swirl generators. While the swirl number may provide a relative measure of the degree of swirl for a particular swirl generator, it is most useful when coupled with a reliable velocity profile (20).

Whenever possible, the experimentally calibrated swirl number will be reported first. If the swirl number is calculated from the available experimental velocity and pressure profiles, a numerical subscript will be included to designate the appropriate equation used. Swirl numbers calculated theoretically on the basis of geometry will be enclosed in parenthesis. Additional information related to swirl generator type and geometry is included in Appendix A.

It should be noted that in many of the investigations included in this Data Book, comparisons were made between 'swirling' and 'non-swirling' flows. In the 'non-swirling' cases, the inlet gases were passed through the swirl generators with their vane angles set to zero. While not introducing swirl, these swirl generators may still have an effect, as will almost any inlet geometry, on the inlet flow patterns. These 'non-swirl' cases have been listed alongside their 'swirl' counterparts in Appendix A.



## IV. DATA REVIEW

### A. SOURCES OF DATA

A principal source of data for this project has been the Combustion Laboratory at Brigham Young University. One of the major purposes of the experimental program at BYU has been to provide detailed profile data for model evaluation. The BYU Combustion Laboratory has been involved in obtaining data in each of the data categories (21). All of the data obtained by the Combustion Laboratory have been available for use in this project.

Extensive use of data from the International Flame Research Foundation has also been made. The IFRF has been heavily involved in many types of flame research for several years. The data sets obtained from the IFRF are very complete, and the measurements are thought to be reliable. However, the IFRF furnaces are not axisymmetric, but are large, and can possibly be approximated as axisymmetric (particularly near the burner) by using the hydraulic diameter as the chamber diameter. This assumption has proven to be reasonably accurate for model predictions at this laboratory (4,22).

An effort has also been made to include data from other research facilities. Investigators throughout the world are studying the various aspects of coal combustion and gasification. It would be impractical to obtain data from every investigator. Many of the data cases that do not originate from the BYU Combustion Laboratory had been previously acquired by the Combustion Laboratory for other research purposes. Additional cases were obtained for those categories which were thought to be deficient.

Journals were extensively used as resources for new data sets (Combustion and Flame, AIAA Journal, and Journal of the Institute of Fuel, were some of the more commonly used journals). Also, papers presented at various symposia (e.g. International Symposia on Combustion, and International Symposium on Applications of Laser-Doppler Anemometry to Fluid Mechanics) were utilized. Tabulated data was requested for many of these non-BYU cases. Unfortunately, not all of the tabulated data requested were supplied.

### B. DATA SETS CONSIDERED

Table 2 summarizes the number of data sets that were considered for inclusion in this data book. A total of 213 data sets, from 52 investigators and 18 different laboratories, were considered. Table 3 lists the important parameters for each data set considered.

All of the 213 cases were rated as to completeness, and availability of the tabulated data. Completeness was rated on a scale of 1 to 3, with 1 being most complete. For those cases where tabulated data from the original investigator was acquired, completeness was a relative measurement of the extensiveness of the included data. A rating of 1 or 2 was acceptable. For the cases where it was impossible to obtain the data in tabular form from the investigator, only cases with a rating of 1 were accepted. This rating indicated that the graphical data reported in the publication was extensive, and that it was suitable for accurate extraction and interpolation from the

TABLE 2  
SUMMARY OF DATA SETS CONSIDERED

<u>Category</u>	<u>Number of Data Sets</u>	<u>Number of Investigations</u>	<u>Number of Laboratories</u>
A. Non-Reacting Gaseous Flow			
1. Without Swirl	23	15	7
2. With Swirl	34	15	9
B. Non-Reacting Particle-Laden Flow			
1. Without Swirl	38	6	2
2. With Swirl	5	1	1
C. Gaseous Combustion			
1. Without Swirl	14	10	7
2. With Swirl	20	11	8
D. Coal Combustion			
1. Without Swirl	37	7	2
2. With Swirl	24	7	3
E. Coal Gasification			
1. Without Swirl	15	7	1
2. With Swirl	1	1	1
F. Coal Slurry Combustion			
2. With Swirl	<u>2</u>	<u>2</u>	<u>1</u>
TOTAL	213	52	18

TABLE 3

## DATA SETS CONSIDERED

## A.1 Non-Reacting Gaseous Flow w/o Swirl

<u>Invest. /Ref.</u>	<u>Chem. System (pri./sec.)</u>	<u>Number of Sets</u>	<u>Test Variables</u>	<u>Measured Properties</u>	<u>Completeness</u>	<u>Comments</u>
1. Baker et al. (23) [Imperial College]	air/air	1	---	u, v, w	3	1- LDV measurements 2- no tabulated data 3- see data sets C.1.1, C.2.2, A.2.2
2. Habib and Whitelaw (24) [Imperial College]	air/air	2	sec. jet velocity	u, v, w	2	1- LDV measurements 2- unknown geometry 3- no tabulated data 4- see data sets A.2.5
3. Jones (25) [BYU]	air/air	1	---	u, u'u'	1	1- LDV measurements 2- inlet turb. intens. 3- quest meas. tech. 4- see data sets A.2.8
4. Leavitt (26) [BYU]	Ar/air	1	---	[Ar], u	3	1- only 3 axial loc. 2- vel. measured with probe 3- see data sets A.2.9, B.1.1, B.2.1
5. Memmott (27) [BYU]	Ar/air	2	sec. inject. angle	[Ar], u	2	1- non-parallel inject 2- changing geometry 3- vel. measured with probe 4- see data sets B.1.2
6. Modarress et al. (28) [Spectron Develop. Lab.]	air/air	1	---	u, u'u', v'v', u'v'	3	1- LDV measurements 2- no tabulated data 3- see data sets B.1.3
7. Owen (29) [United Aircraft Research Lab.]	air/air	1	---	u, u'u', v, v'v'	1	1- LDV measurements 2- recirculating jet 3- no tabulated data
8. Pai et al. (30) [IFRF]	H <sub>2</sub> /air	3	chem geom.	u, T, [H <sub>2</sub> ]	2	1- square chamber 2- vel. measured with probe 3- no tabulated data
9. Sharp (31) [BYU]	Ar/air	2	sec. inject. angles	[Ar], u	2	1- non-parallel inject 2- changing geometry 3- vel. measured with probe 4- see data sets B.1.5

TABLE 3 (Continued)

## A.1 Non-Reacting Gaseous Flow w/o Swirl (continued)

<u>Invest. /Ref.</u>	<u>Chem. System (pri./sec.)</u>	<u>Number of Sets</u>	<u>Test Variables</u>	<u>Measured Properties</u>	<u>Completeness</u>	<u>Comments</u>
10. Smith and Gial (32) [ARO, Inc.]	H <sub>2</sub> /air	1	---	u, u'u', v, v'v'	1	1- LDV measurements 2- No tabular data 3- fuel in sec. 4- see data sets C.1.7
11. Takagi et al. (33) [Osaka Univ.]	H <sub>2</sub> /air	2	pri. jet vel.	u, u'u', v'v', [gas]	2	1- LDV measurements 2- no tabulated data 3- only 3 axial loc. 4- see data sets C.1.9
12. Takagi et al. (34) [Osaka Univ.]	H <sub>2</sub> /air	2	pri. jet vel.	u, u'u', v'v', [gas]	1	1- LDV measurements 2- no tabulated data 3- only 3 axial loc. 4- see data sets C.1.10
13. Tice (35) [BYU]	Ar/air	2	sec. jet velocity	[Ar], u	2	1- changing geometry 2- vel. measured with probe 3- see data sets B.1.6
14. Toral (36) [Imperial College]	air/air	1	---	u, v, w	2	1- vel. measured with probe 2- complete geometry 3- no tabulated data
15. Webb (37) [BYU]	air/air	1	---	u, u'u'	1	1- LDV measurements 2- inlet turb. intens. 3- no freq. shift 4- see data sets A.2.14

## A.2 Non-Reacting Gaseous Flow with Swirl

<u>Invest. /Ref.</u>	<u>Chem. System (pri./sec.)</u>	<u>Number of Sets</u>	<u>Test Variables</u>	<u>Measured Properties</u>	<u>Completeness</u>	<u>Comments</u>
1. Abou-Arab et al. (38) [Univ. Stutt.]	air/air	4	swirl no. mass flow rates	u, u'u', v, v'v'	1	1- LDV measurements 2- negative mass flow rates [integrated]
2. Baker et al. (23) [Imperial College]	air/air	1	---	u, v, w	3	1- LDV measurements 2- no tabulated data 3- see data sets A.1.1, C.1.1, C.1.2

TABLE 3 (Continued)

## A.2 Non-Reacting Gaseous Flow with Swirl (continued)

Invest. /Ref.	Chem. System (pri./sec.)	Number of Sets	Test Variables	Measured Properties	Completeness	Comments
3. Fujii et al. (39) [National Aerospace Lab., Japan]	air/air	3	swirl no.	$u, v, w, u'u',$ $v'v', w'w'$	2	1- LDV measurements 2- no tabulated data 3- see data sets C.2.4
4. Gouldin et al. (40) [Cornell Univ.]	air/air	2	co-swirl/ counter swirl	$u, u'u',$ $w, w'w'$	1	1- LDV measurements 2- frequently used data 3- see data sets F.5
5. Habib and Whitelaw (24) [Imperial College]	air/air	1	---	$u, v, w$	2	1- LDV measurements 2- unknown geometry 3- no tabulated data 4- see data sets A.1.2
6. Hutchinson et al. (41) [Imperial College]	air/air	2	swirl no.	$u, v, w, u'u',$ $v'v', w'w'$	2	1- LDV measurements 2- no tabulated data 3- see data sets C.2.7
7. Jones and Wilhelmi (42) [Imperial College]	propane/air	2	cham. geometry	$u, v, w, u'u',$ $v'v', w'w'$	2	1- LDV measurements 2- complex geometry 3- no tabulated data
8. Jones (25) [BYU]	air/air	1	---	$u, u'u'$	1	1- LDV measurements 2- inlet turb. intens. 3- quest. meas. tech. 4- see data sets A.1.3, D.2.1
9. Leavitt (26) [BYU]	Ar/air	1	---	[Ar], $u$	2	1- vel. measured with probe 2- see data sets A.1.4, B.1.1, B.2.1
10. Mathur and Mac Callum (43) [Univ. of Jodhpur]	air/air	8	swirl no.	$u, v$	3	1- square chamber 2- vel. measured with probe 3- no tabulated data
11. Ramos (44) [Carnegie Mellon Univ.]	air/air	2	co-swirl/ counter swirl	$u, u'u',$ $v, v'v'$	2	1- LDV measurements 2- no tabulated data
12. Samuelson and Brum (45) [UCI]	CO <sub>2</sub> /air	1	---	$u, u'u',$ $w, w'w'$	1	1- LDV measurements 2- see data sets C.2.11
13. Vu and Gouldin (46) [Cornell Univ.]	air/air	2	co-swirl/ counter swirl	$u, u'u',$ $w, w'w'$	1	1- pitot tube measured

TABLE 3 (Continued)

## A.2 Non-Reacting Gaseous Flow with Swirl (continued)

<u>Invest. /Ref.</u>	<u>Chem. System (pri./sec.)</u>	<u>Number of Sets</u>	<u>Test Variables</u>	<u>Measured Properties</u>	<u>Completeness</u>	<u>Comments</u>
14. Webb (37) [BYU]	air/air	1	---	u, u'u'	1	1- LDV measurements 2- inlet turb. intens. 3- no freq. shift 4- see data sets A.1.16
15. Weske and Stunov (47) [Hydrodynamics Institute, USSR]	air/air	3	swirl no.	u, v, w	2	1- vel. measured with probe 2- no tabulated data

## B.1 Non-Reacting Particle-Laden Flow w/o Swirl

<u>Invest. /Ref.</u>	<u>Chem. System (pri./sec.)</u>	<u>Number of Sets</u>	<u>Test Variables</u>	<u>Measured Properties</u>	<u>Completeness</u>	<u>Comments</u>
1. Leavitt (26) [BYU]	coal (Ar)/air	2	cham. geometry	[Ar], f, u	2	1- vel. measured with probe 2- see data sets A.1.4, A.2.9, B.2.1
2. Memmott (27) [BYU]	Si beads (Ar)/ air	8	particle size sec. inject angle	[Ar], f, u	2-3	1- vel. measured with probe 2- non-parallel inject. 3- see data sets A.1.5
3. Modarress et al. (28) [Spectron Development Lab.]	Si beads/ air	3	particle size sol/gas ratio	u(p), u, u'u', v'v', u'v'	1	1- LDV measurements 2- no tabular data 3- see data sets A.1.6
4. Modarress et al. (48) [Spectron Development Lab.]	Si beads/ air	2	sol/gas ratio	u(p), u, u'u', v'v', u'v'	2	1- LDV measurements 2- no tabular data
5. Sharp (31) [BYU]	Si beads (Ar)/ air	12	particle size cham. geometry sec. inject angle	[Ar], f, u	2-3	1- vel. measured with probe 2- non-parallel inject. 3- see data sets A.1.9
6. Tice (35) [BYU]	Si beads (Ar)/ air	11	particle size cham. geometry sec. jet veloc.	[Ar], f, u	2-3	1- vel. measured with probe 2- screens in primary 3- see data sets A.1.14

TABLE 3 (Continued)

## B.2 Non-Reacting Particle-Laden Flow with Swirl

<u>Invest.</u> <u>/Ref.</u>	<u>Chem. System</u> <u>(pri./sec.)</u>	<u>Number</u> <u>of Sets</u>	<u>Test</u> <u>Variables</u>	<u>Measured</u> <u>Properties</u>	<u>Completeness</u>	<u>Comments</u>
1. Leavitt (26) [BYU]	coal (Ar)/air	5	swirl no. cham. geometry	[Ar], $\rho$ , u	2	1- vel. measured with probe 2- see data sets A.1.4, A.2.9, B.1.1

## C.1 Gaseous Combustion w/o Swirl

<u>Invest.</u> <u>/Ref.</u>	<u>Chem. System</u> <u>(pri./sec.)</u>	<u>Number</u> <u>of Sets</u>	<u>Test</u> <u>Variables</u>	<u>Measured</u> <u>Properties</u>	<u>Completeness</u>	<u>Comments</u>
1. Baker et al. (23) [Imperial College]	CH <sub>4</sub> /air	1	---	u, v, w	3	1- LDV measurements 2- no tabulated data 3- see data sets A.1.1, A.2.3, C.2.2
2. Hassan et al. (49) [Imperial College]	CH <sub>4</sub> /air	2	fuel/oxide ratio	T, [gas]	1	1- no tabulated data 2- see data sets C.2.6
3. Lewis, M. (50) [BYU]	CH <sub>4</sub> /air	1	---	[gas]	2	1- vel. measured with probe
4. Michelfelder and Lowes (51) [IFRF]	CH <sub>4</sub> /air	2	fuel oxide ratio cham. geometry	[gas], T u, v, w	1	1- vel. measured with probe 2- square chamber 3- cooled walls 4- see data sets C.1.5, C.2.8, C.2.9
5. Michelfelder and Lowes (51) [IFRF]	propane/air	1	---	[gas], T u, v, w	1	1- vel. measured with probe 2- square chamber 3- cooled walls 4- see data sets C.1.4, C.2.8, C.2.9
6. Rambach et al. (52) [Sand:a]	H <sub>2</sub> /air	1	---	u, u'u', T	1	1- LDV measurements 2- Raleigh T measurements 3- square chamber 4- no tabulated data
7. Smith and Giel (32) [ARO, Inc.]	H <sub>2</sub> /air	1	---	u, u'u', v, v'v', T	1	1- LDV measurements 2- Raman T measurements 3- no tabular data 4- fuel in sec. 5- see data sets A.1.10



TABLE 3 (Continued)

## C.1 Gaseous Combustion w/o Swirl (continued)

Invest. /Ref.	Chem. System (pri./sec.)	Number of Sets	Test Variables	Measured Properties	Completeness	Comments
8. Stevensen et al. (53) [Purdue Univ.]	propane/air	1	---	u	3	1- LDV measurements 2- no tabulated data 3- see data sets A.1.11
9. Takagi et al. (33) [Osaka Univ.]	H <sub>2</sub> /air	2	sec. jet veloc.	u, u'u', v'v', T, [gas]	2	1- LDV measurements 2- no tabulated data 3- only 3 axial loc. 4- see data sets A.1.12
10. Takagi et al. (34) [Osaka Univ.]	H <sub>2</sub> /air	2	sec. jet veloc.	u, u'u', v'v', T, [gas]	1	1- LDV measurements 2- no tabulated data 3- see data sets A.1.13

## C.2 Gaseous Combustion with Swirl

Invest. /Ref.	Chem. System (pri./sec.)	Number of Sets	Test Variables	Measured Properties	Completeness	Comments
1. Baker et al. (23) [Imperial College]	CH <sub>4</sub> /air	1	---	u, v, w	3	1- LDV measurements 2- no tabulated data 3- see data sets A.1.1, A.2.3, C.1.1
2. Barlow (54) [Shell Research Ltd., U.K.]	CH <sub>4</sub> /air	1	---	u, u'u', v, v'v'	2	1- LDV measurements 2- no tabulated data
3. Cernansky and Sawyer (55) [Univ. Calif., Berkeley]	propane/air	1	---	T, [gas]	2	1- no tabulated data 2- vel. measured with probe
4. Fujii et al. (39) [National Aerospace Lab., Japan]	propane/air	1	---	u, v, w, u'u', v'v', w'w'	2	1- LDV measurements 2- no tabulated data 3- see data sets A.1.2
5. Gouldin et al. (40) [Cornell Univ.]	CH <sub>4</sub> /air	2	co-swirl/ counter swirl	u, u'u', w, w'w'	1	1- LDV measurements 2- see data sets A.2.1
6. Hassan et al. (49) [Imperial College]	CH <sub>4</sub> /air	1	---	T, [gas]	1	1- no tabulated data 2- vel. measured with probe 3- see data sets C.1.2

TABLE 3 (Continued)

## C.2 Gaseous Combustion with Swirl (continued)

<u>Invest.</u> <u>/Ref.</u>	<u>Chem. System</u> <u>(pri./sec.)</u>	<u>Number</u> <u>of Sets</u>	<u>Test</u> <u>Variables</u>	<u>Measured</u> <u>Properties</u>	<u>Completeness</u>	<u>Comments</u>
7. Hutchinson et al. (41) [Imperial College]	CH <sub>4</sub> /air	2	swirl no.	u, v, w, u'u', v'v', w'w'	2	1- LDV measurements 2- no tabulated data 3- see data sets A.2.6
8. Michelfelder and Lowes (51) [IFRF]	CH <sub>4</sub> /air	5	cham. geometry fuel/oxide ratio swirl no.	[gas], T, u, v, w	1	1- vel. measured with probe 2- square chamber 3- cooled walls 4- see data sets C.1.4, C.1.5, C.2.9
9. Michelfelder and Lowes (51) [IFRF]	propane/air	1	---	[gas], T u, v, w	1	1- vel. measured with probe 2- square chamber 3- cooled walls 4- see data sets C.1.4, C.1.5, C.2.8
10. Samuelsen and Brum (45) [Univ. Calif., Irvine]	propane/air	3	fuel/oxide ratio	u, u'u', w, w'w'	1	1- LDV measurements 2- see data sets A.2.12
11. Takagi and Okamoto (56) [Osaka Univ.]	propane/air	2	fuel/oxide ratio	T, [gas]	1	1- complex geometry 2- no tabulated data

## D.1 Coal Combustion w/o Swirl

<u>Invest.</u> <u>/Ref.</u>	<u>Chem. System</u> <u>(pri./sec.)</u>	<u>Number</u> <u>of Sets</u>	<u>Test</u> <u>Variables</u>	<u>Measured</u> <u>Properties</u>	<u>Completeness</u>	<u>Comments</u>
1. Beér (57) [IFRF]	anthracite/ air	13	particle size cham. geometry	[gas], u, char anal.	2	1- vel. measured with probe 2- square chamber
2. Beér and Chigier (58) [IFRF]	anthracite/ air	5	cham. geometry	[gas], u, [solid]	3	1- no tabulated data 2- square chamber 3- vel. measured with probe 4- see data sets D.2.3, D.2.4
3. Harding (59) [BYU]	bituminous/ air	1	---	[gas], NO <sub>x</sub> , char anal.	3	1- see data sets D.2.5
4. Hein and Leuckel (60) [IFRF]	anthracite/ air	6	cham. geometry stoic. ratio	[gas], u, v, w, [solid], T char anal.	1	1- square chamber 2- cooled walls 3- vel. measured with probe 4- see data sets D.2.6

TABLE 3 (Continued)

## D.1 Coal Combustion w/o Swirl (continued)

<u>Invest. /Ref.</u>	<u>Chem. System (pri./sec.)</u>	<u>Number of Sets</u>	<u>Test Variables</u>	<u>Measured Properties</u>	<u>Completeness</u>	<u>Comments</u>
5. Michel and Payne (61) [IFRF]	bituminous/ air	6	cham. geometry stoic. ratio	[gas], u, v, w, [solid], T, NO <sub>x</sub> , char anal.	1	1- square chamber 2- cooled walls 3- vel. measured with probe
6. Rees (62) [BYU]	bituminous/ air	2	stoic. ratio	[gas], NO <sub>x</sub> , char anal.	2	
7. Thurgood (9) [BYU]	bituminous/ air	4	particle size sec. jet veloc. sec. inject. angle	[gas] char anal.	2	

## D.2 Coal Combustion with Swirl

<u>Invest. /Ref.</u>	<u>Chem. System (pri./sec.)</u>	<u>Number of Sets</u>	<u>Test Variables</u>	<u>Measured Properties</u>	<u>Completeness</u>	<u>Comments</u>
1. Asay (63) [BYU]	subbituminous/ air	1	---	[gas], NO <sub>x</sub> , char anal.	1	1- see data sets D.2.2, A.2.8
2. Asay (63) [BYU]	bituminous/ air	1	---	[gas], NO <sub>x</sub> , char anal.	1	1- see data sets D.2.1
3. Beér and Chigier (58) [IFRF]	anthracite/ air	5	cham. geometry	[gas], u, [solid]	3	1- square chamber 2- vel. measured with probe 3- no tabulated data 4- see data sets D.1.2, D.2.4
4. Beér and Chigier (58) [IFRF]	bituminous/ air	2	cham. geometry	[gas], u, [solid]	3	1- square chamber 2- vel. measured with probe 3- no tabulated data 4- see data sets D.1.2, D.2.3
5. Godoy et al. (64) [Imperial College]	bituminous/ air	4	swirl no., stoic. ratio	[gas], T	1	1- cooled walls 2- no tabulated data
6. Harding (59) [BYU]	bituminous/ air	2	swirl no.	[gas], NO <sub>x</sub> , char anal.	2	1- 1 set; exit only 2- see data sets D.1.3
7. Hein and Leuckel (60) [IFRF]	anthracite/ air	9	cham. geometry stoic. ratio swirl no.	[gas], u, v, w, [solid], T char anal.	1	1- square chamber 2- cooled walls 3- vel. measured with probe 4- see data sets D.1.4

TABLE 3 (Continued)

## E.1 Coal Gasification w/o Swirl

<u>Invest.</u> <u>/Ref.</u>	<u>Chem. System</u> <u>(pri./sec.)</u>	<u>Number</u> <u>of Sets</u>	<u>Test</u> <u>Variables</u>	<u>Measured</u> <u>Properties</u>	<u>Completeness</u>	<u>Comments</u>
1. Azuhata, et al. (65) [BYU]	bituminous/ O <sub>2</sub>	1	---	[gas], NO <sub>x</sub> , SO <sub>x</sub> , char anal.	2	1- high pressure (4.1 atm)
2. Brown (66) [BYU]	various coals/ O <sub>2</sub>	3	coal type	[gas], NO <sub>x</sub> , SO <sub>x</sub> , char anal.	1	
3. Cope (67) [BYU]	various coals/ O <sub>2</sub>	6	coal type, pressure, flow rates	[gas], NO <sub>x</sub> , SO <sub>x</sub> , char anal.	3	1- only 3 axial stations 2- high pressure (5.5-10 atm)
4. Lewis, G. (68) [BYU]	bituminous O <sub>2</sub>	1	---	[gas], char anal.	2	1- exit data only
5. Skinner (69) [BYU]	bituminous/ O <sub>2</sub>	1	---	[gas], char anal.	3	1- sparse data
6. Soelberg (70) [BYU]	bituminous/ O <sub>2</sub>	1	---	[gas], NO <sub>x</sub> , SO <sub>x</sub> , char anal.	1	
7. Sowa (71) [BYU]	bituminous/ O <sub>2</sub>	2	injector type	[gas], NO <sub>x</sub> , SO <sub>x</sub> , chr anal.	2	1- only 3 axial stations 2- high pressure (5.5 atm) 3- special injector types

## E.2. Coal Gasification with Swirl

<u>Invest.</u> <u>/Ref.</u>	<u>Chem. System</u> <u>(pri./sec.)</u>	<u>Number</u> <u>of Sets</u>	<u>Test</u> <u>Variables</u>	<u>Measured</u> <u>Properties</u>	<u>Completeness</u>	<u>Comments</u>
1. Sowa (71) [BYU]	bituminous/ O <sub>2</sub>	1	---	[gas], NO <sub>x</sub> , SO <sub>x</sub> , char anal.	3	1- only 3 axial stations 2- primary swirl

## F. Coal Slurry Combustion with Swirl

<u>Invest.</u> <u>/Ref.</u>	<u>Chem. System</u> <u>(pri./sec.)</u>	<u>Number</u> <u>of Sets</u>	<u>Test</u> <u>Variables</u>	<u>Measured</u> <u>Properties</u>	<u>Completeness</u>	<u>Comments</u>
1. Rawlins (72) [BYU]	various coals/ O <sub>2</sub>	2	coal	[gas], NO <sub>x</sub> , SO <sub>x</sub> , char anal.	1	1- one case has test errors

available graphs. Lack of tabulated data was noted in the comments for that particular data set (see Table 3).

For all data sets, the particular technique used to measure velocities is noted. Unless otherwise noted, all temperature measurements were made with thermocouples. Cross references are listed for those cases which were part of a multi-category study. Symbol definitions are shown in the nomenclature.

## V. DATA SETS SELECTED

A total of 37 data sets have been selected, of which 17 cases were from the BYU Combustion Laboratory. Seven data sets have also been included from the International Flame Research Foundation (IFRF). In the remaining 14 data sets, a total of 6 different laboratories are represented. Table 4 summarizes selected test conditions while the text that follows indicates measured properties. Detailed test parameters for model computations are summarized in Table 5.

### A. NON-REACTING GASEOUS FLOW

#### 1. Without Swirl

Owen (29): LDV measurements of mean axial velocity and rms axial velocity in a recirculating flow field. No tabulated data available, but used because of emphasis on recirculating flow.

Takagi et al (34): LDV measurements of mean axial velocity and rms axial velocity. Gas concentration measurements made with a stainless steel water-cooled probe. No tabulated data available, but used because of the chemical system (H<sub>2</sub>/air).

Webb (37): LDV measurements of mean axial velocity and rms axial velocity. Inlet turbulence intensities were also measured. Part of the same study as the Webb data set in category A.2 (non-reacting gaseous flow with swirl). It should be noted that measurements were obtained without the use of frequency shifting.

#### 2. With Swirl

Samuelsen and Brum (45): LDV measurements of mean axial and tangential velocities and rms axial and tangential velocities. The flow consists of a primary fuel stream, a swirling air secondary stream, and a dilution air stream (surrounding the secondary). The mass flow rates of the secondary and dilution streams are combined in the data tables. The mass flow rates of these two streams were equal. Part of the same study as the Samuelsen data set in category C.2 (gaseous combustion with swirl).

Webb (37): LDV measurements of mean axial velocity and rms axial velocity. Inlet turbulence intensities were also measured. Part of the same study as the Webb data set in category A.1 (non-reacting gaseous flow without swirl). It should be noted that measurements were obtained without the use of frequency shifting.

Gouldin et al. (40): LDV measurements of Favre-mean axial and tangential velocities, and rms axial and tangential velocities. Swirl is imparted to both the primary and secondary streams. Part of the same study as the Gouldin data sets in category C.2 (gaseous combustion with swirl).

TABLE 4  
SUMMARY OF DATA SETS SELECTED

<u>Category</u>	<u>Number of Data Sets</u>	<u>Number of Investigations</u>	<u>Number of Laboratories</u>
A. Non-reacting Gaseous Flow			
1. Without Swirl	3	3	3
2. With Swirl	4	3	3
B. Non-reacting Particle-Laden Flow			
1. Without Swirl	3	3	2
2. With Swirl	3	1	1
C. Gaseous Combustion			
1. Without Swirl	4	3	3
2. With Swirl	4	3	3
D. Coal Combustion			
1. Without Swirl	5	5	2
2. With Swirl	5	4	3
E. Coal Gasification			
1. Without Swirl	5	3	1
F. Coal Slurry Combustion			
2. With Swirl	<u>1</u>	<u>1</u>	<u>1</u>
TOTAL	37	22	8



TABLE 5  
DATA SETS SELECTED

A.1 Non-Reacting Gaseous Flow w/o Swirl										
Invest. /Ref.	Chem. System	Diameters (m)			Cham. Length (m)	Mass Flow Rates (kg/s)			Stoic. Ratio	Swirl Number
		Pri.	Sec.	Cham.		Pri.	Sec.	Solid		
1. Owen (29) [ARO, Inc.]	air/air	0.0635	0.0889	0.127	1.219	0.0077	0.0891	-----	-----	-----
2. Takagi et al. (34) [Osaka Univ.]	H <sub>2</sub> /air	0.0049	1.04	1.04	2.5	0.000274	0.0508	-----	-----	-----
3. Webb (37) [BYU]	air/air	0.025	0.130	0.206	0.914	0.016	0.51	-----	-----	-----
A.2. Non-Reacting Gaseous Flow with Swirl										
1. Samuelsen and Brum (45) (U. Calif., Irvine]	CO <sub>2</sub> /air	0.001	0.057	0.08	0.50	0.00121	0.936	-----	-----	0.3[0.8]
2. Webb (37) [BYU]	air/air	0.025	0.130	0.206	0.914	0.016	0.51	-----	-----	0.49
3. Gouldin et al. (40) [Cornell Univ.]	air/air	0.0495	0.102	0.105	0.610	0.0718	0.164	-----	-----	Si=0.50 So=0.56
4. Gouldin et al. (40) [Cornell Univ.]	air/air	0.0495	0.102	0.105	0.610	0.0718	0.164	-----	-----	Si=0.50 So=0.56

TABLE 5 (Continued)

B.1 Non-Reacting Particle-Laden Flow w/o Swirl										
Invest. /Ref.	Chem. System	Diameters (m)			Cham. Length (m)	Mass Flow Rates (kg/s)			Stoic. Ratio	Swirl Number
		Pri.	Sec.	Cham.		Pri.	Sec.	Solid		
1. Leavitt (26) [BYU]	coal/air (43 $\mu\text{m}$ )	0.0255	0.127	0.343	0.926	0.0218	0.534	0.0133	-----	-----
2. Sharp (31) [BYU]	Si beads/air (46 $\mu\text{m}$ )	0.0255	0.127	0.260	0.926	0.0223	0.520	0.0149	-----	-----
3. Modarress et al. (28) [Spectron Development Lab.]	Si beads/air (200 $\mu\text{m}$ )	0.02	0.6	0.6	2.0	0.005	0.034	0.0032	-----	-----
B.2 Non-Reacting Particle-Laden Flow with Swirl										
1. Leavitt (26) [BYU]	coal/air (43 $\mu\text{m}$ )	0.0254	0.127	0.206	0.91	0.0182	0.520	0.0014	-----	(0.4)
2. Leavitt (26) [BYU]	coal/air (43 $\mu\text{m}$ )	0.0254	0.127	0.206	0.91	0.0182	0.520	0.0014	-----	(0.4)
3. Leavitt (26) [BYU]	coal/air (43 $\mu\text{m}$ )	0.0254	0.127	0.206	0.91	0.0182	0.520	0.0014	-----	(0.3)

TABLE 5 (Continued)

## C.1 Gaseous Combustion w/o Swirl

Invest. /Ref.	Chem. System	Diameters (m)			Cham. Length (m)	Mass Flow Rates (kg/s)			Stoic. Ratio	Swirl Number
		Pri.	Sec.	Cham.		Pri.	Sec.	Solid		
1. Michelfelder and Lowes (51) [IFRF]	C <sub>3</sub> H <sub>8</sub> /air	0.0189	0.176	2.00	6.25	0.0636	0.832	-----	1.15	-----
2. Michelfelder and Lowes (51) [IFRF]	CH <sub>4</sub> /air	0.0326	0.176	2.00	6.25	0.0778	0.868	-----	1.15	-----
3. Takagi et al. (34) [Osaka Univ.]	H <sub>2</sub> /air	0.0049	1.04	1.04	2.5	0.00274	0.0508	-----	0.96	-----
4. Hassan et al. (49) [Imperial College]	CH <sub>4</sub> /air	0.056	0.104	0.600	3.0	0.00256	0.051	-----	0.77	-----

## C.2. Gaseous Combustion with Swirl

1. Michelfelder and Lowes (51) [IFRF]	CH <sub>4</sub> /air	0.0326	0.176	2.00	6.25	0.0783	0.870	-----	1.15	(0.5)
2. Samuelson and and Brum (45) [U. Calif., Irvine]	prop./air	0.001	0.057	0.08	0.50	0.00122	0.0936	-----	4.93	0.3(0.8)
3. Gouldin et al. (40) [Cornell Univ.]	CH <sub>4</sub> /air	0.0495	0.102	0.105	0.610	0.0696	0.164	-----	1.19	Si=0.50 So=0.56
4. Gouldin et al. (40) [Cornell Univ.]	CH <sub>4</sub> /air	0.0495	0.102	0.105	0.610	0.0696	0.164	-----	1.19	Si=0.50 So=-.56

TABLE 5 (Continued)

## D.1. Coal Combustion w/o Swirl

Invest. /Ref.	Chem. System	Diameters (m)			Cham. Length (m)	Mass Flow Rates (kg/s)			Stoic. Ratio	Swirl Number
		Pri.	Sec.	Cham.		Pri.	Sec.	Solid		
1. Beér (57) [IFRF]	anthra./air (50 $\mu$ m)	0.054	0.15	1.5	9.1	0.040	0.34	0.029	1.15	-----
2. Hein and Leuckel (60) [IFRF]	anthra./air (50 $\mu$ m)	0.0577	0.161	2.0	6.25	0.0542	0.465	0.0414	1.15	-----
3. Thurgood (9) [BYU]	bitum./air (50 $\mu$ m)	0.016	0.054	0.203	1.52	0.0056	0.036	0.0038	1.15	-----
4. Michel and Payne (61) [IFRF]	bitum./air (50 $\mu$ m)	0.0703	0.260	1.900	6.25	0.0708	0.573	0.0589	1.12	-----
5. Rees (62) [BYU]	bitum./air (48 $\mu$ m)	0.016	0.054	0.203	1.52	0.0056	0.020	0.0038	0.70	-----

## D.2 Coal Combustion with Swirl

1. Hein and Leuckel (60) [IFRF]	anthra./air (50 $\mu$ m)	0.0577	0.210	2.0	6.25	0.0542	0.465	0.0414	1.15	(1.0)
2. Hein and Leuckel (60) [IFRF]	anthra./air (50 $\mu$ m)	0.0577	0.161	2.0	6.25	0.0542	0.465	0.0414	1.15	(1.4)
3. Harding (59) [BYU]	bitum./air (50 $\mu$ m)	0.016	0.0842	0.203	1.52	0.0061	0.03	0.0038	1.00	(1.4)
4. Asay (62) [BYU]	subbit./air (45 $\mu$ m)	0.022	0.0842	0.203	1.52	0.0061	0.019	0.0038	1.06	(3.0)
5. Godoy et al. (64) [Imperial College]	bitum./air (45 $\mu$ m)	0.056	0.104	0.600	3.0	0.0076	0.0287	0.4456	1.15	(0.78)

TABLE 5 (Continued)

## E. Coal Gasification

Invest. /Ref.	Chem. System	Diameters (m)			Cham. Length (m)	Mass Flow Rates (kg/s)			Stoic. Ratio	Swirl Number
		Pri.	Sec.	Cham.		Pri.	Sec.	Solid		
1. Soelberg (70) [BYU]	bitum./O <sub>2</sub> (41 μm)	0.0131	0.0287	0.200	1.19	0.0073	0.0018	0.0066	0.50	0.0
2. Brown (66) [BYU]	subbit./O <sub>2</sub> (37 μm)	0.0131	0.0287	0.200	2.00	0.0059	0.0000	0.0078	0.58	0.0
3. Brown (66) [BYU]	lignite/O <sub>2</sub> (51 μm)	0.0131	0.0287	0.200	2.00	0.0059	0.0000	0.0096	0.58	0.0
4. Brown (66) [BYU]	bitum./O <sub>2</sub> (63 μm)	0.0131	0.0287	0.200	2.00	0.0086	0.00067	0.0088	0.49	0.0
5. Azuhata et al. (55) [BYU]	bitum./O <sub>2</sub> (50 μm)	0.0131	0.0287	0.200	2.00	0.0108	0.00417	0.0091	0.40	0.0

## F. Coal Slurry Combustion

1. Rawlins <sup>2</sup> (72) [BYU]	bitum./O <sub>2</sub> (50 μm) <sup>3</sup>	0.0032	0.1450	0.3500	2.10	0.0067	0.461	0.052	1.28	1.1
---------------------------------------	---	--------	--------	--------	------	--------	-------	-------	------	-----

<sup>1</sup>Reactor pressure = 4.1 atm<sup>2</sup>Slurry injector configuration is contained in Appendix A<sup>3</sup>Dry coal mean size

## B. NON-REACTING PARTICLE-LADEN FLOW

### 1. Without Swirl

Leavitt (26): Argon concentration and particle-flux measurements made with a collection probe. Mean axial velocity data were not included due to unreliable measurement techniques. Part of the same study as the Leavitt data sets in category B.2 (non-reacting particle-laden flow with swirl).

Sharp (31): Argon concentration and particle-flux measurements made with a collection probe. Mean axial velocity data were not included due to unreliable measurement techniques.

Modarress et al. (28): LDV measurements of mean axial particle velocity, mean axial and radial gas velocities, and rms axial and radial gas velocities. No tabulated data was available, but selected because this is the only source of reliable velocity data in this category.

### 2. With Swirl

Leavitt (26): Argon concentration and particle-flux measurements made with a collection probe. Mean axial velocity data were not included due to unreliable measurement techniques. Part of the same study as the Leavitt data set in category B.1 (non-reacting particle-laden flow without swirl).

## C. GASEOUS COMBUSTION

### 1. Without Swirl

Michelfelder and Lowes (51): Gas samples collected with a water-cooled gas sampling probe. Gas temperature measurements made with a suction pyrometer. Mean velocity data were not used since the measurement techniques were unreliable. The hydraulic diameter was calculated to be 2.0 m. Water-cooled walls removed 45-50% of the thermal input. Part of the same study as the Michelfelder data set in category C.2 (gaseous combustion with swirl).

Takagi et al. (34): LDV measurements of mean axial velocity and rms axial velocity. Gas concentration measurements made with a thermocouple corrected for radiation losses. No tabulated data available, but used because of a lack of complete data in this category. Part of the same study as the Takagi data set in category A.1 (non-reacting gaseous flow without swirl).

Hassan et al. (49): Gas samples collected with a water-cooled probe. Gas temperature measurements made with a thermocouple. No tabulated data available, but used because of a lack of complete data cases in this category.

### 2. With Swirl

Michelfelder and Lowes (51): Gas samples collected with a water-cooled gas sampling probe. Gas temperature measurements made with a suction pyrometer. Mean velocity data were not used since the measurement techniques were unreliable. The hydraulic diameter was calculated to be 2.0 m. Water-cooled walls removed 45-50% of the thermal input. Part of the same study as the Michelfelder data sets in category C.1 (gaseous combustion without swirl).

Samuelsen and Brum (45): LDV measurements of mean axial and tangential velocities and rms axial and tangential velocities. The flow consisted of a primary fuel stream, a swirling secondary air stream, and a dilution air stream (surrounding the secondary). The mass flow rates of the secondary and dilution streams were combined in the data tables. The mass flow rates of these two streams were equal. Part of the same study as the Samuelsen data set in category A.2 (non-reacting gaseous flow with swirl).

Gouldin et al. (40): LDV measurements of Favre-mean axial and tangential velocities and rms axial and tangential velocities. Swirl is imparted to both primary and secondary streams. Primary stream is premixed methane/air. Part of the same study as the Gouldin data sets in category A.2 (non-reacting gaseous flow with swirl).

## D. COAL COMBUSTION

### 1. Without Swirl

Béer (57): Gas and solid samples collected with a suction probe. Gas temperature measurements made with a suction pyrometer. Mean velocity data were not used since the measurement techniques were unreliable. No wall cooling in this data set. The hydraulic diameter was calculated to be 1.5 m.

Hein and Lenckel (60): Gas and solid samples collected with a water-cooled sample probe. Gas temperature measurements made with a suction pyrometer. Mean velocity data were not used since the measurement techniques were unreliable. Water-cooled walls removed 30-35% of the thermal input. The hydraulic diameter was calculated to be 2.0 m. Part of the same study as the Hein data sets in category D.2 (coal combustion with swirl).

Thurgood (9): Gas and solid samples collected with a water-quenched isokinetic probe.

Michel and Payne (61): Gas and solid samples collected with a water-cooled probe. Gas temperature measurements made with a suction pyrometer. Mean velocity data were not used since the measurement techniques were unreliable. Water-cooled walls removed 31-36% of the thermal input. The hydraulic radius was calculated to be 1.90 m.

Rees (62): Gas and solid samples collected with a water-quenched probe. Gas temperature measurements made with a suction pyrometer.

### 2. With Swirl

Asay (63): Gas and solid samples collected with a water-quenched isokinetic probe. The Jones data set in category A.2 (non-reacting gaseous flow with swirl) simulated this data set (velocity measurements).

Hein and Leuckel (60): Gas and solid samples collected with a water-cooled probe. Gas temperature measurements made with a suction pyrometer. Mean velocity data were not used since the measurement techniques were unreliable. Water-cooled walls removed 30-35% of the thermal input. The hydraulic radius was calculated to be 2.0 m. Part of the same study as the Hein data set in category D.1 (coal combustion without swirl).

Harding (59): Gas and solid samples collected with a water-quenched probe.

Godoy et al. (64): Gas samples collected with water-cooled probe. Gas temperature measurements made with a thermocouple. No tabulated data available, but used because of very detailed measurements. Same reactor used in Hassan data set in category C.1.

#### E. COAL GASIFICATION

Soelberg (70): Gas and solid samples collected with a water-quenched probe.

Brown (66): Gas and solid samples, for three data sets, collected with a water-quenched probe.

Azuhata et al. (65): Gas and solid samples, single data set, collected with water-quenched probe.

#### F. COAL SLURRY COMBUSTION

Rawlins (72): Gas and solid samples, wall temperatures; single data set; collected with water-quenched probe.



## VI. DETAILED DATA PRESENTATION FORMAT

Table 6 is an example of the Asay data set (63) in the format that has been selected for direct computer application. The first section gives the input data necessary for the code to solve the system. Following the input section are the experimental measurements that will be compared against the model predictions. Each type of measurement (e.g. Ar gas mole fraction) is presented as a group. The variable name and number of axial locations are supplied first. Then, for each axial location, the radial locations and variable measurements are given. All of the data presented are format free, except for the logical and alphanumeric input. SI units (kg, m, s) are used exclusively, except for quarl angle where degrees are used. Coal analysis is expressed as mass fractions. Gas species measurements are in mole fractions or in parts per million. Table 7 lists all of the various measurements reported in this study. Abbreviations and units are also listed.

Table 8 is an example of the same data set in tabular form. The first section provides the input data. In each successive section, all of the data for a particular axial location is then presented. It should be noted that, because of the limitations of this type of table and for effective utilization of space, not every datum point of the data cases are included in these tables. Indeed, in some cases there may be a significant portion of the data that has been excluded (for example, detailed measurements near the inlets). For this reason, as well as for convenience, it is recommended that anyone wishing to use these data sets extensively obtain the complete data on magnetic tape from Brigham Young University.



TABLE 6 (Continued)

0.0 , 0.03 , 0.05 , 0.07 , 0.1 ,	!	0.0015, 0.0023, 0.0072, 0.0210, 0.0607, !
0.0282, 0.0269, 0.0255, 0.0169, 0.0035	!	1.02 , 5 ,
1.02 , 5 ,	!	0.0 , 0.03 , 0.05 , 0.07 , 0.1 ,
0.0 , 0.03 , 0.05 , 0.07 , 0.1 ,	!	0.0008, 0.0039, 0.0320, 0.0540, 0.0834, !
0.0259, 0.0244, 0.0087, 0.0060, 0.0 ,	!	1.09 , 5 ,
1.09 , 5 ,	!	0.0 , 0.03 , 0.05 , 0.07 , 0.1 ,
0.0 , 0.03 , 0.05 , 0.07 , 0.1 ,	!	0.0006, 0.0021, 0.0173, 0.0658, 0.0933, !
0.0227, 0.0212, 0.0109, 0.0025, 0.0 ,	!	1.32 , 5 ,
1.32 , 5 ,	!	0.0 , 0.03 , 0.05 , 0.07 , 0.1 ,
0.0 , 0.03 , 0.05 , 0.07 , 0.1 ,	!	0.0019, 0.0037, 0.0095, 0.0143, 0.0143, !
0.0269, 0.0214, 0.0087, 0.0066, 0.0078,	!	1.40 , 5 ,
1.40 , 5 ,	!	0.0 , 0.03 , 0.05 , 0.07 , 0.1 ,
0.0 , 0.03 , 0.05 , 0.07 , 0.1 ,	!	0.0030, 0.0016, 0.0072, 0.0231, 0.0256, !
0.0247, 0.0200, 0.0101, 0.0046, 0.0024,	!	*****
.....	!	N2 !VARIABLE (F)
02 !VARIABLE (F)	!	10 !NO. OF AXIAL LOCATIONS
10 ,	!	0.1 , 5 ,
0.1 , 5 ,	!	!Z1, NO. OF RADIAL LOCATIONS
0.0 , 0.03 , 0.05 , 0.07 , 0.1 ,	!	0.0 , 0.03 , 0.05 , 0.07 , 0.1 , !RADIAL LOCATIONS
0.1666, 0.238 , 0.0929, 0.1369, 0.1463,	!	0.7733, 0.7419, 0.7758, 0.7742, 0.7721, !F(X,Z) MOLE FRAC.
0.18 , 5 ,	!	0.18 , 5 ,
0.0 , 0.03 , 0.05 , 0.07 , 0.1 ,	!	0.0 , 0.03 , 0.05 , 0.07 , 0.1 ,
0.1496, 0.0523, 0.1337, 0.1450, 0.1455,	!	0.7753, 0.7773, 0.8057, 0.8088, 0.8087, !
0.41 , 5 ,	!	0.41 , 5 ,
0.0 , 0.03 , 0.05 , 0.07 , 0.1 ,	!	0.0 , 0.03 , 0.05 , 0.07 , 0.1 ,
0.0443, 0.0181, 0.0509, 0.1329, 0.1333,	!	0.7204, 0.7359, 0.7651, 0.7750, 0.8092, !
0.48 , 5 ,	!	0.48 , 5 ,
0.0 , 0.03 , 0.05 , 0.07 , 0.1 ,	!	0.0 , 0.03 , 0.05 , 0.07 , 0.1 ,
0.0218, 0.0060, 0.0165, 0.1128, 0.1693,	!	0.7082, 0.7176, 0.7452, 0.7745, 0.7721, !
0.71 , 5 ,	!	0.71 , 5 ,
0.0 , 0.03 , 0.05 , 0.07 , 0.1 ,	!	0.0 , 0.03 , 0.05 , 0.07 , 0.1 ,
0.0063, 0.0053, 0.0062, 0.0384, 0.1001,	!	0.7083, 0.7093, 0.7165, 0.7508, 0.7685, !
0.79 , 5 ,	!	0.79 , 5 ,
0.0 , 0.03 , 0.05 , 0.07 , 0.1 ,	!	0.0 , 0.03 , 0.05 , 0.07 , 0.1 ,
	!	0.7244, 0.7256, 0.7276, 0.7664, 0.7710, !
	!	1.02 , 5 ,

TABLE 7  
LISTING OF VARIABLE ABBREVIATIONS FOUND  
IN DATA SETS

<u>Abbreviation</u>	<u>Variable</u>	<u>Units</u>
AR	argon gas concentration	mole fraction
ASH	ultimate analysis ash	mass fraction
C	ultimate analysis carbon	mass fraction
CO	carbon monoxide gas concentration	mole fraction
CO <sub>2</sub>	carbon-dioxide gas concentration	mole fraction
COS	carbon-sulfide gas concentration	ppm
CS <sub>2</sub>	carbon disulfide gas concentration	ppm
H	ultimate analysis hydrogen	mass fraction
H <sub>2</sub>	hydrogen gas concentration	mole fraction
HCN	hydrogen cyanide gas concentration	ppm
H <sub>2</sub> O	steam gas concentration	mole fraction
H <sub>2</sub> S	hydrogen sulfide gas concentration	ppm
N	ultimate analysis nitrogen	mass fraction
N <sub>2</sub>	nitrogen gas concentration	mole fraction
NH <sub>3</sub>	ammonia gas concentration	ppm
NO	NO <sub>x</sub> gas concentration	ppm
O	ultimate analysis oxygen	mass fraction
O <sub>2</sub>	oxygen gas concentration	mole fraction
PURMS	RMS axial particle velocity	m/s
PUVEL	mean axial particle velocity	m/s
PFLX	mean axial particle flux	kg m <sup>2</sup> /s
S	ultimate analysis sulfur	mass fraction
SO <sub>2</sub>	sulfur dioxide gas concentration	ppm
TEMP	mean temperature	K
VRMS	RMS axial gas velocity	m/s
UVEL	mean axial gas velocity	m/s
V-W	reynolds shear stress	m/s
VVEL	mean radial gas velocity	m/s
WRMS	RMS tangential gas velocity	m/s
WVEL	mean tangential gas velocity	m/s

TABLE 8

## EXAMPLE DATA SET IN TABULAR FORM

DATA SET D.2.4 ASAY (63)				DATA SET D.2.4 ASAY (63)					
GEOMETRY (m)		MASS FLOW RATES (kg/s)		AR (mole frac.)					
Primary tube ID	0.0223	Primary gas	0.00610	AXIAL POSITION (m)		RADIAL POSITION (m)			
Secondary tube ID	0.0842	Primary solids	0.00380	0.000	0.030	0.050	0.070	0.100	
Chamber ID	0.2030	Secondary gas	0.01942	0.100	0.0560	0.0337	0.0188	0.0147	0.0144
Chamber length	1.5200	Secondary solids	0.00000	0.180	0.0503	0.0314	0.0143	0.0126	0.0124
Pri. wall thick	0.0032			0.410	0.0363	0.0295	0.0219	0.0147	0.0125
Quarl half angle (degrees)	0.0000			0.480	0.0324	0.0284	0.0247	0.0160	0.0124
Quarl length	0.0400			0.710	0.0248	0.0246	0.0230	0.0196	0.0150
				0.790	0.0253	0.0250	0.0236	0.0217	0.0173
GAS PROPERTIES				1.020	0.0235	0.0228	0.0194	0.0174	0.0155
	Primary	Secondary		1.090	0.0226	0.0223	0.0201	0.0167	0.0145
Temperature (K)	310.0	590.0		1.320	0.0205	0.0192	0.0178	0.0171	0.0171
Pressure (kPa)	86.0	86.0		1.400	0.0206	0.0187	0.0172	0.0163	0.0161
Swirl number	0.0	2.0							
				H2 (mole frac.)					
GAS COMPOSITION (mole fraction - dry basis)				AXIAL POSITION (m)		RADIAL POSITION (m)			
Species	Primary	Secondary		0.000	0.030	0.050	0.070	0.100	
O2	0.2012	0.2094		0.100	0.0000	0.0154	0.0000	0.0000	0.0000
N2	0.7506	0.7812		0.180	0.0000	0.0087	0.0000	0.0000	0.0000
AR	0.0481	0.0094		0.410	0.0216	0.0190	0.0066	0.0000	0.0000
				0.480	0.0294	0.0271	0.0152	0.0000	0.0000
				0.710	0.0314	0.0319	0.0281	0.0143	0.0026
				0.790	0.0282	0.0269	0.0255	0.0169	0.0039
				1.020	0.0259	0.0244	0.0087	0.0060	0.0000
				1.090	0.0227	0.0212	0.0109	0.0025	0.0000
				1.320	0.0269	0.0214	0.0087	0.0066	0.0078
				1.400	0.0247	0.0200	0.0101	0.0046	0.0024
COAL COMPOSITION				O2 (mole frac.)					
Ultimate Analysis (mass frac., dry)		Proximate Analysis (mass frac., as recd.)		AXIAL POSITION (m)		RADIAL POSITION (m)			
C	0.6620	Moisture	0.2784	0.000	0.030	0.050	0.070	0.100	
H	0.0472	Volatile matter	0.3291	0.100	0.1666	0.0238	0.0929	0.1369	0.1468
O	0.2271	Fixed Carbon	0.3464	0.180	0.1496	0.0523	0.1337	0.1450	0.1455
N	0.0097	Ash	0.0497	0.410	0.0443	0.0181	0.0509	0.1329	0.1334
S	0.0052			0.480	0.0218	0.0060	0.0165	0.1128	0.1690
Ash	0.0505			0.710	0.0063	0.0053	0.0062	0.0384	0.1001
				0.790	0.0015	0.0023	0.0072	0.0210	0.0607
				1.020	0.0008	0.0039	0.0320	0.0540	0.0834
				1.090	0.0006	0.0021	0.0173	0.0658	0.0933
				1.320	0.0019	0.0037	0.0095	0.0143	0.0143
				1.400	0.0030	0.0016	0.0072	0.0231	0.0256
Heating Value (J/kg, daf)		2.9763E+07							
Mean Particle Size (m)		3.5003E-05							
Bulk Particle Density (kg/m <sup>3</sup> )		1.3403E+03							

TABLE 8 (Continued)

DATA SET D.2.4  
ASAY (63)

LINE

N2

AXIAL POSITION	RADIAL POSITION				
	0.000	0.030	0.050	0.070	0.100
0.100	0.7733	0.7419	0.7758	0.7742	0.7721
0.180	0.7751	0.7771	0.8057	0.8038	0.8087
0.410	0.7204	0.7359	0.7651	0.7750	0.8092
0.480	0.7082	0.7174	0.7452	0.7745	0.7721
0.710	0.7083	0.7093	0.7165	0.7508	0.7685
0.790	0.7244	0.7256	0.7276	0.7664	0.7710
1.020	0.7284	0.7317	0.7609	0.7673	0.7742
1.090	0.7358	0.7373	0.7582	0.7747	0.7788
1.320	0.7274	0.7389	0.7648	0.7701	0.7692
1.400	0.7333	0.7446	0.7652	0.7761	0.7786

CH4

AXIAL POSITION	RADIAL POSITION				
	0.000	0.030	0.050	0.070	0.100
0.100	0.0000	0.0070	0.0000	0.0000	0.0000
0.180	0.0001	0.0007	0.0000	0.0000	0.0000
0.410	0.0037	0.0024	0.0005	0.0000	0.0000
0.480	0.0054	0.0034	0.0012	0.0000	0.0000
0.710	0.0064	0.0053	0.0048	0.0019	0.0003
0.790	0.0030	0.0023	0.0027	0.0016	0.0003
1.020	0.0022	0.0021	0.0006	0.0004	0.0001
1.090	0.0022	0.0021	0.0008	0.0002	0.0000
1.320	0.0031	0.0023	0.0007	0.0005	0.0005
1.400	0.0036	0.0023	0.0008	0.0003	0.0002

CO

AXIAL POSITION	RADIAL POSITION				
	0.000	0.030	0.050	0.070	0.100
0.100	0.0005	0.0417	0.0057	0.0011	0.0008
0.180	0.0060	0.0244	0.0008	0.0002	0.0003
0.410	0.0534	0.0492	0.0200	0.0024	0.0011
0.480	0.0711	0.0682	0.0430	0.0052	0.0007
0.710	0.0731	0.0719	0.0654	0.0365	0.0100
0.790	0.0629	0.0604	0.0584	0.0410	0.0134
1.020	0.0607	0.0581	0.0254	0.0165	0.0081
1.090	0.0538	0.0515	0.0299	0.0098	0.0025
1.320	0.0614	0.0511	0.0263	0.0210	0.0209
1.400	0.0582	0.0465	0.0274	0.0142	0.0109

DATA SET D.2.4  
ASAY (63)

LINE

CO2

AXIAL POSITION	RADIAL POSITION				
	0.000	0.030	0.050	0.070	0.100
0.100	0.0036	0.1428	0.1068	0.0731	0.0658
0.180	0.0187	0.1257	0.0456	0.0334	0.0331
0.410	0.1203	0.1461	0.1349	0.0731	0.0438
0.480	0.1317	0.1493	0.1542	0.0915	0.0458
0.710	0.1497	0.1510	0.1560	0.1385	0.1034
0.790	0.1547	0.1569	0.1549	0.1514	0.1335
1.020	0.1585	0.1570	0.1530	0.1384	0.1147
1.090	0.1623	0.1633	0.1628	0.1302	0.1129
1.320	0.1587	0.1635	0.1721	0.1705	0.1724
1.400	0.1567	0.1662	0.1719	0.1653	0.1650

H2O

AXIAL POSITION	RADIAL POSITION				
	0.000	0.030	0.050	0.070	0.100
0.100	0.0000	0.2040	0.0827	0.0540	0.0449
0.180	0.0985	0.1172	0.0342	0.0248	0.0249
0.410	0.1806	0.1354	0.1075	0.0552	0.0132
0.480	0.3028	0.1445	0.1338	0.0697	0.0345
0.710	0.1583	0.2062	0.1537	0.1187	0.0880
0.790	0.1340	0.1249	0.1291	0.1230	0.1006
1.020	0.1312	0.1275	0.1168	0.1057	0.0915
1.090	0.1450	0.1290	0.1229	0.0965	0.0811
1.320	0.1277	0.1296	0.1271	0.1236	0.1248
1.400	0.1291	0.1304	0.1287	0.1378	0.1200

H2N

AXIAL POSITION	RADIAL POSITION				
	0.000	0.030	0.050	0.070	0.100
0.100	55.0	27.0	2.0	0.0	4.0
0.180	67.0	12.0	2.0	4.0	0.0
0.410	342.0	223.0	14.0	11.0	13.0
0.480	475.0	297.0	93.0	25.0	24.0
0.710	97.0	158.0	126.0	52.0	4.0
0.790	61.0	162.0	131.0	83.0	29.0
1.020	82.0	64.0	20.0	17.0	15.0
1.090	77.0	90.0	31.0	26.0	22.0
1.320	09.0	63.0	9.0	10.0	16.0
1.400	37.0	52.0	8.0	5.0	5.0

TABLE 8 (Continued)

DATA SET D.2.4  
ASAY (63) !INVE

NH3

AXIAL POSITION	RADIAL POSITION				
	0.000	0.030	0.050	0.070	0.100
0.100	58.0	89.0	39.0	30.0	26.0
0.180	45.0	29.0	22.0	25.0	36.0
0.410	145.0	129.0	49.0	38.0	15.0
0.480	292.0	294.0	179.0	92.0	45.0
0.710	301.0	310.0	280.0	119.0	60.0
0.790	256.0	273.0	224.0	170.0	86.0
1.020	280.0	247.0	119.0	106.0	71.0
1.090	205.0	210.0	115.0	122.0	82.0
1.320	345.0	302.0	133.0	99.0	137.0
1.400	344.0	245.0	130.0	69.0	52.0

NO

AXIAL POSITION	RADIAL POSITION				
	0.000	0.030	0.050	0.070	0.100
0.100	5.0	550.0	360.0	235.0	210.0
0.180	65.0	858.0	170.0	115.0	105.0
0.410	220.0	290.0	300.0	180.0	110.0
0.480	200.0	240.0	280.0	210.0	125.0
0.710	210.0	210.0	240.0	290.0	265.0
0.790	240.0	240.0	260.0	290.0	320.0
1.020	210.0	220.0	270.0	290.0	300.0
1.090	210.0	210.0	240.0	255.0	260.0
1.320	190.0	205.0	265.0	270.0	240.0
1.400	195.0	210.0	250.0	290.0	295.0

N

AXIAL POSITION	RADIAL POSITION				
	0.000	0.030	0.050	0.070	0.100
0.100	0.0100	0.0100	0.0080	0.0060	0.0090
0.180	0.0090	0.0080	0.0040	0.0070	0.0050
0.410	0.0110	0.0090	0.0090	0.0110	0.0100
0.480	0.0110	0.0080	0.0040	0.0120	0.0070
0.710	0.0080	0.0090	0.0070	0.0060	0.0040
0.790	0.0050	0.0070	0.0070	0.0060	0.0050
1.020	0.0050	0.0010	0.0010	0.0020	0.0010
1.090	0.0100	0.0100	0.0120	0.0150	0.0050
1.320	0.0050	0.0040	0.0030	0.0030	0.0040
1.400	0.0040	0.0020	0.0040	0.0030	0.0040

DATA SET D.2.4  
ASAY (63) !INVE

C

AXIAL POSITION	RADIAL POSITION				
	0.000	0.030	0.050	0.070	0.100
0.100	0.6400	0.6010	0.3650	0.2220	0.2640
0.180	0.6500	0.5930	0.2290	0.1710	0.2130
0.410	0.7590	0.6030	0.4700	0.2020	0.1490
0.480	0.6390	0.6190	0.5240	0.2640	0.2240
0.710	0.6530	0.6860	0.6390	0.5240	0.3230
0.790	0.5440	0.5170	0.4830	0.4450	0.3070
1.020	0.4330	0.3760	0.3720	0.3820	0.3560
1.090	0.4000	0.3890	0.3130	0.2820	0.2450
1.320	0.4090	0.3970	0.2720	0.2020	0.3140
1.400	0.5080	0.4400	0.4030	0.3600	0.3100

H

AXIAL POSITION	RADIAL POSITION				
	0.000	0.030	0.050	0.070	0.100
0.100	0.0440	0.0230	0.0150	0.0180	0.0200
0.180	0.0450	0.0320	0.0240	0.0230	0.0240
0.410	0.0340	0.0210	0.0130	0.0100	0.0110
0.480	0.0420	0.0260	0.0150	0.0150	0.0190
0.710	0.0290	0.0230	0.0180	0.0160	0.0140
0.790	0.0240	0.0510	0.0110	0.0100	0.0090
1.020	0.0190	0.0160	0.0160	0.0130	0.0110
1.090	0.0140	0.0180	0.0130	0.0130	0.0090
1.320	0.0160	0.0110	0.0120	0.0100	0.0110
1.400	0.0180	0.0140	0.0130	0.0120	0.0140

O'S

AXIAL POSITION	RADIAL POSITION				
	0.000	0.030	0.050	0.070	0.100
0.100	0.2600	0.2860	0.2540	0.2720	0.2370
0.180	0.2410	0.2120	0.3140	0.3300	0.3430
0.410	0.0940	0.1540	0.1470	0.2860	0.2990
0.480	0.2480	0.1500	0.2000	0.2040	0.2500
0.710	0.1630	0.1790	0.1510	0.1960	0.3450
0.790	0.1710	0.2460	0.1400	0.1910	0.2330
1.020	0.2320	0.2660	0.1900	0.2240	0.1800
1.090	0.4270	0.2020	0.2350	0.2410	0.2280
1.320	0.1770	0.1740	0.2380	0.3100	0.2130
1.400	0.1100	0.1580	0.1710	0.1800	0.2300

TABLE 8 (Continued)

DATA SET D 2.4  
ASAY (53)

INVS

AXIAL POSITION	ASH				
	0.000	0.030	0.050	0.070	0.100
0.100	0.0450	0.0500	0.3580	0.4810	0.4710
0.180	0.0540	0.1530	0.4290	0.4690	0.4140
0.410	0.1020	0.2120	0.3610	0.4910	0.5310
0.480	0.0610	0.1960	0.2570	0.5050	0.5000
0.710	0.1460	0.1940	0.1860	0.2580	0.3130
0.790	0.2520	0.2140	0.3590	0.3480	0.4450
1.020	0.3070	0.3410	0.4210	0.3790	0.4520
1.090	0.1480	0.3820	0.4270	0.4490	0.5130
1.320	0.3930	0.4110	0.4750	0.4750	0.4570
1.400	0.3590	0.3850	0.4890	0.4440	0.4420



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79. Price, T.D., "Pollutant Formation in an Entrained Coal Gasifier," MS Thesis, Brigham Young University, Provo, UT (1980).
80. Hedman, P.O., Smoot, L.D., Fletcher, T.H., Smith, P.J. and Blackham. A.U., "Prediction and Measurement of Entrained Flow Coal Gasification Processes," Final Report Volume I prepared for U.S. DOE, Contract No. DE-AC21-81MC16518 (1985).
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APPENDIX A

SWIRL GENERATOR AND SPRAY INJECTOR SPECIFICATIONS

APPENDIX A  
SWIRL SPECIFICATIONS

DATA SETS A.2.3, A.2.4, C.2.3, C.2.4 (40)

Primary Swirl: Centered inside the 6" diameter furnace pipe is a 2" diameter stainless steel tube (wall thickness = 1/16"), concentric inside a 3" diameter stainless steel tube. The annulus between the 2" and 3" tubes is filled with an aluminum based epoxy. The 6" pipe section is approximately 6' in length. The concentric tubing section is approximately 3' in length. Four slots, 1/8" x 5 1/2", are milled into the tubing section tangent to the inner wall of the 2" tube. These tangential slots provide the swirling component of flow. The magnitude of swirl is controlled by a butterfly valve in the 2" tube as shown in Figure 4. The valve controls the division of the inner flow into either tangential injection or axial injection.

Secondary Swirl: The secondary swirl generator consists of a series of 36 vanes on a 22" diameter. The vanes were individually molded from an aluminum based epoxy, and are of 2 3/16" width and 2 1/4" length with a 1/4" radius at the leading edge. Each vane is attached to a 3/16" diameter stainless steel ground shaft. The shafts are supported in bronze bushings; these, in turn, are press-fitted into a 1/2" aluminum plate of 26" diameter, which is mounted in 1/2" plywood. Backing up the vanes is a 1/4" aluminum plate of 26" diameter. Vane control is gained through a chain and sprocket for chain of 0.1475" pitch. Chain tension is gained through a spring-bar tensioning device. The entire mechanism allows  $\pm 75$  degree vane angle by turning one control shaft.



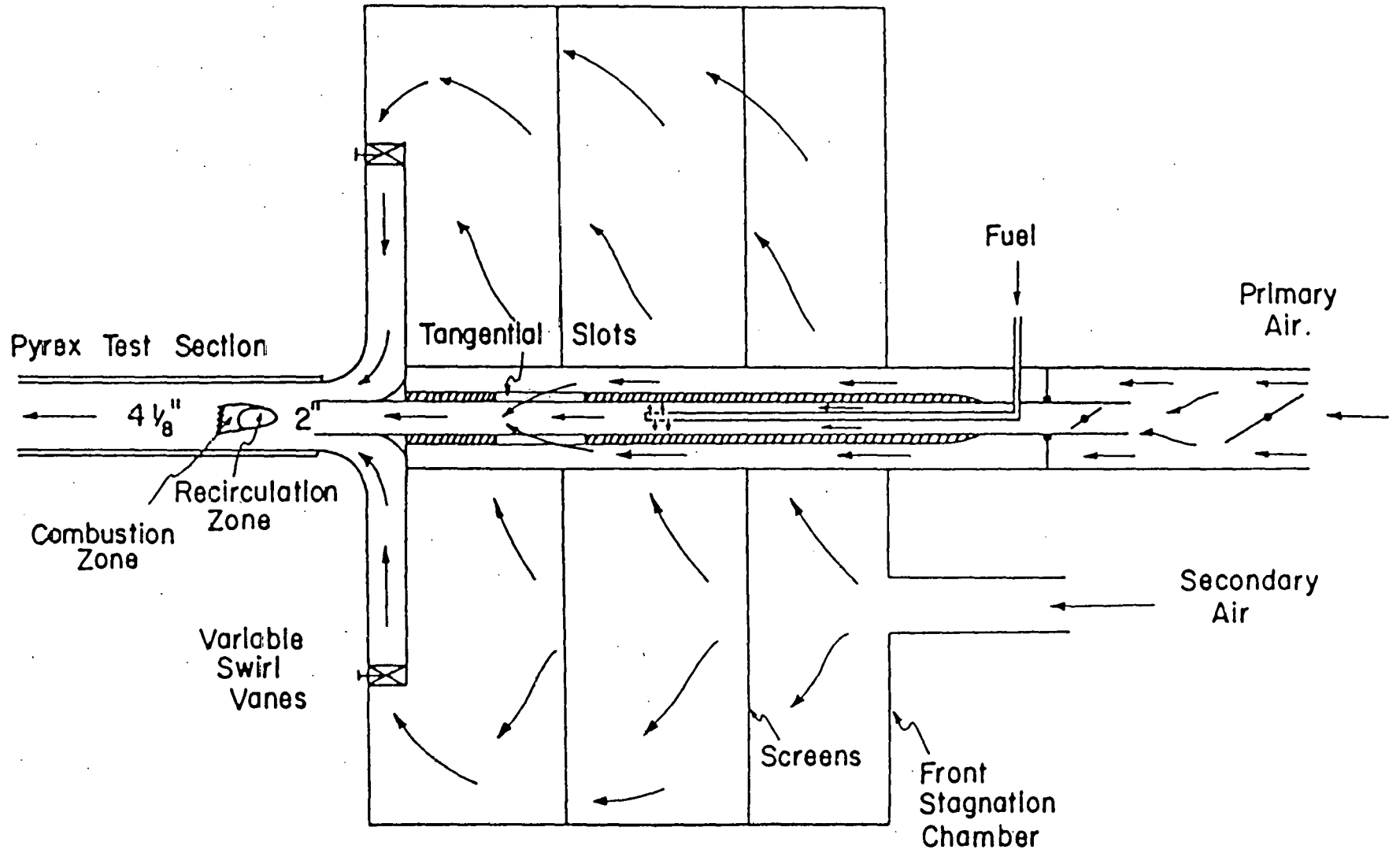


Figure 4. Swirl generator used in data sets A.2.3, A.2.4, C.2.3, C.2.4 (40).

Experimental swirl numbers are made by measuring and integrating the velocity profiles in the inlet region.

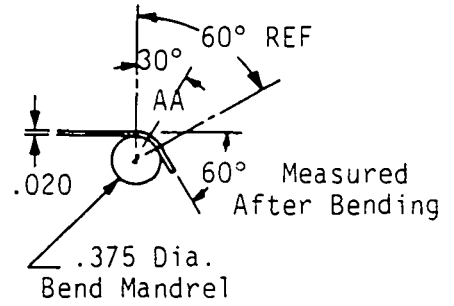
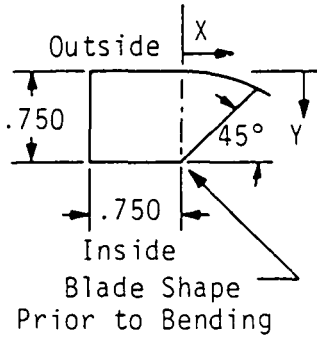
DATA SETS A.2.1, C.2.2 (45)

Secondary Swirl: A set of swirl vanes (57 mm O.D.) is concentrically located within the tube around a 19 mm O.D. centrally positioned fuel delivery tube, Figure 5. The dilution air is introduced through flow straighteners in the outer annulus. The swirl air passes through a set of swirl vanes which impart an angle of turn to the flow, 60 degrees in the present case. For a swirl to dilution ratio of unity, the value used in the present study, the swirl number obtained by integrating across the swirl vanes is 0.8; that obtained by integrating the total inlet mass flux is 0.3.

DATA SETS A.1.3, A.2.2, B.1.1, B.1.2, B.2.1, B.2.2, B.2.3, C.1.1, C.1.2, C.2.1, D.1.1, D.1.2, D.1.3, D.1.4, D.1.5, D.2.1, D.2.2, D.2.3, D.2.4

Secondary Swirl: The swirl generator that is used for these data sets is of the type developed by Beér and Chigier for the IFRF reactors (18). The swirl generator consists of two sets of triangular blocks, one set fixed in position, the other set attached to a moveable plate resting on the fixed blocks. Since all air must pass through the channels made by the two sets of blocks, a non-swirl condition is created when the channels are directed toward the primary tube. This is shown in Figure 6 with the moveable blocks in the solid line positions. A maximum swirl is obtained when all air channels are directed toward a tangent to the circumference of the secondary annulus. This is shown by the dashed lined position in Figure 6. An intermediate positioning of the blocks allows only part of the air to receive a tangential motion and thus an intermediate swirl condition is

DSC 60° Swirl Vanes  
12 Each



Material: 3000 Series Stainless

Braze Mandrel

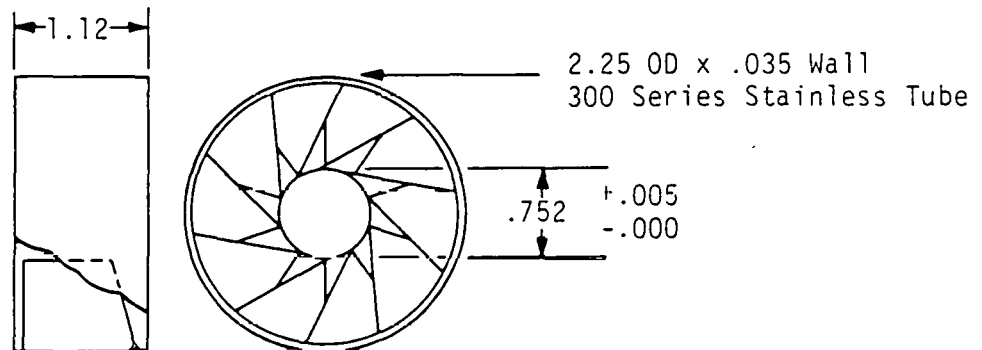
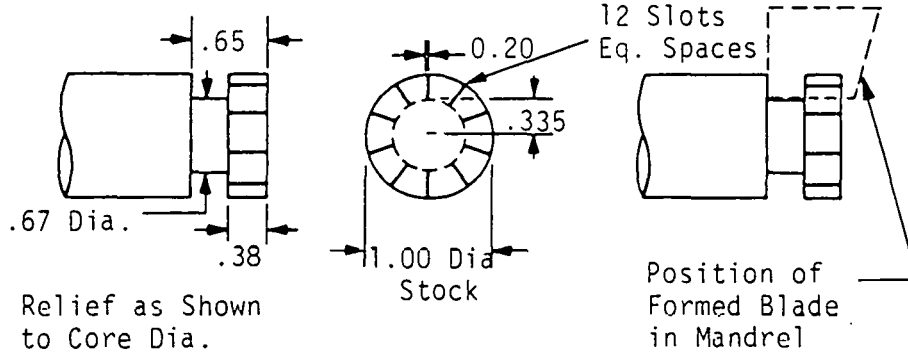


Figure 5. Swirl generator used in data sets A.2.1, C.2.2 (45).

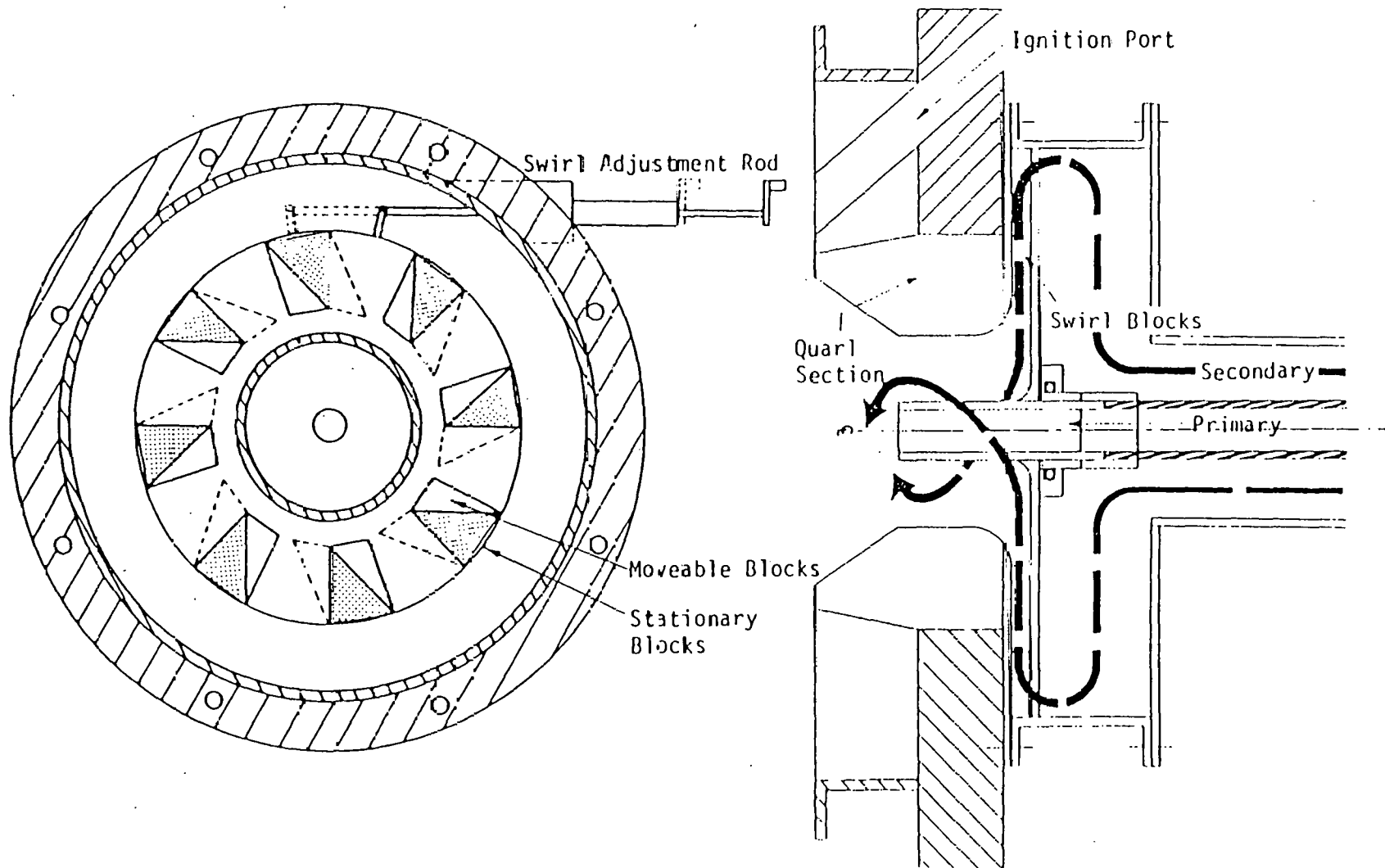


Figure 6. Swirl generator design used in data sets A.1.3, A.2.2, B.1.1, E.1.2, B.2.1, B.2.2, B.2.3, C.1.1, C.1.2, C.2.1, D.1.1, D.1.2, D.1.3, C.1.4, D.1.5, D.2.1, D.2.2, D.2.3, D.2.4 (26). For exact specifications for each data set, see references from Table 5.

established. An exploded view of the swirl generator assembly is shown in Figure 7.

Theoretical Swirl numbers are determined using the angles of the channels. For data sets A.1.3 and A.2.2 experimental swirl numbers are determined by integrating the inlet velocity profiles. These profiles are included in the data sets to be of help in modeling swirling flows. For the other data sets that report an experimental swirl number (BYU), it has been determined through the use of a honeycomb device designed and used by Leavitt (26). It is shown schematically in Figure 8. The torque on the honeycomb caused by the swirling flow was balanced by a leaf spring made of shimstock steel and the angle of deflection was measured. In calibrating the leaf spring, a known force was attached to the shimstock and the angle of deflection was measured; therefore, the angle of deflection of the flow during calibration was related to a known force. Using the angular momentum and the axial momentum, a secondary swirl number was calculated.

#### DATA SET F.1 (72)

Figure 9 provides a schematic diagram of the burner nozzle and swirl block generator used for Data Set F.1. Further details are provided by Rawlins (72).

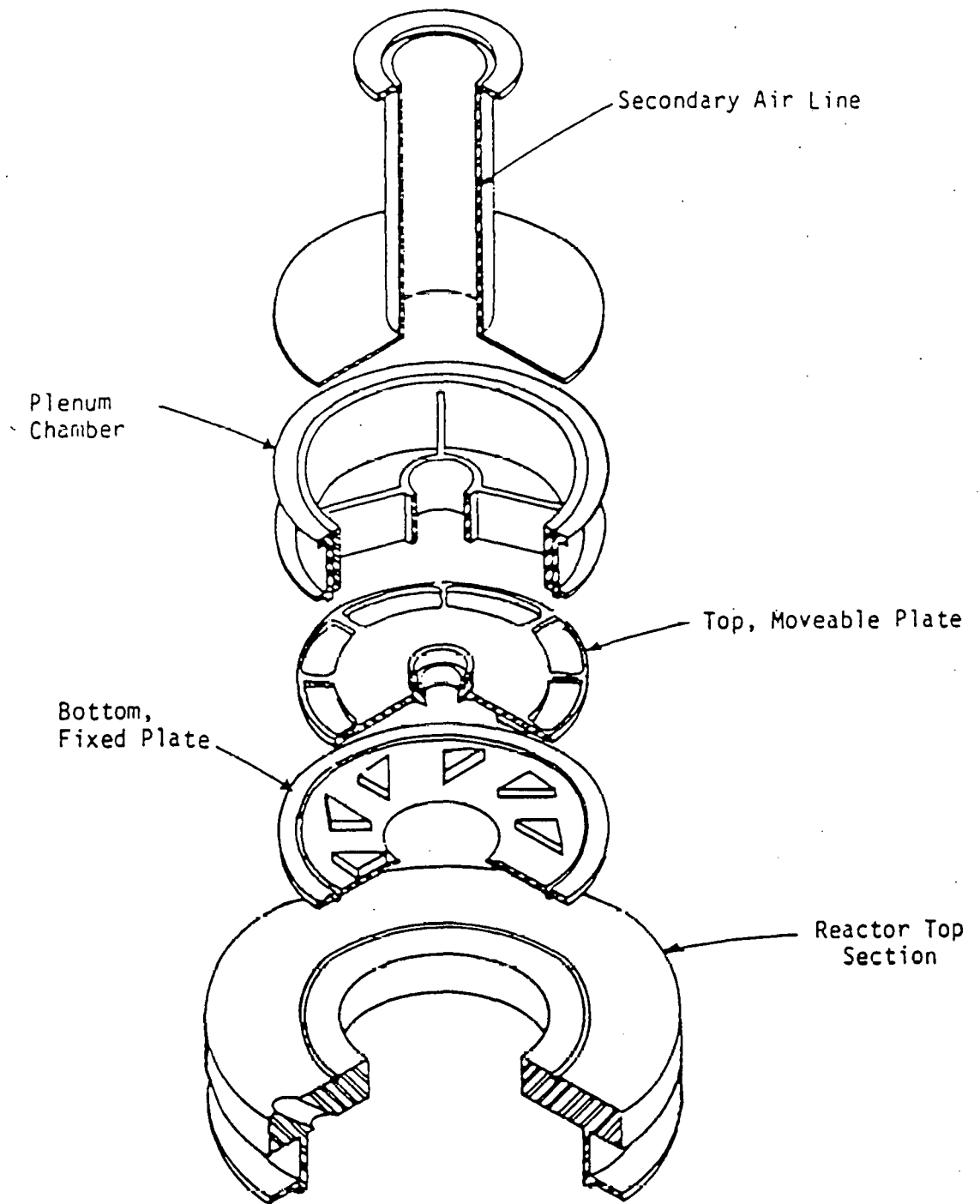


Figure 7. Exploded view of moveable block swirl generator assembly used in data sets A.1.3, A.2.2, B.1.1, B.1.2, B.2.1, B.2.2, B.2.3, D.1.3, D.1.5, D.2.3, D.2.4 (26).

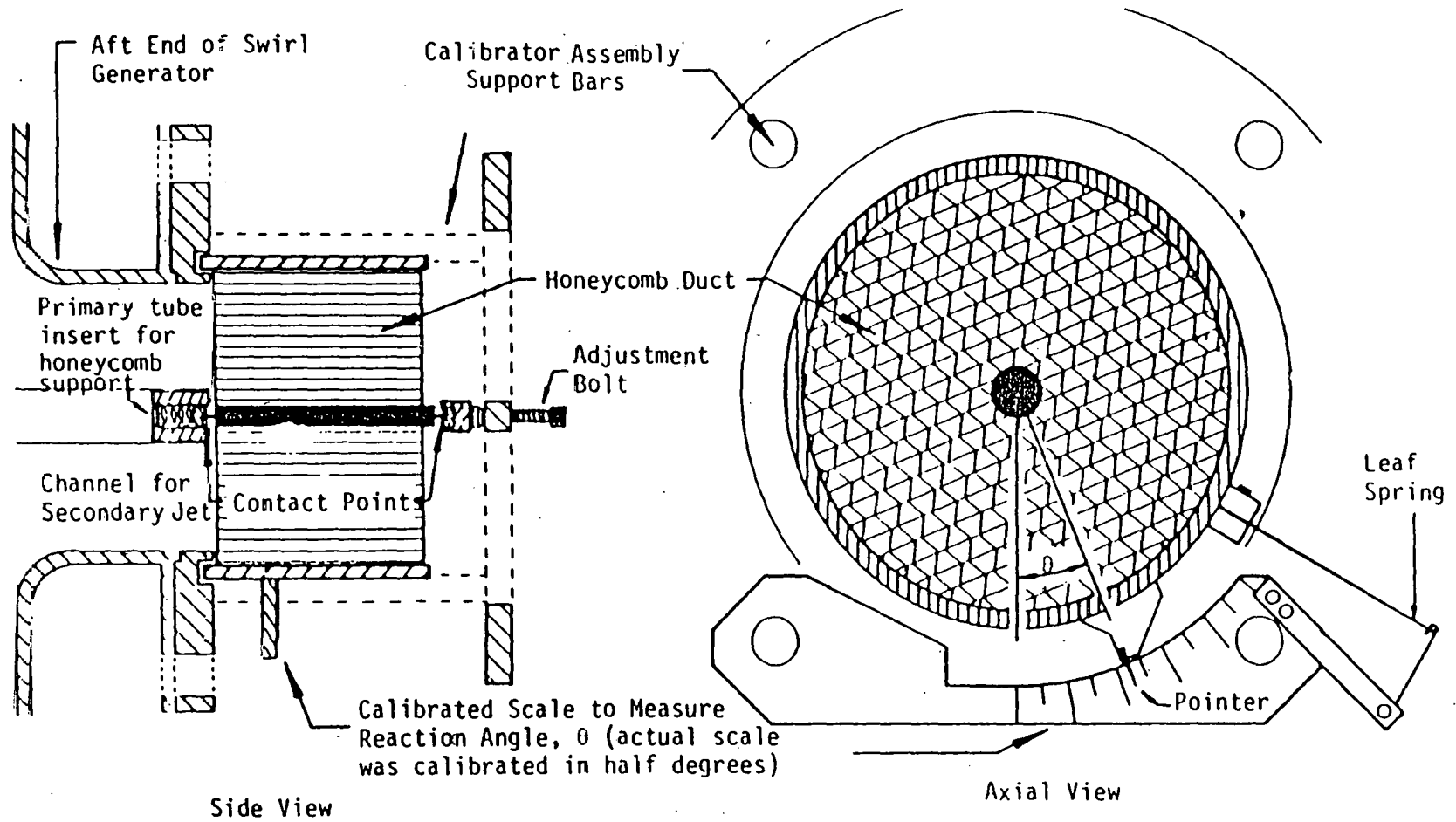


Figure 8. Diagrams of swirl number calibrator used to measure tangential momentum in the moveable block swirl generator used in data sets D.1.3, D.1.5, D.2.3, D.2.4 (26).

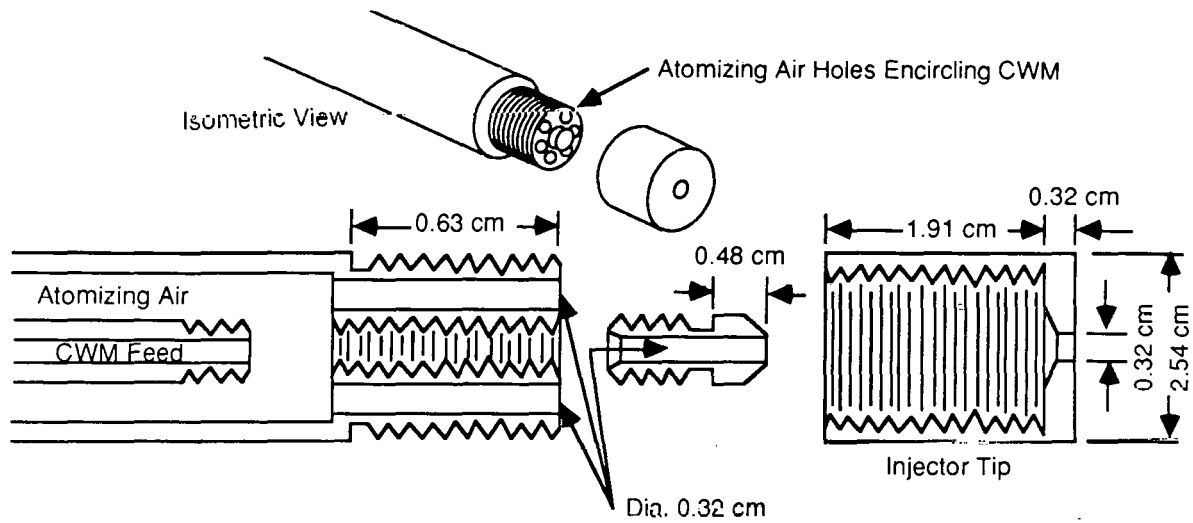


Figure 9a. CWM nozzle used in combustion tests (79).

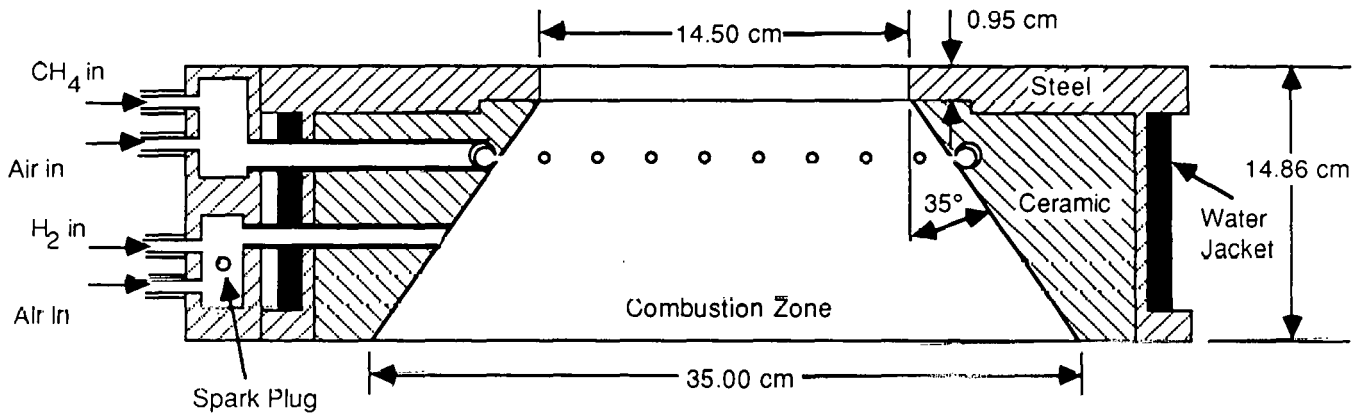


Figure 9b. Quarl section showing hydrogen air-spark ignition and methane injector (79).

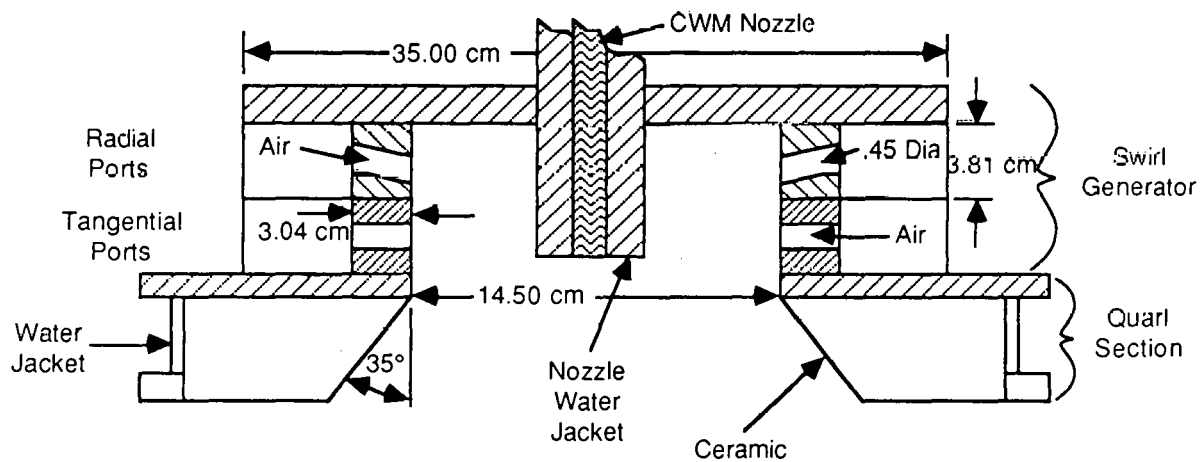


Figure 9c. Schematic of CWM burner showing CWM atomizing nozzle, nozzle water jacket, swirl generator and quarl section (72).



APPENDIX B

DATA SETS

DATA SET A.1.1  
OWEN (29)

GEOMETRY (m)		MASS FLOW RATES (kg/s)	
Primary tube ID	0.0635	Primary gas	0.00770
Secondary tube ID	0.0800	Primary solids	0.00000
Chamber ID	0.1270	Secondary gas	0.68910
Chamber length	1.2200	Secondary solids	0.00000
Pri. wall thick	0.0005		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.0000		

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	298.0	298.0
Pressure (kPa)	101.0	101.0
Swirl number	0.0	0.0

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
N2	0.7900	0.7900
O2	0.2100	0.2100

SOLID PROPERTIES

Mean Particle size (m)	0.0000E+00
Bulk Particle density (kg/m3)	0.0000E+00

DATA SET A.1.1  
OWEN (29)

		UVEL (m/s)							
AXIAL POSITION (m)		0.020	0.025	0.030	0.035	0.040	0.045	0.050	0.055
1.250		-3.29	*****	8.53	19.20	22.40	21.20	6.73	*****
3.000		-7.69	*****	-0.74	*****	10.40	15.50	17.80	18.00
5.000		-2.65	*****	6.20	12.00	15.20	16.20	14.80	9.81
7.000		5.52	7.79	9.81	11.00	12.00	12.50	11.30	6.57
9.000		*****	8.80	9.81	10.10	10.20	*****	9.01	5.62

		VVEL (m/s)							
AXIAL POSITION (m)		0.015	0.020	0.025	0.030	0.035	0.040	0.045	0.050
1.250		0.94	*****	2.15	2.14	*****	*****	3.95	4.43
5.000		-1.66	*****	-2.02	-2.64	-2.93	-2.32	-1.45	-1.32
9.000		*****	-1.69	-1.82	-1.65	*****	-1.29	*****	-0.53

DATA SET A.1.2  
TAKAGI ET AL. (34)

DATA SET A.1.2  
TAKAGI ET AL. (34)

GEOMETRY (m)		MASS FLOW RATES (kg/s)	
Primary tube ID	0.0049	Primary gas	0.00052
Secondary tube ID	0.1040	Primary solids	0.00000
Chamber ID	0.1040	Secondary gas	0.05180
Chamber length	0.2500	Secondary solids	0.00000
Pri. wall thick	0.0005		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.0000		

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	293.0	293.0
Pressure (kPa)	101.0	101.0
Swirl number	0.0	0.0

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
N2	0.5950	0.7800
O2	0.0000	0.2100
H2	0.4050	0.0000
AR	0.0000	0.0095

SOLID PROPERTIES

Mean Particle size (m)	0.0000E+00
Bulk Particle density (kg/m3)	0.0000E+00

		H2 (mole frac.)							
		AXIAL POSITION (m)				RADIAL POSITION (m)			
		0.012	0.013	0.014	0.016	0.018	0.019	0.022	0.025
0.030	*****	*****	*****	*****	*****	*****	*****	*****	*****
0.060	0.0000	*****	0.0000	0.0000	0.0000	*****	*****	*****	*****
0.090	0.0131	*****	0.0014	0.0000	0.0000	*****	*****	*****	*****
0.160	*****	0.0255	*****	0.0145	*****	0.0055	0.0000	0.0000	0.0000

		N2 (mole frac.)							
		AXIAL POSITION (m)				RADIAL POSITION (m)			
		0.012	0.013	0.014	0.016	0.018	0.019	0.022	0.025
0.030	*****	*****	*****	*****	*****	*****	*****	*****	*****
0.050	0.7820	*****	0.7790	0.7820	0.7820	*****	*****	*****	*****
0.090	0.7740	*****	0.7790	0.7790	0.7790	0.7790	*****	*****	*****
0.160	*****	0.7790	*****	0.7860	*****	0.7900	0.7930	0.7900	0.7900

		O2 (mole frac.)							
		AXIAL POSITION (m)				RADIAL POSITION (m)			
		0.012	0.013	0.014	0.016	0.018	0.019	0.022	0.025
0.030	*****	*****	*****	*****	*****	*****	*****	*****	*****
0.060	0.2070	*****	0.2070	0.2070	0.2070	*****	*****	*****	*****
0.090	0.2060	*****	0.2060	0.2080	0.2080	0.2080	*****	*****	*****
0.160	*****	0.1990	*****	0.2040	*****	0.2080	0.2080	0.2080	0.2080

DATA SET A.1.2  
TAKAGI ET AL. (34)

UVEL (m/s)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.012	0.013	0.014	0.016	0.018	0.019	0.020	0.025
0.030	5.59	*****	5.66	5.66	5.73	*****	*****	*****
0.060	5.31	*****	5.31	5.31	5.31	*****	*****	*****
0.090	*****	*****	5.72	5.31	5.38	*****	5.45	*****
0.160	*****	6.05	*****	6.05	*****	5.36	*****	4.95

URMS (m/s)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.006	0.008	0.010	0.012	0.013	0.014	0.016	0.019
0.030	0.62	0.46	0.47	0.47	*****	*****	*****	*****
0.060	1.12	*****	0.48	0.49	*****	0.46	*****	*****
0.090	1.03	0.83	*****	*****	*****	0.47	0.47	*****
0.160	0.76	0.73	0.70	*****	0.61	*****	*****	0.52

VRMS (m/s)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.012	0.013	0.014	0.016	0.018	0.019	0.022	0.025
0.030	0.47	*****	0.45	0.43	0.48	*****	*****	*****
0.060	0.47	*****	0.45	0.43	0.43	*****	*****	*****
0.090	*****	0.47	0.48	0.43	*****	*****	*****	*****
0.160	*****	0.69	*****	*****	*****	0.61	0.62	0.52

DATA SET A.1.2  
TAKAGI ET AL. (34)

WRMS (m/s)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.006	0.008	0.010	0.012	0.013	0.014	0.016	0.019
0.030	0.79	*****	0.47	0.45	*****	*****	*****	*****
0.060	1.20	0.71	0.48	0.44	*****	0.44	*****	*****
0.090	1.08	*****	*****	0.48	*****	0.41	0.41	*****
0.160	0.76	0.71	0.65	*****	0.62	*****	0.47	0.47

DATA SET A.1.3  
WEBB (37)

GEOMETRY (m)		MASS FLOW RATES (kg/s)	
Primary tube ID	0.0250	Primary gas	0.01600
Secondary tube ID	0.1300	Primary solids	0.00000
Chamber ID	0.2060	Secondary gas	0.51000
Chamber length	0.7620	Secondary solids	0.00000
Pri. wall thick	0.0013		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.0000		

GAS PROPERTIES		
	Primary	Secondary
Temperature (K)	295.0	285.0
Pressure (kPa)	89.2	89.2
Swirl number	0.0	0.0

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
N2	0.7900	0.7900
O2	0.2100	0.2100

SOLID PROPERTIES

Mean Particle size (m)	0.0000E+0C
Bulk Particle density (kg/m3)	0.0000E+0C

DATA SET A.1.3  
WEBB (37)

UVEL (m/s)

AXIAL POSITION (m)	RADIAL POSITION (m)								
	0.065	0.070	0.075	0.080	0.085	0.090	0.095	0.100	
0.000	*****	*****	*****	*****	*****	*****	*****	*****	
0.076	17.61	6.65	2.05	-4.10	-7.08	-9.11	*****	-8.92	
0.152	17.43	13.36	10.89	0.70	-1.46	-5.61	-7.79	-7.83	
0.305	*****	14.66	13.53	12.37	11.09	10.18	9.56	11.72	
0.381	15.99	15.12	13.50	12.42	11.82	11.38	10.75	9.39	
0.457	15.35	14.66	14.65	13.92	14.94	13.48	14.18	13.63	
0.533	14.74	14.30	13.15	12.40	11.76	10.82	8.50	12.16	
0.610	14.28	13.81	13.45	13.15	12.82	12.00	10.85	7.68	
0.686	14.81	14.26	14.10	14.23	13.92	13.06	11.62	7.00	

URMS (m/s)

AXIAL POSITION (m)	RADIAL POSITION (m)								
	0.065	0.070	0.075	0.080	0.085	0.090	0.095	0.100	
0.000	*****	*****	*****	*****	*****	*****	*****	*****	
0.076	13.57	11.74	9.02	7.45	6.58	6.10	*****	6.65	
0.152	12.43	12.02	11.70	9.71	8.72	7.87	6.66	6.64	
0.305	*****	9.08	7.09	7.73	6.33	5.92	4.93	5.71	
0.381	9.61	7.81	8.87	7.37	6.87	8.27	6.77	4.82	
0.457	7.62	8.70	7.35	7.14	7.53	8.05	7.76	6.13	
0.533	6.70	6.39	6.28	6.16	5.95	5.97	4.63	6.36	
0.610	8.18	8.43	8.09	8.15	11.22	5.49	6.23	3.85	
0.686	9.32	6.96	9.28	8.57	6.24	6.33	7.34	3.28	

DATA SET A.2.1  
SAMUELSEN AND BRUM (45)

DATA SET A.2.1  
SAMUELSEN AND BRUM (45)

GEOMETRY (m)		MASS FLOW RATES (kg/s)	
Primary tube ID	0.0010	Primary gas	0.00121
Secondary tube ID	0.0570	Primary solids	0.00000
Chamber ID	0.0800	Secondary gas	0.09360
Chamber length	0.5000	Secondary solids	0.00000
Pri. wall thick	0.0090		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.0000		

GAS PROPERTIES		
	Primary	Secondary
Temperature (K)	292.0	293.0
Pressure (kPa)	101.0	101.0
Swirl number	0.0	0.8

GAS COMPOSITION (mole fraction - dry basis)		
Species	Primary	Secondary
CO2	1.0000	0.0000
N2	0.0000	0.7900
O2	0.0000	0.2100

SOLID PROPERTIES	
Mean Particle size (m)	0.0000E+00
Bulk Particle density (kg/m <sup>3</sup> )	0.0000E+00

LEVEL (m/s)									
AXIAL POSITION (m)	RADIAL POSITION (m)								
	0.008	0.012	0.016	0.020	0.024	0.028	0.032	0.036	
0.010	-4.60	14.20	23.70	19.60	18.50	13.00	15.30	15.20	
0.020	-5.86	-5.32	12.10	20.80	22.20	18.20	16.20	16.20	
0.040	-1.91	2.39	7.98	14.90	19.40	19.60	20.40	19.20	
0.070	-1.48	2.66	7.94	12.70	17.10	19.40	20.20	18.60	
0.100	-2.23	5.76	9.11	13.30	15.90	18.50	19.90	18.60	
0.140	7.47	8.56	11.70	13.50	16.00	17.40	18.30	17.20	
0.240	11.10	12.70	14.00	14.70	15.60	16.30	16.30	15.20	

WVEL (m/s)									
AXIAL POSITION (m)	RADIAL POSITION (m)								
	0.008	0.012	0.016	0.020	0.024	0.028	0.032	0.036	
0.010	5.55	5.68	16.80	24.20	24.40	14.20	-0.16	-0.80	
0.020	7.80	7.60	8.17	14.00	20.40	15.70	4.28	-0.64	
0.040	8.97	13.40	15.00	15.80	16.80	13.40	8.39	1.55	
0.070	6.85	10.40	12.80	13.70	12.90	10.50	7.89	5.83	
0.100	7.23	9.76	11.00	10.70	10.60	9.85	8.35	7.63	
0.140	6.17	8.25	9.00	9.49	9.22	8.85	8.78	8.62	
0.240	5.68	7.62	8.82	9.35	8.94	8.72	8.86	8.84	

URMS (m/s)									
AXIAL POSITION (m)	RADIAL POSITION (m)								
	0.008	0.012	0.016	0.020	0.024	0.028	0.032	0.036	
0.010	6.53	10.60	6.26	3.17	3.31	5.18	3.06	2.77	
0.020	5.41	8.55	9.18	6.79	4.05	4.68	4.11	2.84	
0.040	6.14	6.52	6.89	6.39	5.44	5.19	4.95	4.49	
0.070	5.32	5.85	6.05	6.02	5.32	5.10	4.50	4.95	
0.100	5.49	5.85	6.04	5.90	5.67	4.93	4.52	4.89	
0.140	5.11	4.70	4.94	5.30	5.00	4.40	4.23	4.49	
0.240	3.46	3.23	3.46	3.09	3.04	2.94	2.85	2.86	

DATA SET A.2.1  
SAMUELSEN AND BRUM (45)

WRMS (m/s)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.008	0.012	0.016	0.020	0.024	0.028	0.032	0.036
0.010	5.07	7.12	6.93	4.44	3.11	5.76	2.89	2.01
0.020	4.38	5.38	6.47	6.39	3.51	5.20	5.17	2.30
0.040	4.65	4.99	5.35	5.78	5.07	5.78	6.22	4.48
0.070	4.70	5.01	4.70	5.33	4.99	5.32	5.15	4.83
0.100	4.52	4.95	4.97	4.87	4.98	4.37	4.52	4.70
0.140	4.75	4.26	4.40	4.33	4.24	4.13	3.92	3.57
0.240	3.43	3.24	2.86	2.84	2.68	2.53	2.63	2.83

U-W (m/s)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.008	0.012	0.016	0.020	0.024	0.028	0.032	0.036
0.010	-1.04	12.30	-2.42	0.86	0.99	-1.16	-1.44	0.29
0.020	2.62	7.27	2.10	8.04	-0.02	3.67	-3.24	0.19
0.040	5.10	0.71	0.79	5.67	4.08	1.40	-3.21	-0.97
0.070	1.89	3.99	2.23	4.67	10.60	-0.53	3.99	0.22
0.100	4.80	3.52	2.58	-0.25	-2.83	0.04	-0.22	1.28
0.140	4.88	1.51	1.35	0.27	-2.43	-0.13	0.22	0.77
0.240	2.74	1.79	0.63	-0.50	-0.27	-0.22	0.50	0.97

DATA SET A.2.2  
WEBB (37)

DATA SET A.2.2  
WEBB (37)

GEOMETRY (m)                      MASS FLOW RATES (kg/s)

Primary tube ID 0.1250      Primary gas 0.01600  
 Secondary tube ID 0.1300      Primary solids 0.00000  
 Chamber ID 0.2060      Secondary gas 0.51000  
 Chamber length 0.3140      Secondary solids 0.00000  
 Pri. wall thick 0.2013  
 Quarl half angle 0.3000  
     (degrees)  
 Quarl length 5.9000

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	295.0	285.0
Pressure (kPa)	89.2	89.2
Swirl number	0.0	0.5

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
N2	0.7900	0.7900
O2	0.2100	0.2100

SOLID PROPERTIES

Mean Particle size (m)	0.0000E-00
Bulk Particle density (kg/m3)	0.0000E-00

UVEL (m/s)

AXIAL POSITION (m)	RADIAL POSITION (m)								
	0.065	0.070	0.075	0.080	0.085	0.090	0.095	0.100	
0.000	*****	*****	*****	*****	*****	*****	*****	*****	
0.076	13.58	14.52	15.58	16.16	17.03	17.03	17.16	12.93	
0.152	12.93	13.52	14.18	14.65	15.28	15.41	14.82	11.51	
0.229	12.05	11.93	11.64	11.67	11.65	11.60	11.02	11.12	
0.305	13.60	13.71	13.84	13.57	13.33	13.60	12.00	9.75	
0.381	12.56	11.96	11.75	11.43	11.26	11.38	10.81	10.96	
0.457	10.86	10.73	10.52	10.52	10.40	10.60	10.68	11.19	
0.533	10.79	10.57	10.81	10.82	10.53	10.60	10.55	10.76	
0.610	10.26	10.21	10.17	10.06	10.57	10.40	10.86	10.78	

URMS (m/s)

AXIAL POSITION (m)	RADIAL POSITION (m)								
	0.065	0.070	0.075	0.080	0.085	0.090	0.095	0.100	
0.000	*****	*****	*****	*****	*****	*****	*****	*****	
0.076	6.92	7.32	7.33	7.29	7.06	7.30	7.37	4.57	
0.152	4.55	4.57	4.67	4.75	4.88	4.90	4.79	3.89	
0.229	3.61	3.58	3.18	3.01	2.82	2.74	2.58	2.56	
0.305	3.66	3.69	3.83	3.68	3.67	3.74	3.97	3.37	
0.381	3.57	3.51	3.42	3.27	3.13	3.00	2.79	2.65	
0.457	2.69	2.72	2.73	2.55	2.54	2.54	2.57	2.58	
0.533	2.83	2.73	2.63	2.51	2.49	2.45	2.48	2.56	
0.610	2.45	2.56	2.57	2.46	2.47	2.65	2.55	2.55	

WVEL (m/s)

AXIAL POSITION (m)	RADIAL POSITION (m)								
	0.030	0.035	0.040	0.045	0.050	0.055	0.060	0.065	
0.000	29.02	29.48	29.17	27.79	26.23	24.76	21.58	18.27	



DATA SET A.2.2  
WEBB (37)

	W RMS (m/s)							
AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.030	0.035	0.040	0.045	0.050	0.055	0.060	0.065
0.000	7.72	7.51	7.75	8.17	8.86	8.94	9.70	9.32

DATA SET A.2.3  
GOULDIN ET AL. (40)

DATA SET A.2.3  
GOULDIN ET AL. (40)

GEOMETRY (m)		MASS FLOW RATES (kg/s)	
Primary tube ID	0.0495	Primary gas	0.07180
Secondary tube ID	0.1020	Primary solids	0.00000
Chamber ID	0.1050	Secondary gas	0.16400
Chamber length	0.6100	Secondary solids	0.00000
Pri. wall thick	0.0016		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.0000		

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	293.0	293.0
Pressure (kPa)	101.0	101.0
Swirl number	0.5	0.6

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
N2	0.7810	0.7810
O2	0.2100	0.2100
AR	0.0090	0.0090

SOLID PROPERTIES

Mean Particle size (μ)	0.0000E+00
Bulk Particle density (kg/m <sup>3</sup> )	0.0000E+00

		LEVEL (m/s)							
		AXIAL POSITION (m)				RADIAL POSITION (m)			
	0.010	0.015	0.020	0.025	0.030	0.036	0.040	0.043	
0.018	16.68	11.32	38.62	35.22	29.04	27.81	27.50	27.19	
0.028	12.36	25.64	38.31	39.55	32.13	30.28	29.04	29.66	
0.049	6.49	21.63	34.91	40.47	36.77	33.06	33.06	29.35	
0.100	17.51	23.17	32.13	39.24	38.93	36.15	35.22	32.13	
0.554	51.91	52.83	52.22	50.05	43.26	41.40	39.55	37.69	

		URMS (m/s)							
		AXIAL POSITION (m)				RADIAL POSITION (m)			
	0.010	0.015	0.020	0.025	0.030	0.035	0.041	0.042	
0.018	8.51	5.59	3.53	4.56	2.49	2.74	4.26	4.80	
0.028	9.18	7.42	3.95	3.89	2.55	2.19	4.38	4.38	
0.049	8.94	8.27	5.59	3.28	3.34	3.59	3.16	7.11	
0.100	5.47	6.56	6.75	4.32	4.86	4.26	6.08	9.79	
0.554	5.96	6.20	5.17	5.71	7.36	3.77	4.92	7.05	

		VVEL (m/s)							
		AXIAL POSITION (m)				RADIAL POSITION (m)			
	0.025	0.030	0.028	0.034	0.036	0.041	0.042	0.046	
0.018	18.51	25.19	19.12	*****	24.89	21.85	*****	18.82	
0.028	19.42	21.24	*****	*****	23.69	21.85	20.03	*****	
0.049	16.39	17.91	*****	21.24	21.85	21.85	*****	18.82	
0.100	13.66	15.78	*****	*****	19.42	21.55	*****	17.91	
0.554	15.78	15.48	*****	*****	15.78	16.69	16.69	*****	

DATA SET A.2.3  
 GOULDIN ET AL. (40)

VRMS (m/s)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.025	0.028	0.030	0.033	0.035	0.040	0.042	0.045
0.018	2.96	3.15	2.18	*****	1.51	1.88	*****	2.06
0.028	4.30	*****	5.38	*****	3.75	3.10	3.93	*****
0.049	4.11	*****	4.54	5.14	5.99	3.33	*****	3.03
0.100	3.99	*****	3.99	5.81	4.36	3.21	*****	0.04
0.554	3.51	*****	3.21	*****	4.60	3.39	3.51	*****

DATA SET A.2.4  
GOULDIN ET AL. (40)

DATA SET A.2.4  
GOULDIN ET AL. (40)

GEOMETRY (m)		MASS FLOW RATES (kg/s)	
Primary tube ID	0.0495	Primary gas	0.07180
Secondary tube ID	0.1020	Primary solids	0.00000
Chamber ID	0.1050	Secondary gas	0.16400
Chamber length	0.6100	Secondary solids	0.00000
Pri. wall thick	0.0016		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.0000		

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	293.0	293.0
Pressure (kPa)	101.0	101.0
Swirl number	0.5	-0.6

GAS COMPOSITION (mole fraction - dry basis)

Species:	Primary	Secondary
N2	0.7810	0.7810
O2	0.2100	0.2100
AR	0.0090	0.0090

SOLID PROPERTIES

Mean Particle size (m)	0.0000E+00
Bulk Particle density (kg/m <sup>3</sup> )	0.0000E+00

		UVEL (m/s)							
		AXIAL POSITION (m)				RADIAL POSITION (m)			
		0.020	0.024	0.027	0.030	0.035	0.040	0.042	0.419
0.016	37.15	31.37	26.21	25.30	25.91	*****	*****	*****	26.82
0.028	*****	35.36	*****	30.48	24.99	*****	*****	21.95	*****
0.049	*****	32.31	*****	31.70	29.57	*****	*****	30.18	*****
0.100	*****	28.04	*****	29.57	24.99	*****	*****	20.93	*****
0.554	*****	*****	*****	45.10	*****	41.90	*****	40.40	*****

		URMS (m/s)							
		AXIAL POSITION (m)				RADIAL POSITION (m)			
		0.020	0.023	0.025	0.027	0.030	0.035	0.040	0.042
0.016	5.36	5.12	7.07	6.83	6.04	4.39	*****	*****	4.39
0.028	5.79	*****	5.18	*****	6.46	7.25	*****	*****	7.07
0.049	10.73	*****	8.47	*****	7.62	7.38	*****	*****	6.58
0.100	10.73	*****	10.55	*****	9.81	12.58	*****	*****	9.81
0.554	3.41	*****	*****	*****	3.47	*****	*****	3.23	3.78

		VVEL (m/s)							
		AXIAL POSITION (m)				RADIAL POSITION (m)			
		0.010	0.015	0.020	0.025	0.030	0.035	0.040	0.042
0.018	-6.04	-16.30	-19.62	-11.47	21.92	28.38	25.36	23.85	
0.028	-2.42	-9.66	-16.30	-15.10	5.13	25.06	24.76	23.25	
0.049	-4.53	-5.43	-11.17	-10.87	-2.42	17.51	23.85	23.55	
0.100	-6.04	-5.74	-5.43	-3.02	4.83	13.89	19.32	19.93	
0.554	0.00	1.21	3.02	5.74	9.66	13.28	15.70	15.10	

DATA SET A.2.4  
GOULDIN ET AL. (40)

VRMS (m/s)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.010	0.015	0.020	0.024	0.030	0.035	0.040	0.042
C.018	6.92	6.68	4.13	7.47	7.89	2.91	2.91	3.04
C.028	7.35	7.35	5.22	5.59	11.60	5.89	3.28	3.46
C.049	6.56	7.04	6.56	6.68	10.81	9.84	4.25	3.70
C.100	7.96	7.41	7.29	8.14	10.08	8.81	7.55	7.11
G.554	4.62	5.10	5.10	5.59	6.68	6.13	5.59	4.37

DATA SET B.1.1  
LEAVITT (26)

DATA SET B.1.1  
LEAVITT (26)

GEOMETRY (m)		MASS FLOW RATES (kg/s)	
Primary tube ID	0.0255	Primary gas	0.02200
Secondary tube ID	0.1270	Primary solids	0.01331
Chamber ID	0.3430	Secondary gas	0.53400
Chamber length	0.9260	Secondary solids	0.00000
Pri. wall thick	0.0050		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.0000		

		AR (mole frac.)							
		AXIAL POSITION (m)				RADIAL POSITION (m)			
		0.00E	0.011	0.024	0.041	0.082	0.123	0.125	0.161
0.172	0.248E	0.1548	0.0573	0.0122	0.0115	0.0124	0.0130	0.0132	
0.240	0.121C	0.0978	0.0634	0.0209	0.0120	0.0131	0.0120	0.0132	
0.324	0.076C	0.0700	0.0493	0.0317	0.0153	0.0146	0.0136	0.0149	
0.392	0.037C	0.0362	0.0334	0.0321	0.0217	0.0200	0.0172	0.0186	

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	286.0	286.0
Pressure (kPa)	85.0	89.0
Swirl number	0.0	0.0

		PFLX (kg m m/s)							
		AXIAL POSITION (m)				RADIAL POSITION (m)			
		0.00E	0.011	0.024	0.041	0.082	0.123	0.125	0.161
0.172	14.52C	6.940	1.200	0.230	0.010	0.000	0.000	0.000	
0.240	9.14C	5.400	1.120	0.390	0.030	0.000	0.000	0.010	
0.324	6.91C	4.940	1.990	0.860	0.030	0.010	0.070	0.000	
0.391	2.49C	1.920	1.260	1.070	0.020	0.010	0.000	0.000	

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
O2	0.0714	0.2090
N2	0.2660	0.7810
Ar	0.6620	0.0094

SOLID PROPERTIES

Mean Particle size (m)	4.300E-05
Bulk Particle density (kg/m3)	1.340E+03

DATA SET B.1.2  
SHARP (31)

DATA SET B.1.2  
SHARP (31)

GEOMETRY (m)		MASS FLOW RATES (kg/s)	
Primary tube ID	0.0255	Primary gas	0.02230
Secondary tube ID	0.1270	Primary solids	0.01493
Chamber ID	0.2600	Secondary gas	0.52000
Chamber length	0.9260	Secondary solids	0.00000
Pri. wall thick	0.0050		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.0000		

		AR (mole frac.)							
		AXIAL POSITION (m)				RADIAL POSITION (m)			
		0.011	0.013	0.024	0.042	0.055	0.089	0.124	0.125
0.150	0.1833	0.1667	0.0647	0.0128	0.0047	0.0058	0.0069	0.0069	
0.600	0.0739	0.0641	0.0489	0.0343	0.0201	0.0115	0.0126	0.0000	
0.800	0.0392	0.0392	0.0371	0.0344	0.0317	0.0231	0.0231	0.0210	

GAS PROPERTIES		
	Primary	Secondary
Temperature (K)	283.0	283.0
Pressure (kPa)	89.0	89.0
Swirl number	0.0	0.0

		PFLX (kg m m/s)							
		AXIAL POSITION (m)				RADIAL POSITION (m)			
		0.011	0.013	0.024	0.042	0.055	0.089	0.124	0.125
0.150	11.371	9.450	1.364	0.246	0.192	0.008	0.002	0.000	
0.600	6.116	4.745	1.982	0.496	0.172	0.009	0.003	0.002	
0.800	2.674	2.271	1.173	0.905	0.454	0.012	0.000	0.000	

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
O2	0.0630	0.2090
N2	0.2350	0.7810
Ar	0.7020	0.0094

SOLID PROPERTIES

Mean Particle size (m)	4.6000E-05
Bulk Particle density (kg/m3)	2.3300E+03

GEOMETRY (m)                      MASS FLOW RATES (kg/s)

Primary tube ID	0.0200	Primary gas	0.00500
Secondary tube ID	0.0000	Primary solids	0.00320
Chamber ID	0.0000	Secondary gas	0.03400
Chamber length	2.0000	Secondary solids	0.00000
Pri. wall thick	0.0005		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.0000		

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	298.0	298.0
Pressure (kPa)	101.0	101.0
Swirl number	0.0	0.0

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
N2	0.7900	0.7900
O2	0.2100	0.2100

SOLID PROPERTIES

Mean Particle size (m)	2.0000E-04
Bulk Particle density (kg/m <sup>3</sup> )	2.9900E+03

UVEL (m/s)

AXIAL POSITION (m)	RADIAL POSITION (m)								
	0.059	0.078	0.110	0.150	0.190	0.230	0.260	0.290	
0.060	*****	12.20	11.80	11.40	10.80	10.10	9.28	7.68	
6.000	*****	*****	*****	*****	*****	*****	*****	*****	*****
12.000	0.75	*****	*****	*****	*****	*****	*****	*****	*****
18.000	*****	*****	*****	*****	*****	*****	*****	*****	*****

URMS (m/s)

AXIAL POSITION (m)	RADIAL POSITION (m)								
	0.045	0.050	0.078	0.110	0.150	0.190	0.230	0.260	
0.060	*****	*****	0.64	0.74	0.79	0.85	0.97	1.01	
12.000	0.23	0.22	*****	*****	*****	*****	*****	*****	*****

VRMS (m/s)

AXIAL POSITION (m)	RADIAL POSITION (m)								
	0.015	0.020	0.025	0.030	0.035	0.040	0.045	0.050	
12.000	0.25	0.24	0.23	0.22	0.20	0.18	0.16	0.14	



DATA SET B.1.3  
 MODARRESS ET AL. (28)

PUVEL (m/s)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.075	0.110	0.150	0.190	0.230	0.270	0.290	0.300
0.000	*****	*****	*****	*****	*****	*****	*****	*****
0.060	9.49	9.38	9.31	9.20	9.02	8.88	8.77	8.63
6.000	*****	*****	*****	*****	*****	*****	*****	*****
12.000	*****	*****	*****	*****	*****	*****	*****	*****
18.000	*****	*****	*****	*****	*****	*****	*****	*****

PURMS (m/s)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.000	0.036	0.078	0.110	0.150	0.190	0.230	0.260
0.060	0.70	0.72	0.74	0.75	0.76	0.77	0.79	0.81

DATA SET B.2.1  
LEAVITT (26)

GEOMETRY (m)		MASS FLOW RATES (kg/s)	
Primary tube ID	0.0255	Primary gas	0.01320
Secondary tube ID	0.1270	Primary solids	0.01101
Chamber ID	0.2060	Secondary gas	0.52000
Chamber length	0.9100	Secondary solids	0.00000
Pri. wall thick	0.0050		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.0000		

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	280.0	280.0
Pressure (kPa)	89.0	89.0
Swirl number	0.0	0.4

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
O2	0.0846	0.2090
N2	0.3160	0.7810
Ar	0.6000	0.0094

SOLID PROPERTIES

Mean Particle size (m)	5.6000E-06
Bulk Particle density (kg/m3)	7.0800E+01

DATA SET B.2.1  
LEAVITT (26)

	AR (mole frac.)				
AXIAL POSITION (m)	0.000	0.013	0.025	0.051	0.084
0.172	0.0481	0.0448	0.0388	0.0262	0.0146
0.240	0.0367	0.0342	0.0313	0.0259	0.0191
0.324	0.0260	0.0254	0.0244	0.0227	0.0210
0.391	0.0236	0.0239	0.0234	0.0237	0.0236

PFLX (kg m m/s)

AXIAL POSITION (m)	0.000	0.013	0.025	0.051	0.084
0.172	0.410	2.550	1.700	0.280	0.220
0.240	0.960	0.820	1.240	0.380	0.180
0.324	0.820	0.640	1.050	0.170	0.680
0.391	0.670	0.360	1.160	0.240	0.230

DATA SET B.2.2  
LEAVITT (26)

DATA SET B.2.2  
LEAVITT (26)

GEOMETRY (m)

MASS FLOW RATES (kg/s)

Primary tube ID	0.0255	Primary gas	0.01820
Secondary tube ID	0.1270	Primary solids	0.01401
Chamber ID	0.2060	Secondary gas	0.52000
Chamber length	0.9100	Secondary solids	0.00000
Pri. wall thick	0.0050		
Quarl half angle (degrees)	0.0000		
Quarl length	5.9000		

AR (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.013	0.025	0.051	0.084
0.222	0.0346	0.0332	0.0309	0.0248	0.0160
0.290	0.0297	0.0286	0.0268	0.0242	0.0206
0.374	0.0258	0.0260	0.0252	0.0241	0.0229
0.441	0.0244	0.0251	0.0247	0.0244	0.0250

GAS PROPERTIES

Primary Secondary

Temperature (K)	280.0	280.0
Pressure (kPa)	89.0	89.0
Swirl number	0.0	0.4

PFLX (kg m m/s)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.013	0.025	0.051	0.084
0.222	1.870	0.880	1.170	0.240	0.130
0.290	1.690	1.270	1.400	0.220	0.280
0.374	0.800	0.130	0.530	0.390	0.410
0.441	0.480	0.170	0.480	0.150	0.430

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
O2	0.0846	0.2090
N2	0.3160	0.7810
Ar	0.6000	0.0094

SOLID PROPERTIES

Mean Particle size (m)	5.6000E-06
Bulk Particle density (kg/m3)	7.0800E+01

DATA SET E.2.3  
LEAVITT (26)

DATA SET B.2.3  
LEAVITT (26)

GEOMETRY (m)		MASS FLOW RATES (kg/s)	
Primary tube ID	0.0255	Primary gas	0.01820
Secondary tube ID	0.1270	Primary solids	0.01401
Chamber ID	0.2060	Secondary gas	0.02000
Chamber length	0.9100	Secondary solids	0.00000
Pri. wall thick	0.0050		
Quarl half angle	0.0000		
(degrees)			
Quarl length	5.9000		

		AR (mole frac.)				
		RADIAL POSITION (m)				
AXIAL POSITION (m)		0.000	0.013	0.025	0.051	0.084
0.222	0.0297	0.0294	0.0278	0.0257	0.0210	
0.290	0.0266	0.0268	0.0262	0.0242	0.0212	
0.374	0.0259	0.0254	0.0250	0.0244	0.0212	
0.441	0.0258	0.0252	0.0250	0.0250	0.0217	

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	280.0	280.0
Pressure (kPa)	89.0	89.0
Swirl number	0.0	0.4

		PFLX (kg m m/s)				
		RADIAL POSITION (m)				
AXIAL POSITION (m)		0.000	0.013	0.025	0.051	0.084
0.222	0.120	0.010	0.160	0.120	0.400	
0.290	0.140	0.050	0.060	0.050	0.250	
0.374	0.020	0.020	0.030	0.030	0.500	
0.441	0.060	0.040	0.060	0.070	0.140	

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
O2	0.0845	0.2090
N2	0.3160	0.7810
Ar	0.6000	0.0094

SOLID PROPERTIES

Mean Particle size (m)	5.6000E-06
Bulk Particle density (kg/m <sup>3</sup> )	7.0800E+01

DATA SET C.1.1  
MICHELFELDER AND LOWES (51)

DATA SET C.1.1  
MICHELFELDER AND LOWES (51)

GEOMETRY (m)		MASS FLOW RATES (kg/s)	
Primary tube ID	0.0189	Primary gas	0.06360
Secondary tube ID	0.1760	Primary solids	0.00000
Chamber ID	2.0000	Secondary gas	0.83200
Chamber length	6.2500	Secondary solids	0.00000
Pr. wall thick	0.0206		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.0000		

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	299.0	308.0
Pressure (kPa)	101.3	101.3
Swirl number	0.0	0.0

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
CEH8	1.0000	0.0000
N2	0.0000	0.7900
O2	0.0000	0.2100

SOLID PROPERTIES

Mean Particle size (m)	0.0000E+00
Bulk Particle density (kg/m <sup>3</sup> )	0.0000E+00

AXIAL POSITION (m)	O2 (mole frac.)									
	0.300	0.350	0.400	0.500	0.600	0.700	0.750	0.800		
0.370	0.0530	*****	0.2080	0.0550	0.2090	0.0540	*****	0.2090		
0.740	0.0510	*****	0.0620	0.0630	*****	0.0640	*****	*****		
1.110	0.0740	*****	0.2090	0.0630	0.2030	*****	*****	*****		
1.400	0.1100	*****	*****	0.0700	*****	*****	*****	*****		
1.850	0.1140	*****	*****	0.0820	*****	*****	*****	*****		
2.000	0.1100	*****	*****	0.0920	*****	0.0830	*****	*****		
2.750	0.0640	*****	0.2090	0.0820	0.2090	0.0740	0.2090	0.2090		
3.500	0.0260	*****	0.0290	0.0390	0.0450	*****	*****	*****		
4.250	0.0130	0.2090	*****	0.0200	0.0240	*****	*****	*****		
5.000	0.0170	*****	0.2090	0.0230	0.2090	*****	*****	*****		
5.750	0.0190	*****	0.0200	0.0100	0.2090	0.2090	*****	*****		

N2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)									
	0.300	0.350	0.400	0.500	0.600	0.700	0.750	0.800		
0.370	0.8090	*****	0.7910	0.7980	0.7910	*****	*****	0.7910		
0.740	0.8100	*****	0.8050	0.8100	*****	0.8100	*****	*****		
1.110	0.8070	*****	0.7910	0.8130	0.7910	0.8100	*****	*****		
1.400	0.7950	*****	*****	0.7920	*****	*****	*****	*****		
1.850	0.7930	*****	*****	0.7850	*****	*****	*****	*****		
2.000	0.7950	*****	*****	0.7890	*****	*****	*****	*****		
2.750	0.7920	*****	0.7910	0.7920	0.7910	0.8020	0.7910	0.7910		
3.500	0.7800	*****	0.7970	0.8100	*****	*****	*****	*****		
4.250	0.8500	0.7910	0.7910	0.8500	0.8550	*****	*****	*****		
5.000	0.8500	*****	0.7910	0.8500	0.7910	*****	*****	*****		
5.750	0.8400	*****	0.8400	0.8400	0.7910	0.7910	*****	*****		

CO2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)									
	0.175	0.200	0.250	0.300	0.400	0.500	0.600	0.700		
0.370	0.1020	0.1030	*****	0.1260	*****	0.1260	*****	0.1260		
0.740	0.0660	0.0970	0.1120	0.1200	0.1200	0.1200	*****	0.1200		
1.110	*****	0.0650	*****	0.1030	*****	0.1200	*****	0.1130		
1.400	*****	0.0800	*****	0.0910	*****	0.1120	*****	*****		
1.850	*****	0.0860	0.0840	0.0840	*****	0.1040	*****	*****		
2.000	*****	0.0950	*****	0.0850	*****	0.0930	*****	0.1000		
2.750	*****	0.1190	*****	0.1120	*****	0.1060	*****	0.1220		
3.500	*****	0.1280	*****	0.1300	0.1340	0.1340	0.1280	0.1240		
4.250	*****	0.1390	*****	0.1370	*****	0.1430	0.1430	*****		
5.000	*****	0.1450	*****	0.1430	0.1470	0.1450	*****	*****		
5.750	*****	*****	*****	0.1400	0.1480	0.1480	*****	*****		

DATA SET C.1.1  
MICHELFELDER AND LWES (51)

CO (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.100	0.125	0.150	0.200	0.250	0.300	0.400	0.450
0.370	*****	*****	*****	*****	*****	*****	*****	*****
0.740	*****	*****	*****	*****	*****	*****	*****	*****
1.110	0.0040	*****	*****	*****	*****	*****	*****	*****
1.480	0.0770	*****	0.0420	0.0070	*****	*****	*****	*****
1.850	0.0490	0.0430	0.0440	*****	*****	*****	*****	*****
2.000	0.0430	0.0210	0.0100	0.0120	*****	*****	*****	*****
2.750	0.0430	*****	0.0110	0.0130	0.0070	*****	*****	*****
3.500	0.0260	*****	*****	0.0140	*****	0.0150	0.0120	*****
4.250	0.0130	*****	0.0090	0.0060	*****	0.0150	*****	0.0090
5.000	0.0040	*****	0.0030	0.0040	*****	*****	*****	*****

H2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.075	0.100	0.125	0.150	0.200	0.300	0.400	0.450
0.370	*****	*****	*****	*****	*****	*****	*****	*****
0.740	*****	*****	*****	*****	*****	*****	*****	*****
1.110	0.0150	0.0170	*****	*****	*****	*****	*****	*****
1.480	0.0080	0.0020	*****	0.0350	0.0050	*****	*****	*****
1.850	*****	0.0480	0.0330	0.0060	*****	*****	*****	*****
2.000	0.0480	0.0300	0.0150	0.0070	0.0090	*****	*****	*****
2.750	*****	0.0380	*****	0.0200	0.0080	0.0050	*****	*****
3.500	*****	0.0180	*****	*****	0.0090	0.0090	0.0070	*****
4.250	*****	0.0070	*****	0.0050	0.0030	0.0090	*****	0.0050
5.000	*****	0.0040	*****	*****	0.0030	*****	*****	*****

TEMP (K)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.300	0.350	0.400	0.500	0.600	0.700	0.750	0.800
0.370	903.	*****	*****	898.	893.	888.	*****	883
0.555	*****	*****	882.	883.	883.	873.	*****	*****
0.740	873.	*****	872.	863.	*****	*****	*****	*****
0.925	833.	*****	*****	*****	*****	*****	*****	*****
1.110	793.	*****	832.	833.	833.	833.	*****	*****
1.295	803.	*****	*****	*****	*****	*****	*****	*****
1.665	843.	*****	*****	*****	*****	*****	*****	*****
1.850	878.	*****	*****	873.	*****	*****	*****	*****
2.000	993.	*****	*****	903.	*****	903.	*****	*****
2.750	*****	*****	1113.	1033.	1021.	1012.	1003.	993.
3.500	1483.	*****	1343.	1233.	*****	*****	*****	*****
4.250	1443.	1418.	*****	1313.	1273.	*****	*****	*****
5.000	1443.	*****	1404.	1383.	1348.	*****	*****	*****
5.750	1428.	*****	1413.	1398.	1278.	1273.	*****	*****

DATA SET C.1.2  
MICHELFELDER AND LOWES (51)

DATA SET C.1.2  
MICHELFELDER AND LOWES (51)

GEOMETRY (m)		MASS FLOW RATES (kg/s)	
Primary tube ID	0.0326	Primary gas	0.07780
Secondary tube ID	0.1760	Primary solids	0.00000
Chamber ID	2.0000	Secondary gas	0.86800
Chamber length	6.2500	Secondary solids	0.00000
Pri. wall thick	0.0137		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.0000		

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	283.0	299.0
Pressure (kPa)	101.3	101.3
Swirl number	0.0	0.0

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
CH4	1.0000	0.0000
N2	0.0000	0.7900
O2	0.0000	0.2100

SOLID PROPERTIES

Mean Particle size (m)	0.0000E+00
Bulk Particle density (kg/m3)	0.0000E+00

AXIAL POSITION (m)	O2 (mole frac.)									
	0.175	0.200	0.250	0.300	0.400	0.500	0.600	0.700		
0.370	*****	0.0660	*****	0.0570	0.2090	*****	*****	*****		
0.740	*****	0.1150	*****	0.0650	0.2090	0.0720	0.2090	0.2090		
1.110	*****	0.1190	0.1050	*****	0.0510	0.0530	0.2090	*****		
1.480	0.2090	0.1230	0.1230	0.2090	*****	0.0670	0.2090	0.2090		
1.850	0.2090	0.0770	0.0980	0.2090	0.0820	0.0710	0.2090	0.0650		
2.035	0.2090	0.0730	0.2090	0.0970	0.2090	0.0800	0.2090	0.0730		
2.750	*****	0.0490	0.2090	0.0630	0.2090	0.0650	0.2090	0.0710		
3.500	*****	0.0130	*****	0.0310	0.2090	0.0530	0.2090	0.0570		
4.250	*****	0.0150	*****	0.0260	0.2090	0.0320	0.2090	0.0440		
5.000	*****	0.2090	*****	0.0170	0.2090	0.0190	0.2090	0.2090		
5.750	*****	0.0090	*****	0.0150	0.2090	0.0170	0.2090	0.0200		

N2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)									
	0.175	0.200	0.250	0.300	0.400	0.500	0.600	0.700		
0.370	0.7910	0.8290	0.7910	0.8290	0.7910	*****	*****	*****		
0.740	*****	0.8140	*****	0.8360	0.7910	0.8360	0.7910	0.7910		
1.110	0.7910	0.8120	0.8050	0.8240	0.8330	0.8300	0.7910	0.8330		
1.480	0.7910	0.8000	0.7830	0.7910	*****	0.8130	0.7910	0.7910		
1.850	0.7910	0.8370	0.8180	0.7910	0.8300	0.8370	0.7910	0.8370		
2.035	0.7910	0.7910	0.8060	0.7910	*****	*****	*****	*****		
2.750	*****	0.8250	0.7910	0.8210	0.7910	0.8250	0.7910	0.8250		
3.500	*****	0.8230	*****	0.8420	0.7910	0.8360	0.7910	0.8420		
4.250	*****	0.8420	*****	0.8470	0.7910	0.8420	0.7910	0.8420		
5.000	*****	0.7910	*****	0.8430	0.7910	0.8390	0.7910	0.7910		
5.750	*****	0.8460	*****	0.8430	0.7910	0.8430	0.7910	0.8430		

CO2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)									
	0.100	0.150	0.200	0.250	0.300	0.400	0.500	0.700		
0.370	0.0350	0.0920	*****	*****	0.1000	*****	*****	*****		
0.740	*****	*****	0.0720	*****	*****	*****	*****	*****		
1.110	0.0550	*****	0.0640	*****	0.0920	0.1110	0.1070	0.1100		
1.480	0.0750	0.0770	0.0710	0.0830	*****	*****	0.0850	*****		
1.850	0.0840	0.0850	0.0940	0.0830	0.0810	0.0920	0.0980	0.0980		
2.035	0.0540	0.0920	0.0930	*****	*****	*****	*****	*****		
2.750	0.1010	0.1010	0.1000	*****	0.1000	*****	0.1050	0.0980		
3.500	0.1120	*****	0.1100	*****	0.1150	*****	0.1070	0.1070		
4.250	0.1210	*****	0.1220	*****	0.1220	*****	0.1200	0.1140		
5.000	*****	*****	*****	*****	0.1260	*****	0.1270	*****		
5.750	0.1270	*****	0.1320	*****	0.1300	*****	0.1280	0.1250		

DATA SET C.1.2  
MICHELFELDER AND LOWES (51)

O<sub>2</sub> (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.025	0.050	0.075	0.100	0.125	0.150	0.200	0.300
0.740	0.0060	0.0110	0.0050	0.0040	*****	*****	*****	*****
0.925	0.0200	0.0170	0.0170	0.0050	0.0060	*****	*****	*****
1.110	0.0140	0.0210	0.0250	0.0150	*****	*****	*****	*****
1.480	0.0320	0.0350	0.0420	0.0380	*****	0.0080	*****	*****
1.850	0.0440	0.0480	0.0490	0.0470	*****	0.0220	0.0060	*****
2.035	0.0520	0.0550	*****	0.0510	*****	0.0340	0.0080	*****
2.750	0.0600	0.0630	*****	0.0540	*****	0.0460	0.0200	0.0020
3.500	*****	*****	*****	0.0340	*****	*****	0.0230	0.0080
4.250	*****	0.0150	*****	0.0160	*****	*****	0.0100	0.0070

H<sub>2</sub> (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.025	0.050	0.075	0.100	0.125	0.150	0.200	0.300
0.740	0.0050	0.0030	0.0050	0.0000	*****	*****	*****	*****
0.925	0.0100	0.0150	0.0130	0.0030	0.0000	*****	*****	*****
1.110	0.0150	0.0210	0.0220	0.0110	*****	*****	*****	*****
1.480	0.0330	0.0390	0.0410	0.0340	*****	0.0050	*****	*****
1.850	0.0450	0.0470	0.0480	0.0440	*****	0.0170	0.0030	*****
2.035	0.0580	0.0590	*****	0.0520	*****	0.0320	0.0070	*****
2.750	0.0610	0.0650	*****	0.0520	*****	0.0430	0.0180	0.0030
3.500	*****	*****	*****	0.0290	*****	*****	0.0240	0.0060
4.250	*****	0.0120	*****	0.0130	*****	*****	0.0050	0.0050

TEMP (K)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.175	0.200	0.250	0.300	0.400	0.500	0.600	0.700
0.370	883.	903.	903.	903.	903.	*****	*****	*****
0.555	*****	868.	*****	883.	893.	888.	*****	878.
0.740	*****	838.	*****	898.	893.	873.	868.	868.
0.925	798.	808.	808.	*****	873.	868.	868.	*****
1.110	828.	873.	803.	843.	868.	868.	858.	848.
1.295	998.	983.	828.	833.	873.	868.	*****	*****
1.480	1148.	1088.	903.	903.	*****	868.	848.	838.
1.665	1153.	1196.	923.	893.	883.	883.	883.	858.
1.850	1248.	1288.	1008.	1038.	905.	913.	908.	868.
2.035	1428.	1363.	1063.	975.	933.	928.	943.	928.
2.750	*****	1483.	1503.	1348.	1153.	1083.	1063.	1063.
3.500	*****	1613.	*****	1493.	1353.	1258.	1228.	1198.
4.250	*****	1583.	*****	1543.	1483.	1423.	1368.	1323.
5.000	*****	1543.	*****	1518.	1473.	1433.	1398.	1353.
5.750	*****	1478.	*****	1463.	1443.	1423.	1403.	1383.



GEOMETRY (m)		MASS FLOW RATES (kg/s)	
Primary tube ID	0.0049	Primary gas	0.00027
Secondary tube ID	1.0400	Primary solids	0.00000
Chamber ID	1.0400	Secondary gas	0.05080
Chamber length	2.5000	Secondary solids	0.00000
Pri. wall thick	0.0011		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.0000		

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	293.0	293.0
Pressure (kPa)	101.0	101.0
Swirl number	0.0	0.0

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
N2	0.5950	0.7800
O2	0.0000	0.2100
H2	0.4050	0.0000
AR	0.0000	0.0095

SOLID PROPERTIES

Mean Particle size (m)	0.0000E+00
Bulk Particle density (kg/m3)	0.0000E+00

		H2O (mole frac.)							
		AXIAL POSITION (m)				RADIAL POSITION (m)			
		0.008	0.010	0.012	0.013	0.014	0.016	0.019	0.022
0.030	0.0000	0.0000	0.0000	0.0000	*****	*****	*****	*****	*****
0.060	0.0330	0.0021	0.0000	0.0000	*****	0.0000	*****	*****	*****
0.090	0.0985	0.0326	0.0044	0.0044	*****	0.0000	0.0000	*****	*****
0.160	0.1390	0.0959	*****	0.0503	*****	0.0014	0.0000	0.0000	0.0000

		H2 (mole frac.)							
		AXIAL POSITION (m)				RADIAL POSITION (m)			
		0.008	0.010	0.012	0.013	0.014	0.016	0.019	0.022
0.030	*****	0.0000	0.0000	0.0000	*****	*****	*****	*****	*****
0.060	0.0007	0.0000	0.0000	0.0000	*****	0.0000	*****	*****	*****
0.090	0.0037	0.0000	0.0000	0.0000	*****	0.0000	0.0000	*****	*****
0.160	0.0076	0.0034	*****	0.0000	*****	0.0000	0.0000	0.0000	0.0000

		O2 (mole frac.)							
		AXIAL POSITION (m)				RADIAL POSITION (m)			
		0.013	0.014	0.016	0.018	0.019	0.020	0.022	0.025
0.030	*****	*****	*****	*****	*****	*****	*****	*****	*****
0.060	*****	0.2110	*****	0.2120	*****	*****	*****	*****	*****
0.090	*****	0.2100	0.2090	*****	*****	0.2160	*****	*****	*****
0.160	0.1630	*****	0.2070	*****	0.2080	*****	0.2120	0.2100	0.2100

DATA SET C.1.3  
TAKAGI ET AL. (34)

DATA SET C.1.3  
TAKAGI ET AL. (34)

N2 (mole frac.)

URMS (m/s)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.013	0.014	0.016	0.018	0.019	0.020	0.022	0.025
0.030	*****	*****	*****	*****	*****	*****	*****	*****
0.060	*****	0.784G	*****	0.788G	*****	*****	*****	*****
0.090	*****	0.7910	0.7930	*****	0.7960	*****	*****	*****
0.160	0.7820	*****	0.7830	*****	0.7890	*****	0.7920	0.792C

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.008	0.010	0.012	0.013	0.014	0.016	0.018	0.025
0.030	0.48	*****	0.50	*****	0.51	*****	*****	*****
0.060	0.52	0.42	0.43	*****	0.50	0.4E	0.48	*****
0.090	1.84	0.83	0.50	*****	*****	0.65	*****	*****
0.160	3.07	2.54	*****	1.49	*****	0.71	*****	0.56

TEMP (K)

VRMS (m/s)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.012	0.013	0.014	0.016	0.019	0.020	0.022	0.025
0.030	305.	*****	*****	*****	*****	*****	*****	*****
0.060	346.	*****	31E.	*****	*****	*****	*****	*****
0.090	435.	*****	36E	332.	*****	299.	*****	*****
0.160	*****	848.	*****	552.	397.	*****	341.	324.

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.005	0.006	0.008	0.010	0.012	0.013	0.014	0.016
0.030	0.63	*****	*****	0.44	0.45	*****	*****	*****
0.060	*****	0.87	*****	0.41	0.37	*****	0.37	*****
0.090	*****	1.26	0.93	0.53	*****	*****	*****	0.46
0.160	*****	1.36	1.32	1.24	*****	1.01	*****	0.69

UVEL (m/s)

WRMS (m/s)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.012	0.013	0.014	0.016	0.018	0.020	0.022	0.025
0.030	0.52	*****	0.5C	*****	0.53	*****	*****	*****
0.060	0.55	*****	0.5E	0.55	0.53	*****	*****	*****
0.090	0.53	*****	0.53	0.56	*****	0.57	*****	*****
0.160	*****	0.65	*****	0.56	*****	*****	0.54	0.52

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.006	0.008	0.010	0.012	0.013	0.014	0.016	0.019
0.030	0.60	*****	0.40	0.41	*****	*****	*****	*****
0.060	1.42	*****	0.41	0.38	*****	0.36	*****	*****
0.090	1.55	1.01	0.50	0.38	*****	0.36	0.38	*****
0.160	1.48	1.45	1.14	*****	0.76	*****	0.48	0.43

GEOMETRY (m)		MASS FLOW RATES (kg/s)		CO (mole frac.)					
Primary tube ID	0.0560	Primary gas	0.00256						
Secondary tube ID	0.1040	Primary solids	0.00000						
Chamber ID	0.6000	Secondary gas	0.05100						
Chamber length	3.0000	Secondary solids	0.00000						
Pri. wall thick	0.0000								
Quarl half angle	0.0000								
(degrees)									
Quarl length	0.1000								
GAS PROPERTIES				O2 (mole frac.)					
	Primary	Secondary							
Temperature (K)	293.0	293.0							
Pressure (kPa)	101.0	101.0							
Swirl number	0.0	0.0							
GAS COMPOSITION (mole fraction - dry basis)									
Species:	Primary	Secondary							
CH4	0.0360	0.0000							
C2H6	0.0325	0.0000							
C3H8	0.0070	0.0000							
C4H1	0.0027	0.0000							
CO2	0.0013	0.0000							
O2	0.0000	0.2100							
N2	0.0178	0.7900							
SOLID PROPERTIES				CO2 (mole frac.)					
Mean Particle size (m)		0.0000E+00							
Bulk Particle density (kg/m3)		0.0000E+00							

AXIAL POSITION (m)	0.180	0.200	0.220	0.240	0.260	0.280	0.300	1.200
0.117	*****	*****	*****	*****	*****	*****	*****	*****
0.617	0.0000	*****	*****	*****	*****	*****	*****	*****
1.117	*****	*****	*****	*****	*****	*****	*****	*****
1.617	*****	*****	*****	*****	*****	*****	*****	0.0010
4.117	0.0960	0.0950	0.0950	0.0940	0.0940	0.0930	0.0920	*****

AXIAL POSITION (m)	0.160	0.180	0.200	0.220	0.240	0.260	0.280	0.300
0.117	0.0120	0.0110	0.0100	0.0110	0.0110	0.0100	0.0100	0.0100
0.617	0.0340	0.0330	0.0300	0.0270	0.0250	0.0240	0.0230	*****
1.117	0.0210	0.0230	0.0240	0.0240	0.0240	0.0250	0.0240	0.0240
1.617	0.0230	0.0230	0.0240	0.0250	0.0260	0.0260	0.0260	*****
2.117	0.0240	0.0230	0.0230	0.0230	0.0230	0.0230	0.0230	0.0230
4.117	0.0220	0.0220	0.0220	0.0220	0.0220	0.0220	0.0220	0.0210

AXIAL POSITION (m)	0.160	0.180	0.200	0.220	0.240	0.260	0.280	0.300
0.117	0.1140	0.1140	0.1170	0.1170	0.1170	0.1140	0.1130	0.1120
0.617	0.0910	0.0910	0.0930	0.0960	0.0970	0.0980	0.0980	*****
1.117	0.1060	0.1050	0.1040	0.1030	0.1030	0.1030	0.1040	0.1050
1.617	0.1090	0.1100	0.1080	0.1080	0.1070	0.1070	0.1080	*****
2.117	0.1070	0.1070	0.1070	0.1070	0.1070	0.1070	0.1070	0.1070
4.117	0.1100	0.1100	0.1100	0.1100	0.1100	0.1090	0.1090	0.1100

DATA SET C.1.4  
 HASSAN ET AL. (49)

TEMP (K)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.160	0.180	0.200	0.220	0.240	0.260	0.280	0.300
0.117	1639.	1634.	1632.	1635.	1625.	1601.	1576.	1565.
0.250	1685.	1665.	1640.	1609.	1603.	1599.	1587.	1535.
0.383	1767.	1707.	1666.	1627.	1614.	*****	*****	*****
0.750	1910.	1873.	1833.	1792.	1754.	1713.	1687.	1655.
1.250	1933.	1899.	1874.	1833.	1793.	1742.	1709.	1664.
1.750	1795.	1781.	1783.	1774.	1766.	1754.	1693.	1599.
2.250	1724.	1720.	1716.	1699.	1695.	1679.	1657.	1582.

DATA SET C.2.1  
MICHELFELDER AND LOWES (51)

DATA SET C.2.1  
MICHELFELDER AND LOWES (51)

GEOMETRY (m)		MASS FLOW RATES (kg/s)	
Primary tube ID	0.0326	Primary gas	0.07830
Secondary tube ID	0.1760	Primary solids	0.00000
Chamber ID	2.0000	Secondary gas	0.87000
Chamber length	6.2500	Secondary solids	0.00000
Pri. wall thick	0.0137		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.0000		

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	279.0	303.0
Pressure (kPa)	101.3	101.3
Swirl number	0.0	0.5

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
CH4	1.0000	0.0000
N2	0.0000	0.7900
O2	0.0000	0.2100

SOLID PROPERTIES

Mean Particle size (m)	0.0000E+00
Bulk Particle density (kg/m3)	0.0000E+00

		O2 (mole frac.)							
		AXIAL POSITION (m)				RADIAL POSITION (m)			
		0.250	0.300	0.400	0.500	0.600	0.650	0.700	0.800
0.370	0.2890	*****	0.2090	0.0420	*****	*****	0.0420	*****	
0.555	0.0910	0.0690	0.0640	*****	*****	*****	*****	*****	
0.740	0.1170	0.1070	0.2090	0.0550	*****	*****	*****	*****	
0.925	*****	0.1050	0.0760	0.0610	0.0530	*****	0.0540	0.2090	
1.110	*****	0.0850	0.2090	0.0750	0.2090	*****	*****	0.2090	
1.480	*****	0.0680	0.2090	0.2890	0.0690	*****	0.2890	0.0770	
1.850	0.2890	0.0420	0.0540	0.0550	0.0520	*****	0.0550	0.2090	
2.750	*****	0.0240	0.0280	0.0290	*****	0.0300	0.2090	0.0280	
3.500	*****	0.0100	0.0210	0.0120	*****	0.0210	0.2090	0.0120	
4.250	*****	0.0070	0.0110	0.0110	*****	*****	0.2090	0.0100	
5.000	*****	0.0100	0.2090	0.0070	0.0070	*****	0.0110	*****	
5.750	*****	0.0120	0.2090	0.0110	0.0130	*****	0.0130	0.2090	

		N2 (mole frac.)							
		AXIAL POSITION (m)				RADIAL POSITION (m)			
		0.250	0.300	0.400	0.500	0.600	0.650	0.700	0.800
0.370	0.7910	*****	0.7910	0.0500	*****	*****	0.0500	*****	
0.555	0.8100	0.0100	*****	*****	*****	*****	*****	*****	
0.740	*****	0.8130	0.7910	*****	*****	*****	*****	*****	
0.925	*****	0.7090	0.0070	0.3160	*****	*****	0.0150	0.7910	
1.110	*****	0.8100	0.7910	0.8130	0.7910	*****	*****	0.7910	
1.480	*****	0.8390	0.7910	0.7910	0.8420	*****	0.7910	0.8350	
1.850	0.7910	0.8230	0.8340	0.8340	0.8400	*****	0.8370	0.7910	
2.750	*****	0.8470	0.8340	0.8370	*****	0.8400	0.7910	0.8470	
3.500	*****	0.8500	0.8420	0.8500	*****	0.8370	0.7910	0.8500	
4.250	*****	0.8500	0.8500	0.8500	*****	*****	0.7910	0.8580	
5.000	*****	0.8580	0.7910	0.8500	0.8660	*****	0.8640	*****	
5.750	*****	0.8500	0.7910	0.8520	0.8460	*****	0.8480	0.7910	

		CO2 (mole frac.)							
		AXIAL POSITION (m)				RADIAL POSITION (m)			
		0.250	0.300	0.400	0.500	0.600	0.650	0.700	0.800
0.370	*****	0.1200	*****	0.1170	*****	*****	0.1160	*****	
0.555	0.0090	0.1810	0.1040	*****	*****	*****	*****	*****	
0.740	*****	*****	*****	0.1180	*****	*****	*****	*****	
0.925	*****	0.0810	0.0990	0.1060	0.1080	*****	0.1080	*****	
1.110	*****	*****	*****	0.1030	*****	*****	*****	*****	
1.480	*****	0.0960	0.1030	*****	0.1040	*****	*****	0.0970	
1.850	*****	0.1110	0.1090	0.1090	0.1110	*****	0.1090	*****	
2.750	*****	0.1220	0.1230	0.1240	*****	0.1260	*****	0.1260	
3.500	*****	0.1300	0.1260	0.1330	*****	0.1290	*****	0.1350	
4.250	*****	0.1360	0.1350	0.1350	*****	*****	*****	0.1370	

5.000 \*\*\*\*\* 0.1270 \*\*\*\*\* 0.1280 0.1300 \*\*\*\*\* 0.1320 \*\*\*\*\*  
 5.750 \*\*\*\*\* 0.1230 0.1280 0.1190 0.1230 \*\*\*\*\* 0.1230 \*\*\*\*\*

DATA SET C.2.1  
 MICHELFELDER AND LOWES (51)

CO (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.025	0.050	0.075	0.100	0.125	0.150	0.200	0.300
0.370	0.0020	0.0030	*****	*****	*****	*****	*****	*****
0.555	0.0060	0.0050	0.0060	0.0150	0.0050	*****	*****	*****
0.740	0.0140	0.0150	0.0150	0.0110	0.0050	*****	*****	*****
0.925	0.0190	0.0170	*****	0.0140	*****	*****	0.0030	*****
1.110	0.0200	0.0210	*****	0.0230	*****	*****	0.0150	0.0090
1.480	*****	0.0360	*****	0.0300	*****	0.0220	0.0140	0.0040
1.850	*****	0.0400	0.0370	0.0330	*****	0.0270	0.0200	0.0100
2.750	*****	*****	*****	0.0200	*****	*****	0.0120	0.0050
3.500	*****	*****	*****	0.0060	*****	*****	0.0050	0.0040

H2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.025	0.050	0.075	0.100	0.125	0.150	0.200	0.300
0.370	0.0050	0.0120	*****	*****	*****	*****	*****	*****
0.555	0.0260	0.0150	0.0050	*****	*****	*****	*****	*****
0.740	0.0180	0.0170	0.0150	0.0100	0.0000	*****	*****	*****
0.925	0.0210	0.0130	*****	0.0190	*****	*****	0.0040	*****
1.110	0.0270	0.0250	*****	0.0220	*****	*****	0.0100	0.0000
1.480	*****	0.0310	*****	0.0330	*****	0.0190	0.0120	0.0040
1.850	*****	0.0330	0.0350	0.0320	*****	0.0260	0.0180	0.0080
2.750	*****	*****	*****	0.0150	*****	*****	0.0090	0.0030
3.500	*****	*****	*****	0.0050	*****	*****	0.0040	0.0030

TEMP (K)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.250	0.300	0.400	0.500	0.600	0.650	0.700	0.800
0.370	1008.	*****	1058.	1023.	*****	*****	1033.	*****
0.555	913	99.	*****	*****	*****	*****	*****	*****
0.740	898	948.	1025.	1038.	*****	*****	*****	*****
1.110	*****	117.	1071.	*****	*****	*****	*****	*****
1.295	*****	118.	1098.	1088.	1098.	*****	1083.	1083.
1.480	*****	127.	1261.	1143.	1138.	*****	1128.	1123.
1.665	*****	1358.	1243.	1183.	1158.	*****	1148.	1148.
1.850	1478	144.	*****	1243.	1203.	*****	1183.	1163.
2.035	*****	145.	1348.	1353.	1233.	*****	1208.	*****
2.750	*****	155.	1443.	1423.	*****	1353.	1353.	1308.
3.500	*****	154.	1463.	1463.	*****	1393.	1388.	1388.
4.250	*****	149.	*****	*****	*****	*****	1363.	1338.
5.000	*****	142.	1423.	1393.	1373.	*****	1348	*****
5.750	*****	137.	1373.	1348.	1333.	*****	*****	*****

DATA SET C.2.2  
SAMUELSEN AND BRUM (45)

DATA SET C.2.2  
SAMUELSEN AND BRUM (45)

GEOMETRY (m)                      MASS FLOW RATES (kg/s)

Primary tube ID	0.0010	Primary gas	0.00122
Secondary tube ID	0.0570	Primary solids	0.00000
Chamber ID	0.0800	Secondary gas	0.09360
Chamber length	0.5000	Secondary solids	0.00000
Pri. wall thick	0.0090		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.0000		

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	292.0	293.0
Pressure (kPa)	101.0	101.0
Swirl number	0.0	0.8

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
C3H8	1.0000	0.0000
N2	0.0000	0.7900
O2	0.0000	0.2100

SOLID PROPERTIES

Mean Particle size (m)	0.0000E+00
Bulk Particle density (kg/m3)	0.0000E+00

UVEL (m/s)

	AXIAL POSITION (m)								
	0.022	0.024	0.026	0.028	0.030	0.032	0.034	0.036	
	0.005	20.50	16.70	15.00	17.40	12.70	14.60	15.60	*****
	0.010	*****	19.70	*****	15.90	*****	15.00	*****	16.90
	0.020	*****	24.90	*****	23.70	*****	19.40	*****	18.10
	0.040	*****	17.23	*****	26.80	*****	28.60	*****	25.00
	0.070	*****	21.00	*****	25.00	*****	25.80	*****	26.00
	0.100	*****	22.10	*****	23.60	*****	24.60	*****	24.70
	0.140	*****	24.30	*****	25.70	*****	26.40	*****	24.60
	0.240	*****	27.70	*****	27.70	*****	27.40	*****	26.20

WVEL (m/s)

	AXIAL POSITION (m)								
	0.020	0.022	0.024	0.026	0.028	0.030	0.032	0.036	
	0.010	27.30	28.50	26.70	24.90	10.30	-0.58	-0.46	-0.31
	0.010	19.60	*****	23.60	*****	18.60	*****	2.11	-0.87
	0.020	6.81	*****	13.90	*****	18.30	*****	6.94	-0.34
	0.040	6.24	*****	6.43	*****	11.00	*****	11.80	5.02
	0.070	12.00	*****	12.10	*****	11.90	*****	8.42	4.60
	0.100	12.30	*****	11.10	*****	9.12	*****	7.32	5.52
	0.140	11.00	*****	9.29	*****	7.88	*****	7.17	6.98
	0.240	9.18	*****	8.31	*****	7.43	*****	7.28	7.71

URMS (m/s)

	AXIAL POSITION (m)								
	0.022	0.024	0.026	0.028	0.030	0.032	0.034	0.036	
	0.005	2.65	2.90	4.05	4.47	4.29	2.81	2.75	*****
	0.010	*****	3.47	*****	4.44	*****	4.74	*****	3.23
	0.020	*****	4.65	*****	3.75	*****	5.21	*****	3.44
	0.040	*****	6.49	*****	5.11	*****	5.40	*****	4.77
	0.070	*****	5.15	*****	3.98	*****	4.67	*****	4.68
	0.100	*****	4.04	*****	4.29	*****	4.58	*****	4.58
	0.140	*****	3.78	*****	3.38	*****	3.37	*****	3.60
	0.240	*****	3.64	*****	2.86	*****	2.63	*****	3.17

DATA SET C.2.2  
SAMUELSEN AND BRUN (45)

WRMS (m/s)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.020	0.022	0.024	0.026	0.028	0.030	0.032	0.036
0.010	3.15	2.77	2.39	2.85	9.13	3.21	3.54	*****
0.010	4.80	*****	3.64	*****	4.90	*****	5.02	2.05
0.020	5.96	*****	4.91	*****	3.84	*****	5.95	2.51
0.040	5.37	*****	5.44	*****	4.88	*****	4.94	5.18
0.070	5.03	*****	4.09	*****	3.75	*****	4.72	4.74
0.100	3.58	*****	3.52	*****	4.41	*****	4.26	3.95
0.140	3.79	*****	3.36	*****	3.28	*****	3.44	3.46
0.240	2.72	*****	2.57	*****	2.61	*****	2.66	7.42

U-W (m/s)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.008	0.012	0.016	0.020	0.024	0.028	0.032	0.036
0.010	*****	3.16	12.90	6.61	0.76	0.63	-7.95	-0.10
0.020	18.00	-6.36	5.13	2.11	6.33	1.04	-2.68	-1.97
0.040	1.21	2.95	3.25	-2.13	4.28	8.48	2.13	2.42
0.070	-1.42	2.25	6.25	1.83	2.77	1.54	3.36	-1.45
0.100	-1.34	-3.11	-5.15	-1.50	-0.46	1.11	0.35	-0.90
0.140	3.54	-0.62	-1.87	-0.91	0.85	-0.06	0.71	1.38
0.240	-3.09	6.12	2.69	1.72	0.79	-0.24	0.81	0.31



DATA SET C.2.3  
GOULDIN ET AL. (40)

DATA SET C.2.3  
GOULDIN ET AL. (40)

GEOMETRY (m)			MASS FLOW RATES (kg/s)			UVEL (m/s)					
Primary tube ID	0.0495	Primary gas	0.06580								
Secondary tube ID	0.1020	Primary solids	0.00000								
Chamber ID	0.1050	Secondary gas	0.06800								
Chamber length	0.6100	Secondary solids	0.00000								
Pri. wall thick	0.0016										
Quarl half angle	0.0000										
(degrees)											
Quarl length	0.0000										
GAS PROPERTIES						AXIAL POSITION (m)					
	Primary	Secondary									
Temperature (K)	293.0	293.0	0.010	0.015	0.020	0.025	0.030	0.035	0.040	0.045	
Pressure (kPa)	101.0	101.0	0.016	35.33	36.30	35.16	26.61	29.18	27.51	27.44	27.00
Swirl number	0.5	0.6	0.033	36.32	36.47	34.76	32.12	30.25	28.67	27.88	27.54
			0.050	32.10	34.51	34.97	30.14	29.00	29.11	28.35	27.85
			0.083	32.19	34.85	35.12	33.75	31.01	29.50	28.88	28.23
			0.139	28.99	33.44	34.03	33.11	30.71	28.23	28.57	28.73
			0.246	33.54	34.09	33.63	31.72	29.91	29.35	28.50	28.61
			0.443	34.60	34.37	33.25	31.74	30.47	29.43	29.10	29.12
										URMS (m/s)	
										AXIAL POSITION (m)	
GAS COMPOSITION (mole fraction - dry basis)										RADIAL POSITION (m)	
Species	Primary	Secondary	0.010	0.015	0.020	0.025	0.030	0.035	0.040	0.045	
CH4	0.0738	0.0000	0.016	8.22	5.70	5.38	5.80	7.20	2.81	2.72	2.76
C2H6	0.0031	0.0000	0.033	5.61	4.72	6.16	4.59	4.08	3.60	3.35	3.82
C3H8	0.0008	0.0000	0.050	9.79	5.45	5.67	4.30	4.03	3.27	2.81	2.98
N2	0.7200	0.7810	0.083	5.60	5.77	3.39	4.20	4.02	3.59	3.21	3.50
O2	0.1940	0.2100	0.139	5.29	5.82	4.55	4.90	3.24	3.02	2.98	2.80
AR	0.0086	0.0093	0.246	5.68	4.79	4.16	3.09	3.23	3.37	2.23	2.00
			0.443	3.37	3.20	2.47	3.45	3.53	3.65	3.28	2.31
SOLID PROPERTIES										VVEL (m/s)	
Mean Particle size (m)	0.0000E+00									AXIAL POSITION (m)	
Bulk Particle density (kg/m3)	0.0000E+00									RADIAL POSITION (m)	
			0.010	0.015	0.020	0.025	0.030	0.034	0.039	0.044	
			0.016	33.69	34.58	30.50	22.25	32.88	31.75	25.61	19.60
			0.033	34.23	35.85	31.65	26.01	32.18	30.77	25.61	21.24
			0.050	31.24	35.81	30.98	27.94	31.56	29.55	24.41	19.04
			0.083	33.11	33.34	29.39	28.75	30.08	29.68	24.72	19.68
			0.139	28.72	28.94	26.53	28.00	27.04	25.88	25.03	23.51
			0.246	28.72	30.29	29.28	28.65	27.38	26.18	25.91	24.35
			0.443	27.34	29.70	28.80	27.36	26.31	25.20	23.74	22.79

DATA SET C 2.3  
GOULDIN ET AL. (40)

VRMS (m/s)

AXIAL POSITION (m)	RADIAL POSITION (m)								
	0.010	0.015	0.020	0.025	0.030	0.034	0.039	0.044	
0.016	3.13	3.42	3.96	5.53	4.16	4.74	5.25	2.97	
0.033	3.95	3.51	3.83	4.82	3.69	3.46	2.58	2.26	
0.050	6.59	5.22	4.09	3.85	3.27	2.48	2.66	4.03	
0.083	6.23	4.91	4.07	3.58	5.24	2.81	1.34	4.35	
0.139	5.80	5.00	6.00	3.75	6.25	6.01	1.17	3.87	
0.246	4.81	4.09	3.78	3.51	3.40	3.55	2.69	3.20	
0.443	5.03	3.23	2.79	3.89	4.01	3.20	3.36	4.25	

DATA SET C.2.4  
GOULDIN ET AL. (40)

DATA SET C.2.4  
GOULDIN ET AL. (40)

GEOMETRY (m)			MASS FLOW RATES (kg/s)			VEL (m/s)					
Primary tube ID	0.0495	Primary gas	0.06580								
Secondary tube ID	0.1020	Primary solids	0.00300								
Chamber ID	0.1050	Secondary gas	0.06300								
Chamber length	0.6100	Secondary solids	0.00000								
Pri. wall thick	0.0016										
Quarl half angle	0.0000										
(degrees)											
Quarl length	0.0000										
GAS PROPERTIES						AXIAL POSITION (m)					
	Primary	Secondary									
Temperature (K)	293.0	293.0									
Pressure (kPa)	101.0	101.0									
Swirl number	0.5	-0.6									
			RADIAL POSITION (m)								
			0.010	0.015	0.020	0.025	0.030	0.035	0.040	0.045	
			0.014	25.00	651.00	32.50	36.00	28.95	27.90	27.28	28.11
			0.032	7.56	26.58	34.12	33.86	30.05	29.39	29.09	28.85
			0.052	3.34	19.97	30.78	32.15	30.76	30.89	30.88	30.80
			0.075	10.23	19.97	27.02	30.28	31.65	31.39	31.90	31.00
			0.100	15.74	22.05	26.53	31.98	31.92	31.93	32.32	31.07
			0.140	22.12	24.30	27.97	28.72	30.00	29.98	30.24	30.30
			0.245	28.22	28.52	29.06	29.23	29.23	29.35	29.39	29.08
			0.443	31.30	30.91	30.47	30.58	30.30	30.08	29.98	29.11
			URMS (m/s)								
GAS COMPOSITION (mole fraction - dry basis)			AXIAL POSITION (m)								
Species	Primary	Secondary	0.010	0.015	0.020	0.025	0.030	0.035	0.040	0.045	
CH4	0.0738	0.0000	0.014	11.99	9.87	8.29	7.21	3.81	3.03	3.01	3.51
C2H6	0.0031	0.0000	0.032	13.67	10.40	6.21	5.88	5.89	3.62	3.15	3.55
C3H8	0.0008	0.0000	0.052	3.34	19.97	30.78	32.15	30.76	30.89	30.88	30.80
N2	0.7200	0.7810	0.075	10.23	19.97	27.02	30.28	31.65	31.39	31.90	31.00
O2	0.1940	0.2100	0.100	15.74	22.05	26.53	31.98	31.92	31.93	32.32	31.07
AR	0.0086	0.0093	0.140	22.12	24.30	27.97	28.72	30.00	29.98	30.24	30.30
			0.245	28.22	28.52	29.06	29.23	29.23	29.35	29.39	29.08
			0.443	31.30	30.91	30.47	30.58	30.30	30.08	29.98	29.11
SOLID PROPERTIES			RADIAL POSITION (m)								
Mean Particle size (m)	0.0000E+00		VVEL (m/s)								
Bulk Particle density (kg/m3)	0.0000E+00										
			AXIAL POSITION (m)								
			0.010	0.015	0.020	0.025	0.030	0.034	0.039	0.044	
			0.014	-20.05	-29.21	-29.42	-17.12	28.29	31.38	29.57	28.78
			0.032	-11.95	-20.77	-25.26	-17.85	3.14	22.93	28.08	26.13
			0.052	-14.32	-20.35	-20.20	-13.08	-4.63	7.59	23.72	25.34
			0.075	-13.03	-14.07	-12.00	-7.12	-2.26	13.55	22.11	22.50
			0.100	-7.93	-8.37	-7.89	-1.84	4.57	12.66	19.20	16.12
			0.140	-4.74	-5.12	-2.28	0.54	7.11	11.21	18.79	17.00
			0.245	0.38	2.29	8.54	9.98	11.19	14.97	18.65	18.61
			0.443	3.13	5.44	7.99	10.01	13.03	15.25	16.41	16.66

DATA SET C.2.4  
 GOULDIN ET AL. (40)

VRMS (m/s)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.010	0.015	0.020	0.025	0.030	0.035	0.039	0.044
0.014	7.20	4.94	3.80	10.27	6.45	5.05	4.01	3.70
0.032	10.20	7.51	5.63	7.49	12.90	9.97	5.48	5.97
0.052	9.94	10.65	8.30	8.36	8.62	12.50	3.03	4.58
0.075	10.44	10.25	10.43	10.08	10.06	12.06	7.72	5.19
0.100	11.10	10.48	10.68	11.29	11.81	11.27	6.88	5.39
0.140	9.87	8.89	9.70	10.12	10.48	10.66	8.83	6.14
0.245	5.76	5.92	6.85	7.50	6.81	6.72	5.80	5.55
0.443	3.39	3.57	3.73	3.97	4.19	4.54	4.82	5.20

DATA SET D.1.1  
BEER (57)

DATA SET D.1.1  
BEER (57)

(GEOMETRY (m)                      MASS FLOW RATES (kg/s)

Primary tube ID	0.0540	Primary gas	0.04000
Secondary tube ID	0.1500	Primary solids	0.02897
Chamber ID	1.5000	Secondary gas	0.34000
Chamber length	9.1000	Secondary solids	0.00000
Pri. wall thick	0.0000		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.0400		

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	353.0	773.0
Pressure (kPa)	86.0	86.0
Swirl number	0.0	0.0

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
N2	0.7550	0.7550
O2	0.2310	0.2310
AR	0.0140	0.0140

DUAL COMPOSITION

Ultimate Analysis (mass frac., dry)		Proximate Analysis (mass frac., as recd.)	
C	0.8760	Moisture	0.0110
H	0.0352	Volatile matter	0.0786
O	0.0154	Fixed Carbon	0.8570
N	0.0102	Ash	0.0530
S	0.0101		
Ash	0.0536		
Heating Value (J/kg, daf)		3.3900E+07	
Mean Particle Size (m)		7.5000E-05	
Bulk Particle Density (kg/m3)		3.4000E+03	

CO2 (mole frac.)

AXIAL POSITION (m)	0.000	0.100	0.150	0.200	0.300	0.550
0.500	*****	*****	*****	*****	*****	0.1340
1.200	0.0060	*****	*****	*****	*****	0.1280
2.000	0.0360	0.0480	*****	*****	*****	*****
2.700	0.0650	*****	0.0800	*****	0.0820	*****
3.300	0.0900	*****	0.0980	*****	0.0920	*****
4.050	0.1080	*****	0.1060	*****	0.1080	*****
5.500	0.1300	*****	*****	0.1160	*****	*****
7.000	0.1410	*****	*****	*****	*****	*****

N2 (mole frac.)

AXIAL POSITION (m)	0.000	0.100	0.150	0.200	0.300	0.550
0.500	*****	*****	*****	*****	*****	0.7720
1.200	0.6710	*****	*****	*****	*****	0.7730
2.000	0.7220	0.7560	*****	*****	*****	*****
2.700	0.7440	*****	0.7610	*****	0.7560	*****
3.300	0.7670	*****	0.7670	*****	0.7700	*****
4.050	0.7760	*****	0.7730	*****	0.7730	*****
5.500	0.7750	*****	*****	0.7840	*****	*****
7.000	0.7720	*****	*****	*****	*****	*****

O2 (mole frac.)

AXIAL POSITION (m)	0.000	0.100	0.150	0.200	0.300	0.550
0.500	*****	*****	*****	*****	*****	0.0500
1.200	0.1770	*****	*****	*****	*****	0.0560
2.000	0.1520	0.1500	*****	*****	*****	*****
2.700	0.1230	*****	0.1120	*****	0.1090	*****
3.300	0.0920	*****	0.0930	*****	0.0950	*****
4.050	0.0760	*****	0.0820	*****	0.0800	*****
5.500	0.0570	*****	*****	0.0650	*****	*****
7.000	0.0420	*****	*****	*****	*****	*****

DATA SET D.1.1  
BEER (57)

TEMP (K)

AXIAL POSITION (m)	0.000	0.100	0.150	0.200	0.300	0.550
0.500	*****	*****	*****	*****	*****	1484.
1.200	880.	*****	*****	*****	*****	1481.
2.000	1058.	1133.	*****	*****	*****	*****
2.700	1333.	*****	1393	*****	1433.	*****
3.300	1603.	*****	1588	*****	1523.	*****
4.050	1694.	*****	1669.	*****	1587.	*****
5.500	1713.	*****	*****	1703.	*****	*****
7.000	1668.	*****	*****	*****	*****	*****

DATA SET D.1.2  
HEIN AND LEUCKEL (60)

DATA SET D.1.2  
HEIN AND LEUCKEL (60)

GEOMETRY (m)		MASS FLOW RATES (kg/s)	
Primary tube ID	0.0577	Primary gas	0.05420
Secondary tube ID	0.1610	Primary solids	0.04139
Chamber ID	2.0000	Secondary gas	0.46530
Chamber length	6.2500	Secondary solids	0.00030
Pri. wall thick	0.0132		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.5100		

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	353.0	573.0
Pressure (kPa)	101.3	101.3
Swirl number	0.0	0.0

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
N2	0.7900	0.7900
O2	0.2100	0.2100

COAL COMPOSITION

Ultimate Analysis (mass frac., dry)		Proximate Analysis (mass frac., as recd.)	
C	0.8400	Moisture	0.0500
H	0.0378	Volatile matter	0.0999
O	0.0325	Fixed Carbon	0.7680
N	0.0063	Ash	0.0820
S	0.0078		
Ash	0.0820		

Heating Value (J/kg, daf)	3.5930E+07
Mean Particle Size (µm)	5.0000E-05
Bulk Particle Density (kg/m <sup>3</sup> )	1.3000E+03

		O2 (mole frac.)							
AXIAL POSITION (m)	RADIAL POSITION (m)								
	0.050	0.100	0.150	0.200	0.250	0.300	0.400	0.600	
0.400	*****	0.1080	0.0650	0.0550	*****	0.0530	0.0520	*****	
0.600	*****	0.1320	0.0810	0.0620	*****	0.0510	0.0500	*****	
0.800	0.1540	0.1340	0.0970	0.0670	*****	0.0500	0.0520	0.0510	
1.150	*****	0.1310	0.0980	0.0790	*****	0.0550	0.0470	0.0450	
1.600	0.1360	0.1280	0.1180	0.1060	*****	0.0820	0.0650	0.0520	
1.950	*****	0.1320	0.0810	*****	0.0910	*****	0.0700	0.0580	
2.750	*****	0.0990	0.0910	*****	0.0880	*****	0.0740	0.0580	
3.500	*****	0.0890	*****	*****	0.0840	*****	0.0860	0.0640	
4.250	*****	0.0750	*****	*****	0.0890	*****	0.0720	*****	

N2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.050	0.100	0.150	0.200	0.250	0.300	0.400	0.600
0.400	*****	0.7940	0.7960	0.7960	*****	0.7920	0.7980	*****
0.600	*****	0.7940	0.8000	0.7960	*****	0.7980	0.7980	*****
0.800	0.7850	0.7890	0.7890	0.7940	*****	0.7940	0.7960	0.7940
1.150	*****	0.7920	0.7910	0.7920	*****	0.7960	0.7940	0.7980
1.600	*****	0.7920	0.7940	0.7920	*****	0.7960	0.7980	0.7980
1.950	*****	0.7940	0.8000	*****	0.7940	*****	0.7960	0.7920
2.750	*****	0.7940	0.7920	*****	0.7890	*****	0.7960	0.7960
3.500	*****	0.7920	*****	*****	0.7940	*****	0.7920	0.7940
4.250	*****	0.7940	*****	*****	0.7940	*****	0.7940	*****

CO2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.050	0.100	0.150	0.200	0.250	0.300	0.400	0.600
0.400	*****	0.0920	0.1280	0.1380	*****	0.1390	0.1410	*****
0.600	*****	0.0710	0.1130	0.1330	*****	0.1420	0.1400	*****
0.800	0.0490	0.0670	0.1010	0.1250	*****	0.1460	0.1420	0.1400
1.150	*****	0.0700	0.1000	0.1130	*****	0.1360	0.1400	0.1440
1.600	*****	0.0810	0.0830	0.0930	*****	0.1140	0.1290	0.1400
1.950	*****	0.0710	0.1100	*****	0.1050	*****	0.1240	0.1340
2.750	*****	0.0970	0.1040	*****	0.1040	*****	0.1200	0.1310
3.500	*****	0.1040	*****	*****	0.1080	*****	0.1090	0.1280
4.250	*****	0.1170	*****	*****	0.1070	*****	0.1200	*****

DATA SET D.1.2  
HEIN AND LEUCKEL (60)

TEMP (K)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.050	0.100	0.150	0.200	0.250	0.300	0.400	0.500
0.400	*****	970.	1193.	1232.	*****	1230.	1231.	*****
0.600	*****	935.	1123.	1218.	*****	1235.	1238.	*****
0.800	778.	873.	1083.	1163.	*****	1228.	1238.	1238.
1.150	*****	943.	1038.	1103.	*****	1198.	1223.	1218.
1.600	*****	1013.	1038.	1103.	*****	1188.	1203.	1238.
1.950	*****	1028.	1063.	*****	1148.	*****	1218.	1243.
2.750	*****	1138.	1151.	*****	1198.	*****	1238.	1288.
3.500	*****	1208.	*****	*****	1228.	*****	1263.	1305.
4.250	*****	1283.	*****	*****	1293.	*****	1305.	*****



DATA SET D.1.3  
THURGOOD (9)

DATA SET D.1.3  
THURGOOD (9)

GEOMETRY (m)		MASS FLOW RATES (kg/s)	
Primary tube ID	0.0160	Primary gas	0.00560
Secondary tube ID	0.0540	Primary solids	0.00380
Chamber ID	0.2030	Secondary gas	0.03610
Chamber length	1.5200	Secondary solids	0.00000
Pri. wall thick	0.0005		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.0000		

		CO2 (mole frac.)					
		AXIAL POSITION (m)			RADIAL POSITION (m)		
	0.000	0.019	0.045	0.054	0.076	0.089	
0.178	0.0027	0.0070	0.0830	*****	0.0599	*****	
0.330	0.0687	0.0141	0.0249	0.0298	*****	0.0362	
0.483	0.0104	0.0098	0.0195	*****	0.0319	*****	
0.787	0.0339	0.0395	0.0391	*****	0.0343	*****	
1.092	0.0678	0.0733	0.0569	*****	0.0616	*****	
1.397	0.1284	0.1282	0.1094	0.1205	*****	0.1250	

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	356.0	589.0
Pressure (kPa)	101.0	101.0
Swirl number	0.0	0.0

		CO (mole frac.)					
		AXIAL POSITION (m)			RADIAL POSITION (m)		
	0.000	0.019	0.045	0.054	0.076	0.089	
0.178	*****	*****	*****	*****	0.0095	*****	
0.330	*****	*****	0.0022	0.0028	*****	0.0038	
0.483	*****	*****	*****	*****	0.0020	*****	
0.787	0.0069	0.0065	0.0019	*****	*****	*****	
1.092	0.0120	0.0101	0.0032	*****	0.0010	*****	
1.397	0.0025	0.0021	0.0004	0.0009	*****	*****	

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
N2	0.7390	0.7830
O2	0.2020	0.2080
AR	0.0593	0.0093

H2 (mole frac.)

COAL COMPOSITION

Ultimate Analysis (mass frac., dry)		Proximate Analysis (mass frac., as recd.)	
C	0.7020	Moisture	0.0240
H	0.0566	Volatile matter	0.4540
O	0.1340	Fixed Carbon	0.4370
N	0.0140	Ash	0.0860
S	0.0050		
Ash	0.0886		

		AXIAL POSITION (m)			RADIAL POSITION (m)		
	0.000	0.019	0.045	0.054	0.076	0.089	
0.178	*****	*****	*****	*****	0.0066	*****	
0.787	0.0015	0.0014	0.0014	*****	*****	*****	
1.092	0.0033	0.0027	0.0009	*****	0.0004	*****	
1.397	0.0007	0.0007	0.0003	0.0004	*****	0.0001	

Heating Value (J/kg. daf)	2.9400E+04
Mean Particle Size (m)	4.8000E-05
Bulk Particle Density (kg/m <sup>3</sup> )	3.4000E+03

DATA SET D.1.3  
THURGOOD (9)

DATA SET D.1.3  
THURGOOD (9)

O2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)					
0.000	0.019	0.045	0.054	0.076	0.089	
0.178	0.2039	0.2001	0.0952	*****	0.1044	*****
0.330	0.1990	0.1971	0.1817	0.1773	*****	0.1667
0.483	0.1918	0.1929	0.1823	*****	0.1623	*****
0.787	0.1505	0.1416	0.1458	*****	0.1559	*****
1.092	0.0845	0.0859	0.1022	*****	0.1081	*****
1.397	0.0685	0.0680	0.0764	0.0710	*****	0.0713

N2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)					
0.000	0.019	0.045	0.054	0.076	0.089	
0.178	0.7528	0.7768	0.8037	*****	0.7776	*****
0.330	0.7670	0.7740	0.7783	0.7770	*****	0.7799
0.483	0.7776	0.7809	0.7845	*****	0.7897	*****
0.787	0.7919	0.7952	0.7967	*****	0.7955	*****
1.092	0.8155	0.8111	0.8203	*****	0.8125	*****
1.397	0.7837	0.7845	0.7971	0.7909	*****	0.7872

AR (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)					
0.000	0.019	0.045	0.054	0.076	0.089	
0.178	0.0405	0.0161	0.0140	*****	0.0115	*****
0.330	0.0253	0.0148	0.0124	0.0131	*****	0.0134
0.483	0.0202	0.0154	0.0132	*****	0.0142	*****
0.787	0.0153	0.0158	0.0151	*****	0.0144	*****
1.092	0.0169	0.0169	0.0166	*****	0.0164	*****
1.397	0.0162	0.0165	0.0165	0.0162	*****	0.0164

C (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)					
0.000	0.019	0.045	0.054	0.076	0.089	
0.178	0.7271	0.7008	*****	*****	0.4117	*****
0.330	0.7250	0.7238	0.6371	0.6306	*****	0.4974
0.483	0.6883	0.6958	0.5565	*****	0.4398	*****
0.787	0.7027	*****	0.6730	*****	0.5457	*****
1.092	0.6769	0.6571	0.6657	*****	0.5756	*****
1.397	0.6012	0.6037	0.4874	0.5293	*****	0.4916

H (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)					
0.000	0.019	0.045	0.054	0.076	0.089	
0.178	0.0554	0.0533	*****	*****	0.0047	*****
0.330	0.0467	0.0414	0.0213	0.0214	*****	0.0201
0.483	0.0505	0.0508	0.0310	*****	0.0277	*****
0.787	0.0510	0.0495	0.0427	*****	0.0295	*****
1.092	0.0382	0.0307	0.0268	*****	0.0173	*****
1.397	0.0175	0.0139	0.0114	0.0115	*****	0.0114

O (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)					
0.000	0.019	0.045	0.054	0.076	0.089	
0.178	0.1240	0.1285	*****	*****	0.1204	*****
0.330	0.1022	0.0981	0.0784	0.0600	*****	0.0725
0.483	0.1612	0.1433	0.1303	*****	0.1026	*****
0.787	0.1269	*****	0.1144	*****	0.0869	*****
1.092	0.1003	0.1095	0.0692	*****	0.0569	*****
1.397	0.0538	0.0417	0.0737	0.0484	*****	0.0532

DATA SET D.1.3  
T-HURGOOD (9)

S (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)					
	0.000	0.019	0.045	0.054	0.076	0.089
0.178	0.0061	0.0053	*****	*****	0.0037	*****
0.330	0.0069	0.0065	0.0060	0.0057	*****	0.0033
0.483	0.0053	0.0055	0.0038	*****	0.0035	*****
0.737	0.0052	0.0051	0.0049	*****	0.0044	*****
1.092	0.0049	0.0047	0.0046	*****	0.0046	*****
1.397	0.0054	0.0044	0.0029	0.0032	*****	0.0036

N (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)					
	0.000	0.019	0.045	0.054	0.076	0.089
0.178	0.0146	0.0141	*****	*****	0.0093	*****
0.330	0.0145	0.0145	0.0136	0.0135	*****	0.0114
0.483	0.0139	0.0140	0.0128	*****	0.0097	*****
0.737	0.0142	0.0141	0.0139	*****	0.0117	*****
1.092	0.0137	0.0145	0.0128	*****	0.0106	*****
1.397	0.0113	0.0110	0.0108	0.0105	*****	0.0111

ASH (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)					
	0.000	0.019	0.045	0.054	0.076	0.089
0.178	0.0595	0.1135	*****	*****	0.4502	*****
0.330	0.1047	0.1157	0.2436	0.2688	*****	0.3953
0.483	0.0950	0.1051	0.2651	*****	0.4167	*****
0.737	0.1121	0.1111	0.1511	*****	0.3218	*****
1.092	0.1540	0.2035	0.2209	*****	0.3350	*****
1.397	0.3108	0.3253	0.4138	0.3971	*****	0.4291

DATA SET D.1.4  
MICHEL AND PAYNE (61)

DATA SET D.1.4  
MICHEL AND PAYNE (61)

GEOMETRY (m)		MASS FLOW RATES (kg/s)	
Primary tube ID	0.0703	Primary gas	0.07080
Secondary tube ID	0.2500	Primary solids	0.05887
Chamber ID	1.9500	Secondary gas	0.57300
Chamber length	6.2500	Secondary solids	0.00600
Pri. wall thick	0.0184		
Quarl half angle	0.0500		
(degrees)			
Quarl length	0.0500		

GAS PROPERTIES		
	Primary	Secondary
Temperature (K)	353.0	773.0
Pressure (kPa)	101.0	101.0
Swirl number	0.0	0.0

GAS COMPOSITION (mole fraction - dry basis)		
Species	Primary	Secondary
N2	0.7900	0.7900
O2	0.2100	0.2100

COAL COMPOSITION			
Ultimate Analysis (mass frac., dry)		Proximate Analysis (mass frac., as recd.)	
C	0.7470	Moisture	0.0200
H	0.0470	Volatile matter	0.3200
O	0.1110	Fixed Carbon	0.5840
N	0.0112	Ash	0.0760
S	0.0085		
Ash	0.0760		

Heating Value (J/kg, daf)	3.1000E+07
Mean Particle Size (m)	7.5000E-05
Bulk Particle Density (kg/m <sup>3</sup> )	1.3000E+03

CO (mole frac.)										
AXIAL POSITION (m)	RADIAL POSITION (m)									
	0.500	0.850	0.875	0.900	0.950	1.000	1.100	1.200		
0.500	*****	0.0003	*****	0.0019	*****	0.0014	0.0009	*****		
0.750	*****	*****	*****	0.0015	0.0050	0.0500	*****	*****		
1.000	0.0005	0.0020	0.0330	0.0450	0.0900	0.1000	*****	*****		
1.100	0.0005	*****	*****	0.0360	*****	0.0960	*****	*****		
1.200	0.0022	0.0050	*****	0.0540	*****	0.0900	*****	*****		
1.500	0.0024	*****	*****	0.0600	*****	0.0780	*****	*****		
1.900	0.0016	0.0360	*****	0.0420	0.0480	0.0480	0.0390	0.0015		
3.500	0.0014	*****	*****	*****	*****	0.0020	*****	*****		

CO2 (mole frac.)										
AXIAL POSITION (m)	RADIAL POSITION (m)									
	0.850	0.875	0.900	0.950	1.000	1.100	1.150	1.200		
0.100	0.1400	0.1100	0.0750	*****	*****	*****	*****	*****		
0.300	0.1020	*****	0.0130	0.0025	0.0025	*****	*****	*****		
0.500	0.0320	*****	0.0300	*****	0.0150	0.0025	*****	*****		
0.750	0.0700	*****	0.0260	0.0625	0.0750	0.0660	0.0665	*****		
1.000	0.0320	0.0860	0.0940	0.1050	0.0950	*****	*****	*****		
1.100	*****	*****	0.1025	*****	0.0950	*****	*****	*****		
1.200	0.0935	*****	0.1075	*****	0.1040	*****	*****	*****		
1.500	*****	*****	0.1140	*****	0.1115	*****	*****	*****		
1.900	0.1250	*****	0.1200	0.1200	0.1200	0.1200	*****	0.1170		
3.500	*****	*****	*****	*****	0.1460	*****	*****	*****		

O2 (mole frac.)										
AXIAL POSITION (m)	RADIAL POSITION (m)									
	0.950	0.980	1.000	1.020	1.030	1.100	1.150	1.200		
0.000	*****	0.2100	0.2100	0.2100	0.2100	*****	*****	*****		
0.100	0.2100	*****	0.2100	*****	*****	*****	*****	*****		
0.300	0.2000	*****	0.2000	*****	*****	*****	*****	*****		
0.500	*****	*****	0.1900	*****	*****	0.1850	*****	*****		
0.750	0.1380	*****	0.1150	*****	*****	0.1450	0.1430	*****		
1.000	0.0150	*****	0.0100	*****	*****	*****	*****	*****		
1.100	*****	*****	0.0300	*****	*****	*****	*****	*****		
1.200	*****	*****	0.0220	*****	*****	*****	*****	*****		
1.500	*****	*****	0.0290	*****	*****	*****	*****	*****		
1.900	0.0400	*****	0.0350	*****	*****	0.0550	*****	0.0450		
3.500	*****	*****	0.0340	*****	*****	*****	*****	*****		

DATA SET D.1.4  
MICHEL AND PAYNE (61)

H<sub>2</sub> (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.700	0.750	0.800	0.850	0.900	0.950	1.000	1.100
0.750	0.0056	*****	0.0035	0.0031	*****	0.0059	*****	*****
1.000	0.0020	*****	0.0016	*****	0.0082	*****	*****	*****
1.200	*****	0.0011	0.0021	0.0038	0.0090	*****	*****	*****
1.500	0.0018	*****	0.0022	*****	0.0039	*****	0.0224	*****
1.900	*****	*****	0.0041	*****	0.0075	0.0080	0.0082	0.0080

TEMP (K)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.850	0.875	0.900	0.925	0.950	1.000	1.100	1.200
0.100	1423.	1088.	883.	848.	853.	623.	*****	*****
0.300	1308.	*****	1013.	*****	1073.	823.	*****	*****
0.500	1198.	*****	1033.	*****	*****	1073.	1033.	*****
0.750	1203.	*****	1473.	*****	1608.	1313.	1623.	*****
1.000	1573.	1633.	1643.	*****	1613.	1508.	*****	*****
1.500	*****	*****	1763.	*****	*****	1673.	*****	*****
1.900	1653.	*****	1713.	*****	1733.	1743.	1673.	1453.
3.500	*****	*****	*****	*****	*****	1593.	*****	*****

NO (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.875	0.900	0.925	0.950	1.000	1.100	1.150	1.200
0.100	0.0	0.0	0.0	0.0	0.0	*****	*****	*****
0.300	*****	23.0	*****	*****	15.0	*****	*****	*****
0.500	*****	55.0	*****	*****	50.0	110.0	*****	*****
0.750	*****	70.0	*****	235.0	140.0	215.0	110.0	*****
1.000	320.0	375.0	*****	490.0	350.0	*****	*****	*****
1.100	*****	450.0	*****	*****	420.0	*****	*****	*****
1.200	*****	390.0	*****	*****	440.0	*****	*****	*****
1.500	*****	370.0	*****	*****	460.0	*****	*****	*****
1.900	*****	310.0	*****	360.0	390.0	310.0	*****	240.0
1.900	*****	420.0	*****	440.0	420.0	310.0	*****	240.0
3.500	*****	*****	*****	*****	300.0	*****	*****	*****

DATA SET D.1.5  
REES (62)

GEOMETRY (m)		MASS FLOW RATES (kg/s)	
Primary tube ID	0.0160	Primary gas	0.00595
Secondary tube ID	0.0540	Primary solids	0.01013
Chamber ID	0.2030	Secondary gas	0.02000
Chamber length	1.5200	Secondary solids	0.00000
Pri. wall thick	0.0010		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.0400		

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	336.0	589.0
Pressure (kPa)	36.0	86.0
Swirl number	0.0	0.0

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
N2	0.7610	0.7900
O2	0.2030	0.2100
AR	0.0370	0.0000

COAL COMPOSITION

Ultimate Analysis (mass frac., dry)		Proximate Analysis (mass frac., as recd.)	
C	0.7230	Moisture	0.0280
H	0.0560	Volatile matter	0.4480
O	0.1150	Fixed Carbon	0.4310
N	0.0140	Ash	0.0930
S	0.0040		
Ash	0.0880		

Heating value (J/kg, daf)	2.9300E+04
Mean Particle Size (m)	4.9000E-05
Bulk Particle Density (kg/m <sup>3</sup> )	1.3400E+03

DATA SET D.1.5  
REES (62)

		O2 (mole frac.)				
AXIAL POSITION (m)		RADIAL POSITION (m)				
		0.000	0.020	0.050	0.070	0.095
0.330	0.2010	0.1980	0.1390	0.2080	0.0300	
0.480	0.1920	0.1790	0.1290	0.1120	0.0750	
0.640	0.1600	0.1740	0.1130	0.0860	0.0620	
0.790	0.1170	*****	0.0690	0.0950	0.0740	
0.940	0.0240	0.1230	0.0310	0.0400	0.0280	
1.090	0.0140	0.0560	0.0250	0.0290	0.0360	
1.250	0.0230	0.0800	0.0190	0.0830	0.0210	
1.400	0.0090	0.0060	0.1430	0.0290	0.1720	

CO2 (mole frac.)

AXIAL POSITION (m)		RADIAL POSITION (m)				
		0.000	0.020	0.050	0.070	0.095
0.330	0.0090	0.0170	0.0450	0.0050	0.1040	
0.480	0.0090	0.0210	0.0460	0.0650	0.1130	
0.640	0.0340	0.0230	0.0800	0.1030	0.1200	
0.790	0.0760	0.0712	0.1090	0.0030	0.1230	
0.940	0.0960	0.0510	0.1350	0.1750	0.1980	
1.090	0.1570	0.1250	0.1910	0.1810	0.1550	
1.250	0.1330	0.0680	0.1590	0.1020	0.1660	
1.400	0.1490	0.1550	0.1230	0.1170	0.1340	

CO (mole frac.)

AXIAL POSITION (m)		RADIAL POSITION (m)				
		0.000	0.020	0.050	0.070	0.095
0.330	0.0000	0.0000	0.0040	0.0000	0.0020	
0.480	0.0000	0.0000	0.0000	0.0000	0.0000	
0.640	0.0000	0.0000	0.0000	0.0000	0.0000	
0.790	0.0100	0.0010	0.0023	0.0000	0.0000	
0.940	0.0790	0.0090	0.0300	0.0040	0.0060	
1.090	0.0250	0.0140	0.0050	0.0030	0.0000	
1.250	0.0140	0.0140	0.0100	0.0030	0.0050	
1.400	0.0150	0.0150	0.0290	0.0080	0.0000	

DATA SET D.1.5  
REES (62)

H2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.050	0.070	0.095
0.330	0.0001	0.0001	0.0005	0.0009	0.0074
0.480	0.0000	0.0000	0.0000	0.0003	0.0002
0.640	0.0004	0.0002	0.0005	0.0002	0.0002
0.790	0.0040	0.0007	0.0008	0.0005	0.0002
0.940	0.0160	0.0210	0.0080	0.0007	0.0008
1.090	0.0120	0.0080	0.0020	0.0023	0.0005
1.250	0.0060	0.0030	0.0030	0.0019	0.0010
1.400	0.0070	0.0070	0.0050	0.0049	0.0040

DATA SET D.2.1  
HEIN AND LEUCKEL (50)

DATA SET D.2.1  
HEIN AND LEUCKEL (60)

GEOMETRY (m)		MASS FLOW RATES (kg/s)	
Primary tube ID	0.0577	Primary gas	0.05420
Secondary tube ID	0.2100	Primary solids	0.04139
Chamber ID	2.0000	Secondary gas	0.04650
Chamber length	6.2500	Secondary solids	0.00000
Pri. wall thick	0.032		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.530		

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	353.0	573.0
Pressure (kPa)	101.0	101.0
Swirl number	0.0	1.0

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
N2	0.7900	0.7900
O2	0.2100	0.2100

COAL COMPOSITION

Ultimate Analysis (mass frac., dry)		Proximate Analysis (mass frac., as recd.)	
C	0.8400	Moisture	0.0500
H	0.0378	Volatile matter	0.0999
O	0.0325	Fixed Carbon	0.7680
N	0.0063	Ash	0.0820
S	0.0078		
Ash	0.0820		

Heating Value (J/kg, daf)	3.5900E+07
Mean Particle Size (m)	5.0000E-05
Bulk Particle Density (kg/m3)	1.3000E+03

AXIAL POSITION (m)	O2 (mole frac.)								
	0.050	0.100	0.150	0.200	0.250	0.300	0.400	0.600	
0.400	0.1540	0.1490	0.1390	0.1230	*****	0.0900	0.0740	*****	
0.600	0.1400	0.1400	0.1210	0.1230	*****	0.1060	0.0930	*****	
0.800	0.1370	0.1330	0.1230	0.1280	*****	0.1120	0.0980	0.0790	
1.150	*****	0.1130	*****	0.1080	*****	0.1020	0.0910	0.0840	
1.600	0.1120	0.1130	*****	0.1130	*****	*****	0.1040	0.0880	
1.950	*****	0.1040	*****	*****	0.1010	*****	0.1020	*****	
2.750	*****	*****	*****	*****	0.1000	*****	0.1030	0.1080	
3.500	*****	*****	*****	*****	0.1100	*****	0.0970	0.0880	
4.250	*****	*****	*****	*****	0.0740	*****	0.0730	*****	

AXIAL POSITION (m)	N2 (mole frac.)								
	0.050	0.100	0.150	0.200	0.250	0.300	0.400	0.600	
0.400	0.7900	0.7920	0.7950	0.7970	*****	0.7990	0.7970	*****	
0.600	0.7900	0.7900	0.7900	0.7900	*****	0.7920	0.7970	*****	
0.800	0.7920	0.7900	0.7920	0.7950	*****	0.7950	0.7970	0.7990	
1.150	*****	0.7900	*****	0.7950	*****	0.7950	0.7970	0.7970	
1.600	0.7950	0.7990	*****	0.7970	*****	*****	0.7990	0.8020	
1.950	*****	0.7950	*****	*****	0.7970	*****	0.7950	*****	
2.750	*****	*****	*****	*****	0.7920	*****	0.7950	0.7930	
3.500	*****	*****	*****	*****	0.7920	*****	0.7950	0.7990	
4.250	*****	*****	*****	*****	0.7950	*****	0.7970	*****	

AXIAL POSITION (m)	CO2 (mole frac.)								
	0.050	0.100	0.150	0.200	0.250	0.300	0.400	0.600	
0.400	0.0500	0.0540	0.0630	0.0780	*****	0.1060	0.1200	*****	
0.600	0.0590	0.0620	0.0790	0.0760	*****	0.0720	0.1040	*****	
0.800	0.0640	0.0680	0.0660	0.0700	*****	0.0860	0.0980	0.1200	
1.150	*****	0.0840	*****	0.0900	*****	0.0960	0.1050	0.1100	
1.600	0.0870	0.0860	*****	0.0860	*****	*****	0.0920	0.1080	
1.950	*****	0.0930	*****	*****	0.0960	*****	0.0960	*****	
2.750	*****	*****	*****	*****	0.0960	*****	0.0940	0.0910	
3.500	*****	*****	*****	*****	0.0880	*****	0.0990	0.1060	
4.250	*****	*****	*****	*****	0.1180	*****	0.1190	*****	



DATA SET D.2.1  
HEIN AND LEUCKEL (60)

TEMP (K)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.050	0.100	0.150	0.200	0.250	0.300	0.400	0.600
0.400	813.	848.	923.	1028.	*****	1198.	1218.	*****
0.600	885.	903.	945.	1005.	*****	1146.	1208.	*****
0.800	913.	933.	983.	1023.	*****	1123.	1183.	1213.
1.150	*****	1053.	*****	1088.	*****	1138.	1183.	1223.
1.600	1113.	1123.	*****	1153.	*****	*****	1193.	1223.
1.950	*****	1176.	*****	*****	1198.	*****	1203.	*****
2.750	*****	*****	*****	*****	1238.	*****	1233.	1218.
3.500	*****	*****	*****	*****	1318.	*****	1303.	1298.
4.250	*****	*****	*****	*****	1365.	*****	1351.	*****

DATA SET D.2.2  
HEIN AND LEUCKEL (60)

DATA SET D.2.2  
HEIN AND LEUCKEL (60)

GEOMETRY (m)		MASS FLOW RATES (kg/s)	
Primary tube ID	0 0577	Primary gas	0.05420
Secondary tube ID	0 1613	Primary solids	0.04139
Chamber ID	2 0003	Secondary gas	0.46500
Chamber length	6 2503	Secondary solids	0.00000
Pri. wall thick	0.0132		
Quarl half angle	0.0003		
(degrees)			
Quarl length	0.5100		

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	353.0	573.0
Pressure (kPa)	101.3	161.3
Swirl number	0.0	1.4

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
N2	0.7903	0.7900
O2	0.2103	0.2100

COAL COMPOSITION

Ultimate Analysis (mass frac., dry)		Proximate Analysis (mass frac., as recd.)	
C	0.8400	Moisture	0.0500
H	0.0378	Volatile matter	0.0999
O	0.0325	Fixed Carbon	0.7680
N	0.0063	Ash	0.0820
S	0.0078		
Ash	0.0820		

Heating Value (J/kg, daf)	3.5930E-07
Mean Particle Size (μ)	5.0000E-05
Bulk Particle Density (kg/m <sup>3</sup> )	1.3000E-03

		O2 (mole frac.)								
		AXIAL POSITION (m)			RADIAL POSITION (m)					
		0.050	0.100	0.150	0.200	0.250	0.300	0.400	0.600	
0.400	0.1600	0.1580	*****	0.1420	*****	0.1090	0.0900	*****		
0.600	0.1510	0.1540	0.1430	*****	*****	0.1290	0.1090	*****		
0.800	0.1380	0.1410	0.1380	0.1390	*****	0.1330	0.1060	0.0960		
1.150	*****	0.1270	*****	0.1300	*****	0.1270	0.1200	0.1070		
1.600	*****	0.1270	*****	0.1300	*****	0.1270	0.1200	0.1070		
1.950	*****	0.0830	*****	*****	0.0800	*****	0.0860	0.0840		
2.750	*****	*****	*****	*****	0.0650	*****	0.0700	0.0760		
3.500	*****	*****	*****	*****	0.0630	*****	0.0670	0.0600		
4.250	*****	0.0620	*****	*****	0.0630	*****	0.0770	*****		
5.000	*****	*****	*****	*****	*****	*****	*****	*****		
5.750	*****	*****	*****	*****	*****	*****	*****	*****		

N2 (mole frac.)

		AXIAL POSITION (m)								
		0.050	0.100	0.150	0.200	0.250	0.300	0.400	0.600	
0.400	0.7870	0.7870	*****	0.7900	*****	0.7920	0.7920	*****		
0.600	0.7920	0.7850	0.7950	*****	*****	0.7920	0.7920	*****		
0.800	0.7900	0.7920	0.7920	0.7920	*****	0.7900	0.7950	0.7970		
1.150	*****	0.7950	*****	0.7950	*****	0.7950	0.7950	0.7950		
1.950	*****	0.7950	*****	*****	0.7950	*****	0.7920	0.7970		
2.750	*****	*****	*****	*****	0.7970	*****	0.7970	0.7980		
3.500	*****	*****	*****	*****	0.7980	*****	0.7970	*****		
4.250	*****	*****	*****	*****	0.7970	*****	0.7970	*****		
5.000	*****	*****	*****	*****	*****	*****	*****	*****		

CO2 (mole frac.)

		AXIAL POSITION (m)								
		0.300	0.400	0.500	0.600	0.868	0.870	0.872	0.873	
0.400	0.0860	0.1030	*****	*****	*****	*****	*****	*****	*****	
0.600	0.0730	0.0890	*****	*****	*****	*****	*****	*****	*****	
0.800	0.0690	0.0910	*****	0.1010	*****	*****	*****	*****	*****	
1.150	0.0740	*****	0.0790	0.0910	*****	*****	*****	*****	*****	
1.600	0.0740	0.0790	*****	0.0910	*****	*****	*****	*****	*****	
1.950	*****	0.1100	*****	0.1120	*****	*****	*****	*****	*****	
2.750	*****	0.1230	*****	0.1180	*****	*****	*****	*****	*****	
3.500	*****	*****	*****	*****	0.1320	0.1300	0.1280	0.1270	*****	
4.250	*****	0.1180	*****	*****	*****	*****	*****	*****	*****	
5.000	*****	*****	*****	*****	*****	*****	*****	*****	*****	
5.750	*****	*****	*****	*****	*****	*****	*****	*****	*****	

DATA SET D.2.2  
HEIN AND LEUCKEL (60)

TEMP (K)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.050	0.100	0.150	0.200	0.250	0.300	0.400	0.600
0.400	783.	733.	793.	853.	*****	1038.	1113.	*****
0.600	863.	855.	873.	*****	*****	993.	1101.	*****
0.800	963.	988.	951.	955.	*****	1003.	1083.	1153.
1.150	*****	1083.	*****	1093.	*****	1081.	1093.	1163.
1.600	1208.	1208.	*****	1223.	*****	*****	1208.	1198.
1.950	*****	273.	*****	*****	1273.	*****	1271.	1233.
2.750	*****	*****	*****	*****	1368.	*****	1371.	1363.
3.500	*****	*****	*****	*****	1383.	*****	1383.	1398.
4.250	*****	1343.	*****	*****	1343.	*****	1353.	*****

DATA SET E.2.3  
HARDING (59)

GEOMETRY (m)		MASS FLOW RATES (kg/s)	
Primary tube ID	0.0159	Primary gas	0.0061C
Secondary tube ID	0.0842	Primary solids	0.0038C
Chamber ID	0.2030	Secondary gas	0.02990
Chamber length	1.5200	Secondary solids	0.00000
Pri. wall thick	0.0063		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.0400		

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	356.0	550.0
Pressure (kPa)	87.0	87.0
Swirl number	0.0	2.2

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
O2	0.2020	0.2090
N2	0.7530	0.7810
Ar	0.0450	0.0094

COAL COMPOSITION

Ultimate Analysis (mass frac., dry)		Proximate Analysis (mass frac., as recd.)	
C	0.7080	Moisture	0.0270
H	0.0560	Volatile matter	0.4540
O	0.1290	Fixed Carbon	0.4270
N	0.0140	Ash	0.0920
S	0.0060		
Ash	0.0950		
Heating Value (J/kg, Saf)		3.3500E+07	
Mean Particle Size (m)		4.3000E-05	
Bulk Particle Density (kg/m3)		1.3400E+03	

DATA SET D.2.3  
HARDING (59)

		AR (mole frac.)				
AXIAL POSITION (m)	RADIAL POSITION (m)					
	0.000	0.030	0.051	0.081	0.101	
C.102	0.0084	0.0093	0.0087	0.0000	0.0091	
C.178	0.0097	0.0087	0.0095	0.0096	0.0091	
C.254	0.0251	0.0197	0.0115	0.0098	0.0098	
0.330	0.0210	0.0210	0.0097	0.0100	0.0092	
0.483	0.0103	0.0120	0.0089	0.0091	0.0078	
0.535	0.0168	0.0133	0.0102	0.0091	0.0251	
0.711	0.0083	0.0147	0.0094	0.0106	0.0166	
1.237	0.0139	0.0131	0.0133	0.0109	0.0116	
1.448	0.0101	0.0000	0.0126	0.0000	0.0126	

H2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.030	0.051	0.081	0.101
0.102	0.0000	0.0000	0.0000	0.0000	0.0000
0.178	0.0008	0.0000	0.0000	0.0000	0.0000
0.254	0.0057	0.0140	0.0002	0.0002	0.0000
0.330	0.0238	0.0656	0.0014	0.0005	0.0000
0.483	0.0001	0.0254	0.0000	0.0000	0.0000
0.635	0.0158	0.0154	0.0008	0.0001	0.0000
0.711	0.0030	0.0084	0.0087	0.0057	0.0008
1.237	0.0058	0.0018	0.0043	0.0046	0.0031
1.448	0.0067	0.0000	0.0051	0.0000	0.0018

O2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.030	0.051	0.081	0.101
C.102	0.1775	0.1388	0.1763	0.1844	0.1603
0.178	0.1813	0.1021	0.1713	0.1716	0.1790
0.254	0.0401	0.0340	0.1540	0.1750	0.1739
0.330	0.0836	0.0383	0.1162	0.1670	0.1692
0.483	0.0336	0.0574	0.0809	0.1658	0.1727
0.635	0.0144	0.0358	0.0531	0.1378	0.1344
0.711	0.0267	0.0357	0.0662	0.1282	0.1400
1.237	0.0474	0.0546	0.0794	0.0790	0.0938
1.448	0.0000	0.0000	0.0000	0.0000	0.0116

DATA SET D.2.3  
HARDING (59)

N2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.030	0.030	0.051	0.081	0.101
0.102	0.7722	0.7684	0.7991	0.8156	0.7902
0.178	0.7677	0.7495	0.7910	0.7916	0.7905
0.254	0.7010	0.7254	0.7866	0.7934	0.7906
0.330	0.7405	0.7318	0.7795	0.7923	0.7939
0.483	0.7114	0.7160	0.7613	0.7982	0.7996
0.635	0.7302	0.7318	0.7363	0.7837	0.7888
0.711	0.7359	0.7385	0.7525	0.7802	0.7867
1.237	0.7596	0.7544	0.7617	0.7695	0.7409
1.448	0.7346	0.0000	0.7462	0.0000	0.7589

CH4 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.030	0.051	0.081	0.101
0.102	0.0001	0.0005	0.0000	0.0000	0.0000
0.178	0.0005	0.0023	0.0000	0.0000	0.0000
0.254	0.0090	0.0028	0.0000	0.0000	0.0000
0.330	0.0077	0.0060	0.0002	0.0000	0.0001
0.483	0.0093	0.0118	0.0010	0.0000	0.0000
0.635	0.0078	0.0045	0.0021	0.0002	0.0001
0.711	0.0052	0.0041	0.0018	0.0001	0.0000
1.237	0.0013	0.0015	0.0011	0.0009	0.0007
1.448	0.0000	0.0000	0.0000	0.0000	0.0000

CO (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.030	0.051	0.081	0.101
0.102	0.0030	0.0144	0.0000	0.0000	0.0000
0.178	0.0062	0.0260	0.0000	0.0000	0.0000
0.254	0.0745	0.0489	0.0004	0.0000	0.0000
0.330	0.0458	0.0554	0.0062	0.0000	0.0002
0.483	0.0639	0.0576	0.0180	0.0002	0.0002
0.635	0.0551	0.0470	0.0295	0.0050	0.0021
0.711	0.0443	0.0422	0.0262	0.0056	0.0031
1.237	0.0179	0.0183	0.0123	0.0109	0.0086
1.448	0.0442	0.0000	0.0273	0.0000	0.0132

DATA SET D.2.3  
HARDING (59)

CO2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.030	0.051	0.081	0.101
0.102	0.0256	0.0427	0.0108	0.0000	0.0275
0.178	0.0217	0.0694	0.0191	0.0185	0.0145
0.254	0.0859	0.1026	0.0322	0.0148	0.0175
0.330	0.0628	0.0895	0.0585	0.0211	0.0188
0.483	0.1065	0.0933	0.0840	0.0181	0.0134
0.635	0.1110	0.1046	0.1084	0.0426	0.0333
0.711	0.1152	0.1044	0.0926	0.0501	0.0400
1.237	0.1037	0.1026	0.0866	0.0845	0.0956
1.448	0.1338	0.0000	0.1408	0.0000	0.1379

H2O (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.030	0.051	0.081	0.101
0.102	0.0132	0.0259	0.0051	0.0000	0.0128
0.178	0.0117	0.0420	0.0091	0.0088	0.0069
0.254	0.0556	0.0528	0.0151	0.0068	0.0082
0.330	0.0149	0.0524	0.0284	0.0092	0.0087
0.483	0.0649	0.0266	0.0459	0.0085	0.0063
0.635	0.0488	0.0475	0.0595	0.0215	0.0162
0.711	0.0616	0.0520	0.0426	0.0195	0.0187
1.237	0.0503	0.0537	0.0413	0.0397	0.0456
1.448	0.0706	0.0000	0.0679	0.0000	0.0639

HCN (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.030	0.051	0.081	0.101
0.102	48.0	49.0	37.0	9.0	20.0
0.178	696.0	1480.0	848.0	237.0	170.0
0.254	2480.0	1440.0	710.0	394.0	737.0
0.330	4900.0	4770.0	1150.0	504.0	127.0
0.483	552.0	429.0	351.0	160.0	129.0
0.635	2580.0	2680.0	1280.0	148.0	96.0
0.711	855.0	688.0	680.0	111.0	124.0
1.237	2344.0	2200.0	829.0	412.0	933.0
1.448	851.0	0.0	490.0	0.0	507.0

DATA SET D.2.3  
HARDING (59)

DATA SET D.2.3  
HARDING (59)

AXIAL POSITION (m)	MIB (ppm)				
	0.000	0.030	0.051	0.081	0.101
0.102	435.0	495.0	358.0	121.0	256.0
0.178	502.0	502.0	311.0	95.0	161.0
0.254	2420.0	451.0	772.0	553.0	557.0
0.330	2660.0	5540.0	1050.0	963.0	287.0
0.483	751.0	6E5.0	601.0	463.0	605.0
0.635	1110.0	923.0	745.0	365.0	309.0
0.711	1170.0	306.0	334.0	308.0	233.0
1.237	1105.0	931.0	350.0	228.0	1023.0
1.448	467.0	0.0	301.0	0.0	433.0

AXIAL POSITION (m)	C (mass frac.)				
	0.000	0.030	0.051	0.081	0.101
0.102	0.5880	0.7035	0.6644	0.6643	0.6164
0.178	0.7108	0.1035	0.5752	0.5653	0.6067
0.254	0.7314	0.6962	0.5011	0.5571	0.5069
0.330	0.7076	0.7035	0.6237	0.5138	0.5724
0.483	0.7105	0.7114	0.7264	0.6999	0.6E45
0.635	0.7485	0.7606	0.7304	0.6775	0.6296
0.711	0.6874	0.6254	0.6278	0.5143	0.5137
1.237	0.5996	0.6585	0.6148	0.5520	0.5351
1.448	0.6508	0.0000	0.5736	0.0000	0.6029

AXIAL POSITION (m)	NO (ppm)				
	0.030	0.030	0.051	0.081	0.101
0.102	20.0	345.0	95.0	95.0	105.0
0.178	185.0	540.0	125.0	100.0	65.0
0.254	150.0	525.0	130.0	50.0	40.0
0.330	310.0	475.0	340.0	110.0	100.0
0.483	300.0	275.0	420.0	100.0	75.0
0.635	365.0	380.0	425.0	245.0	215.0
0.711	322.0	345.0	410.0	275.0	295.0
1.237	405.0	305.0	355.0	295.0	265.0
1.448	372.0	0.0	425.0	0.0	418.0

AXIAL POSITION (m)	H (mass frac.)				
	0.000	0.030	0.051	0.081	0.101
0.102	0.0529	0.0473	0.0362	0.0480	0.0417
0.178	0.0537	0.0463	0.0422	0.0362	0.0413
0.254	0.0564	0.0362	0.0207	0.0400	0.0436
0.330	0.0528	0.0415	0.0215	0.0250	0.0357
0.483	0.0485	0.0420	0.0158	0.0269	0.0345
0.635	0.0405	0.0248	0.0363	0.0060	0.0116
0.711	0.0424	0.0307	0.0115	0.0103	0.0129
1.237	0.0254	0.0234	0.0099	0.0093	0.0058
1.448	0.0069	0.0000	0.0064	0.0000	0.0040

AXIAL POSITION (m)	N (mass frac.)				
	0.000	0.030	0.051	0.081	0.101
0.102	0.0122	0.0133	0.0119	0.0122	0.0131
0.178	0.0133	0.0128	0.0102	0.0107	0.0104
0.254	0.0135	0.0130	0.0085	0.0103	0.0113
0.330	0.0135	0.0126	0.0103	0.0087	0.0110
0.483	0.0127	0.0127	0.0119	0.0120	0.0119
0.635	0.0136	0.0127	0.0128	0.0100	0.0105
0.711	0.0121	0.0098	0.0069	0.0068	0.0088
1.237	0.0085	0.0083	0.0070	0.0073	0.0064
1.448	0.0066	0.0000	0.0069	0.0000	0.0081

AXIAL POSITION (m)	O-S (mass frac.)				
	0.000	0.030	0.051	0.081	0.101
0.102	0.1488	0.1414	0.1595	0.1520	0.1381
0.178	0.1489	0.1343	0.1628	0.1637	0.1477
0.254	0.1356	0.1330	0.1804	0.1742	0.1491
0.330	0.1386	0.1244	0.1281	0.1615	0.1620
0.483	0.1363	0.1318	0.0862	0.1182	0.1431
0.635	0.1231	0.0889	0.1143	0.0738	0.0828
0.711	0.1363	0.1207	0.1121	0.1392	0.1379
1.237	0.1296	0.1238	0.1060	0.1220	0.1338
1.448	0.1203	0.0000	0.1514	0.0000	0.0790

DATA SET D.2.3  
HARDING (59)

ASH (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.030	0.051	0.081	0.101
0.102	0.0981	0.0945	0.1280	0.1235	0.1307
0.173	0.0733	0.1031	0.2096	0.2241	0.1909
0.254	0.0631	0.1216	0.2893	0.2184	0.2291
0.330	0.0875	0.1180	0.2164	0.2910	0.2189
0.403	0.0919	0.1021	0.1606	0.1430	0.1097
0.635	0.0742	0.1130	0.1062	0.2327	0.2635
0.711	0.1198	0.2134	0.2417	0.3294	0.3267
1.237	0.2369	0.1860	0.1523	0.3000	0.9400
1.448	0.1354	0.0000	0.2517	0.0000	0.3060

DATA SET D.2.4  
ASAY (63)

DATA SET D.2.4  
ASAY (63)

GEOMETRY (m)		MASS FLOW RATES (kg/s)	
Primary tube ID	0.0223	Primary gas	0.00610
Secondary tube ID	0.0842	Primary solids	0.00380
Chamber ID	0.2030	Secondary gas	0.01942
Chamber length	1.5200	Secondary solids	0.00000
Pri. wall thick	0.0032		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.0400		

GAS PROPERTIES		
	Primary	Secondary
Temperature (K)	310.C	590.C
Pressure (kPa)	86.C	86.C
Swirl number	0.0	2.C

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
O2	0.2012	0.2094
N2	0.7506	0.7812
AR	0.0481	0.0094

COAL COMPOSITION

Ultimate Analysis (mass frac., dry)		Proximate Analysis (mass frac., as recd.)	
C	0.6620	Moisture	0.2784
H	0.0472	Volatile matter	0.3291
O	0.2271	Fixed Carbon	0.3464
N	0.0097	Ash	0.0497
S	0.0052		
Ash	0.0505		

Heating Value (J/kg, dnf)	2.9750E+C7
Mean Particle Size (m)	3.5000E-C5
Bulk Particle Density (kg/m3)	1.3400E+03

AXIAL POSITION (m)	AR (mole frac.)				
	0.000	0.030	0.050	0.070	0.100
0.100	0.0560	0.0337	0.0188	0.0147	0.0141
0.180	0.0503	0.0314	0.0143	0.0126	0.0121
0.410	0.0363	0.0295	0.0219	0.0147	0.0125
0.480	0.0324	0.0284	0.0247	0.0160	0.0124
0.710	0.0248	0.0246	0.0230	0.0196	0.0150
0.790	0.0253	0.0250	0.0236	0.0217	0.0171
1.020	0.0235	0.0228	0.0194	0.0174	0.0155
1.090	0.0226	0.0223	0.0201	0.0167	0.0145
1.320	0.0205	0.0192	0.0178	0.0171	0.0171
1.400	0.0206	0.0197	0.0172	0.0163	0.0163

H2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.030	0.050	0.070	0.100
0.100	0.0000	0.0154	0.0000	0.0000	0.0000
0.180	0.0000	0.0087	0.0000	0.0000	0.0000
0.410	0.0216	0.0190	0.0066	0.0000	0.0000
0.480	0.0294	0.0271	0.0152	0.0000	0.0000
0.710	0.0314	0.0319	0.0281	0.0143	0.0026
0.790	0.0282	0.0269	0.0255	0.0169	0.0039
1.020	0.0259	0.0244	0.0087	0.0060	0.0000
1.090	0.0227	0.0212	0.0109	0.0025	0.0000
1.320	0.0269	0.0214	0.0087	0.0066	0.0078
1.400	0.0247	0.0200	0.0101	0.0046	0.0024

O2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.030	0.050	0.070	0.100
0.100	0.1666	0.0238	0.0929	0.1369	0.1468
0.180	0.1496	0.0523	0.1337	0.1450	0.1455
0.410	0.0443	0.0181	0.0509	0.1329	0.1334
0.480	0.0218	0.0060	0.0165	0.1128	0.1690
0.710	0.0063	0.0053	0.0062	0.0384	0.1001
0.790	0.0015	0.0023	0.0072	0.0210	0.0607
1.020	0.0008	0.0039	0.0320	0.0540	0.0834
1.090	0.0006	0.0021	0.0173	0.0658	0.0933
1.320	0.0019	0.0037	0.0095	0.0143	0.0143
1.400	0.0030	0.0016	0.0072	0.0231	0.0256



DATA SET D.2.4  
ASAY (63)

N2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.030	0.050	0.070	0.100
0.100	0.7733	0.7419	0.7758	0.7742	0.7721
0.180	0.7753	0.7773	0.8057	0.8086	0.8087
0.410	0.7204	0.7359	0.7651	0.7756	0.8092
0.480	0.7082	0.7176	0.7452	0.7745	0.7721
0.710	0.7083	0.7093	0.7165	0.7506	0.7685
0.790	0.7244	0.7256	0.7276	0.7664	0.7710
1.020	0.7284	0.7317	0.7609	0.7673	0.7742
1.090	0.7358	0.7373	0.7582	0.7747	0.7788
1.320	0.7274	0.7389	0.7648	0.7701	0.7692
1.400	0.7333	0.7446	0.7652	0.7761	0.7786

C4H4 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.030	0.050	0.070	0.100
0.100	0.0000	0.0070	0.0000	0.0000	0.0000
0.180	0.0001	0.0002	0.0000	0.0000	0.0000
0.410	0.0037	0.0024	0.0005	0.0000	0.0000
0.480	0.0054	0.0034	0.0012	0.0000	0.0000
0.710	0.0064	0.0059	0.0048	0.0019	0.0003
0.790	0.0030	0.0029	0.0027	0.0015	0.0003
1.020	0.0022	0.0021	0.0006	0.0004	0.0001
1.090	0.0022	0.0021	0.0008	0.0002	0.0000
1.320	0.0031	0.0023	0.0007	0.0005	0.0005
1.400	0.0036	0.0023	0.0008	0.0003	0.0002

CO (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.030	0.050	0.070	0.100
0.100	0.0005	0.0417	0.0057	0.0011	0.0008
0.180	0.0060	0.0244	0.0008	0.0002	0.0003
0.410	0.0534	0.0492	0.0200	0.0024	0.0011
0.480	0.0711	0.0682	0.0430	0.0052	0.0007
0.710	0.0731	0.0719	0.0654	0.0365	0.0100
0.790	0.0629	0.0604	0.0584	0.0410	0.0134
1.020	0.0607	0.0581	0.0254	0.0165	0.0081
1.090	0.0538	0.0515	0.0299	0.0098	0.0025
1.320	0.0614	0.0511	0.0263	0.0210	0.0209
1.400	0.0582	0.0465	0.0274	0.0142	0.0109

DATA SET D.2.4  
ASAY (63)

CO2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.030	0.050	0.070	0.100
0.100	0.0036	0.1428	0.1068	0.0731	0.0658
0.180	0.0187	0.1257	0.0456	0.0334	0.0331
0.410	0.1203	0.1461	0.1349	0.0731	0.0438
0.480	0.1317	0.1493	0.1542	0.0915	0.0458
0.710	0.1497	0.1510	0.1560	0.1385	0.1034
0.790	0.1547	0.1569	0.1549	0.1514	0.1335
1.020	0.1585	0.1570	0.1530	0.1384	0.1187
1.090	0.1623	0.1633	0.1628	0.1302	0.1109
1.320	0.1587	0.1635	0.1721	0.1705	0.1704
1.400	0.1567	0.1662	0.1719	0.1653	0.1660

H2O (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.030	0.050	0.070	0.100
0.100	0.0000	0.2040	0.0827	0.0540	0.0489
0.180	0.0985	0.1172	0.0342	0.0248	0.0249
0.410	0.1806	0.1354	0.1075	0.0552	0.0332
0.480	0.3028	0.1445	0.1338	0.0697	0.0345
0.710	0.1583	0.2062	0.1537	0.1187	0.0808
0.790	0.1340	0.1249	0.1291	0.1230	0.1006
1.020	0.1312	0.1275	0.1168	0.1057	0.0915
1.090	0.1450	0.1290	0.1229	0.0965	0.0811
1.320	0.1277	0.1296	0.1271	0.1236	0.1248
1.400	0.1291	0.1304	0.1287	0.1378	0.1200

HCN (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.030	0.050	0.070	0.100
0.100	55.0	27.0	2.0	0.0	4.0
0.180	67.0	12.0	2.0	4.0	0.0
0.410	342.0	223.0	14.0	11.0	13.0
0.480	475.0	297.0	93.0	25.0	24.0
0.710	197.0	158.0	126.0	52.0	4.0
0.790	163.0	162.0	131.0	83.0	29.0
1.020	82.0	64.0	20.0	17.0	15.0
1.090	77.0	90.0	31.0	26.0	22.0
1.320	109.0	63.0	9.0	10.0	16.0
1.400	137.0	52.0	8.0	5.0	5.0

DATA SET D.2.4  
ASAY (63)

NH3 (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.030	0.050	0.070	0.100
0.100	58.0	89.0	39.0	30.0	26.0
0.180	45.0	25.0	22.0	25.0	36.0
0.410	145.0	125.0	49.0	18.0	15.0
0.480	292.0	294.0	179.0	42.0	45.0
0.710	301.0	310.0	280.0	119.0	60.0
0.790	256.0	273.0	224.0	170.0	86.0
1.020	280.0	247.0	119.0	166.0	71.0
1.090	205.0	210.0	115.0	122.0	82.0
1.320	345.0	302.0	133.0	59.0	137.0
1.400	344.0	245.0	130.0	59.0	52.0

NO (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.030	0.050	0.070	0.100
0.100	5.0	550.0	360.0	235.0	210.0
0.180	65.0	158.0	170.0	115.0	105.0
0.410	226.0	290.0	300.0	180.0	110.0
0.480	200.0	240.0	280.0	210.0	125.0
0.710	210.0	210.0	240.0	250.0	265.0
0.790	240.0	240.0	260.0	250.0	320.0
1.020	210.0	220.0	270.0	250.0	300.0
1.090	210.0	210.0	240.0	255.0	260.0
1.320	190.0	205.0	265.0	270.0	240.0
1.400	195.0	210.0	250.0	250.0	295.0

N (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.030	0.050	0.070	0.100
0.100	0.0100	0.0100	0.0080	0.0050	0.0090
0.180	0.0090	0.0080	0.0040	0.0070	0.0050
0.410	0.0110	0.0090	0.0090	0.0110	0.0100
0.480	0.0110	0.0080	0.0040	0.0120	0.0070
0.710	0.0080	0.0090	0.0070	0.0060	0.0040
0.790	0.0090	0.0070	0.0070	0.0050	0.0050
1.020	0.0090	0.0010	0.0010	0.0020	0.0010
1.090	0.0100	0.0100	0.0120	0.0150	0.0050
1.320	0.0050	0.0040	0.0030	0.0030	0.0040
1.400	0.0040	0.0020	0.0040	0.0030	0.0040

DATA SET D.2.4  
ASAY (63)

C (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.030	0.050	0.070	0.100
0.100	0.6400	0.6010	0.3650	0.2220	0.2640
0.180	0.6500	0.5930	0.2290	0.1710	0.2130
0.410	0.7590	0.6030	0.4700	0.2020	0.1490
0.480	0.5390	0.6190	0.5240	0.2640	0.2240
0.710	0.5530	0.6860	0.6390	0.5240	0.3230
0.790	0.5440	0.5170	0.4830	0.4450	0.3070
1.020	0.4330	0.3760	0.3720	0.3820	0.3560
1.090	0.4000	0.3890	0.3130	0.2820	0.2450
1.320	0.4090	0.3970	0.2720	0.2020	0.3140
1.400	0.5080	0.4400	0.4030	0.3600	0.3100

H (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.030	0.050	0.070	0.100
0.100	0.0440	0.0230	0.0150	0.0180	0.0200
0.180	0.0450	0.0320	0.0240	0.0230	0.0240
0.410	0.0340	0.0210	0.0130	0.0100	0.0110
0.480	0.0420	0.0260	0.0150	0.0150	0.0190
0.710	0.0290	0.0230	0.0180	0.0160	0.0140
0.790	0.0240	0.0510	0.0110	0.0100	0.0090
1.020	0.0190	0.0160	0.0160	0.0130	0.0110
1.090	0.0140	0.0180	0.0130	0.0130	0.0090
1.320	0.0160	0.0110	0.0120	0.0100	0.0110
1.400	0.0180	0.0140	0.0130	0.0120	0.0140

O-S (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.030	0.050	0.070	0.100
0.100	0.2600	0.2860	0.2540	0.2720	0.2370
0.180	0.2410	0.2120	0.3140	0.3300	0.3430
0.410	0.0940	0.1540	0.1470	0.2860	0.2990
0.480	0.2480	0.1500	0.2090	0.2040	0.2500
0.710	0.1630	0.1790	0.1510	0.1960	0.3450
0.790	0.1710	0.2460	0.1400	0.1910	0.2330
1.020	0.2320	0.2660	0.1900	0.2240	0.1800
1.090	0.4270	0.2020	0.2350	0.2410	0.2280
1.320	0.1770	0.1740	0.2380	0.3100	0.2130
1.400	0.1100	0.1580	0.1710	0.1800	0.2300

DATA SET D.2.4  
ASAY (63)

ASH (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.030	0.050	0.070	0.100
0.100	0.0450	0.0800	0.3580	0.4810	0.4710
0.180	0.0540	0.1530	0.4290	0.4690	0.4140
0.410	0.1020	0.2120	0.3610	0.4910	0.5310
0.480	0.0610	0.1960	0.2570	0.5050	0.5000
0.710	0.1460	0.1040	0.1860	0.2580	0.3130
0.790	0.2520	0.2140	0.3590	0.3480	0.4450
1.020	0.3070	0.3410	0.4210	0.3790	0.4520
1.090	0.1480	0.3820	0.4270	0.4480	0.5130
1.320	0.3930	0.4140	0.4750	0.4750	0.4570
1.400	0.3590	0.3850	0.4890	0.4440	0.4420

DATA SET D.2.5  
GODOY ET AL (64)

DATA SET D.2.5  
GODOY ET AL (64)

GEOMETRY (m)		MASS FLOW RATES (kg/s)	
Primary tube ID	0.0222	Primary gas	0.00763
Secondary tube ID	0.0560	Primary solids	0.00332
Chamber ID	0.6300	Secondary gas	0.02872
Chamber length	3.0000	Secondary solids	0.00000
Pri. wall thick	0.048		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.0432		

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	300.0	500.0
Pressure (kPa)	101.0	101.0
Swirl number	0.0	0.8

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
O2	0.2100	0.2100
N2	0.7805	0.7805
AR	0.0095	0.0095

COAL COMPOSITION

Ultimate Analysis (mass frac., dry)		Proximate Analysis (mass frac., as recd.)	
C	0.7381	Moisture	0.0630
H	0.0515	Volatile matter	0.3580
O	0.1383	Fixed Carbon	0.5370
N	0.0145	Ash	0.0420
S	0.0155		
Ash	0.0420		
Heating Value (J/kg, dry)		3.0050E+07	
Mean Particle Size (m)		4.5000E-05	
Bulk Particle Density (kg/m <sup>3</sup> )		1.3400E+03	

AXIAL POSITION (m)	O2 (mole frac.)								
	0.220	0.230	0.240	0.250	0.260	0.270	0.280	0.290	
0.217	*****	0.0700	*****	0.0690	*****	0.0690	*****	0.0690	
0.775	0.0740	*****	0.0780	*****	0.0850	0.0810	0.0880	0.0900	
1.331	0.0830	*****	0.0880	0.0900	0.0940	*****	0.0980	*****	
1.889	*****	0.0760	0.0790	0.0800	*****	0.0810	0.0840	0.0840	
2.446	0.0680	*****	*****	0.0600	*****	*****	*****	0.0650	
3.003	0.0420	*****	*****	0.0440	*****	0.0490	*****	0.0450	

AXIAL POSITION (m)	CO2 (mole frac.)								
	0.220	0.230	0.240	0.250	0.260	0.270	0.280	0.290	
0.217	*****	0.1220	*****	0.1230	*****	0.1210	*****	0.1230	
0.775	0.1170	*****	0.1130	*****	0.1080	0.1100	0.1070	0.1050	
1.331	0.1060	*****	0.1010	0.1020	0.0970	*****	0.0940	*****	
1.889	*****	0.1160	0.1130	0.1120	*****	0.1080	0.1090	0.1090	
2.446	0.1220	*****	*****	0.1300	*****	*****	*****	0.1250	
3.003	0.1450	*****	*****	0.1440	*****	0.1390	*****	0.1420	

AXIAL POSITION (m)	CO (mole frac.)								
	0.220	0.230	0.240	0.250	0.260	0.270	0.280	0.290	
0.217	*****	0.0010	*****	0.0010	*****	0.0010	*****	0.0010	
0.775	0.0000	*****	0.0000	*****	0.0000	*****	0.0000	0.0000	
1.331	0.0000	*****	0.0000	*****	0.0000	*****	0.0000	*****	
1.889	*****	0.0000	*****	0.0000	*****	0.0000	*****	0.0000	
2.446	0.0000	*****	*****	0.0000	*****	*****	*****	0.0000	
3.003	0.0000	*****	*****	0.0000	*****	0.0000	*****	0.0000	

DATA SET D.2.5  
GODOY ET AL (64)

CH4 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.020	0.030	0.040	0.050	0.060	0.070	0.080	0.120
0.217	*****	*****	*****	*****	*****	*****	*****	*****
0.775	*****	*****	*****	*****	*****	*****	*****	*****
1.331	*****	*****	*****	*****	*****	*****	*****	*****

DATA SET D.2.5  
GODOY ET AL (64)

TEMP (K)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.220	0.230	0.240	0.250	0.260	0.270	0.280	0.290
0.230	1352.	*****	1369.	*****	1351.	*****	1346.	1346.
0.379	*****	1382.	*****	1373.	*****	1364.	1363.	1348.
0.527	*****	*****	1381.	*****	1366.	*****	1327.	1298.
0.936	*****	1406.	*****	1390.	*****	1371.	1353.	1318.
1.493	*****	1405.	*****	1395.	*****	1378.	*****	1290.

DATA SET E.1.1  
SOELBERG (70)

DATA SET E.1.1  
SOELBERG (70)

GEOMETRY (m)                      MASS FLOW RATES (kg/s)

Primary tube ID	0.0131	Primary gas	0.0070
Secondary tube ID	0.0287	Primary solids	0.0006
Chamber ID	0.1600	Secondary gas	0.00180
Chamber length	1.3500	Secondary solids	0.0000
Pri. wall thick	0.0000		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.0510		

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	367.0	450.0
Pressure (kPa)	87.0	87.0
Swirl number	0.0	0.0

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
O2	0.8910	0.0000
He	0.0000	0.0011
Ar	0.1000	0.0000
H2O	0.0000	0.9970

COAL COMPOSITION

Ultimate Analysis (mass frac., dry)	Proximate Analysis (mass frac., as recd.)
C 0.7080	Moisture 0.0270
H 0.0560	Volatile matter 0.4540
O 0.1290	Fixed Carbon 0.4270
N 0.0140	Ash 0.0920
S 0.0060	
Ash 0.0950	
Heating Value (J/kg, saf)	3.3600E+07
Mean Particle Size (m)	4.3000E-05
Bulk Particle Density (kg/m3)	1.3400E+03

AR (mole frac.)

	RADIAL POSITION (m)				
AXIAL POSITION (m)	0.000	0.020	0.040	0.060	0.075
0.130	0.1030	0.0823	0.0583	0.0572	0.0587
0.200	0.0843	0.0963	0.0598	0.0546	0.0513
0.279	0.0578	0.0699	0.0646	0.0596	0.0584
0.339	*****	0.0728	0.0696	0.0631	0.0601
0.514	0.0532	0.0577	0.0575	0.0602	0.0583
0.810	0.0516	0.0529	0.0545	0.0545	0.0558
1.119	0.0516	0.0511	0.0531	0.0540	0.0557

H2 (mole frac.)

	RADIAL POSITION (m)				
AXIAL POSITION (m)	0.000	0.020	0.040	0.060	0.075
0.130	0.0346	0.1490	0.2240	0.2440	0.2580
0.200	0.1180	0.0767	0.2150	0.2540	0.2420
0.279	0.2330	0.1730	0.1760	0.1930	0.2000
0.339	*****	0.1540	0.1730	0.1870	0.2000
0.514	0.2410	0.2080	0.2120	0.2040	0.2140
0.810	0.2360	0.2310	0.2390	0.2360	0.2290
1.119	0.2550	0.2540	0.2520	0.2440	0.2420

O2 (mole frac.)

	RADIAL POSITION (m)				
AXIAL POSITION (m)	0.000	0.020	0.040	0.060	0.075
0.130	0.6310	0.0141	0.0050	0.0050	0.0050
0.200	0.1677	0.0832	*****	*****	*****
0.279	0.0212	0.0086	0.0010	*****	*****
0.339	*****	0.0076	*****	*****	*****

DATA SET E.1.1  
SOELBERG (70)

DATA SET E.1.1  
SOELBERG (70)

N2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.075
0.130	0.0270	0.0272	0.0205	0.0230	0.0019
0.200	0.0430	0.0580	0.0303	0.0325	0.0339
0.279	0.0264	0.0275	0.0265	0.0272	0.0244
0.339	*****	0.0317	0.0281	0.0274	0.0244
0.514	0.0108	0.0152	0.0146	0.0228	0.0400
0.810	0.0175	0.0205	0.0179	0.0179	0.0180
1.119	0.0113	0.0132	0.0120	0.0112	0.0135

CH4 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.075
0.130	0.0010	0.0010	0.0015	0.0020	0.0024
0.200	0.0049	*****	0.0016	0.0017	0.0012
0.279	0.0151	0.0016	0.0007	0.0011	0.0017
0.339	*****	0.0019	0.0005	0.0009	0.0015
0.514	0.0110	0.0039	0.0035	0.0053	0.0041
0.810	0.0072	0.0066	0.0067	0.0059	0.0068
1.119	0.0082	0.0082	0.0090	0.0096	0.0102

CO (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.075
0.130	0.0506	0.3030	0.4310	0.4390	0.4530
0.200	0.2480	0.1670	0.4280	0.4270	0.4450
0.279	0.4510	0.3530	0.4020	0.4220	0.4210
0.339	*****	0.3950	0.3950	0.3990	0.4090
0.514	0.4760	0.4680	0.4680	0.4430	0.4400
0.810	0.4680	0.4580	0.4480	0.4410	0.4330
1.119	0.4430	0.4440	0.4380	0.4380	0.4340

CO2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.075
0.130	0.1400	0.4070	0.2560	0.2260	0.2180
0.200	0.3340	0.5170	0.2640	0.2490	0.2260
0.279	0.1960	0.3380	0.2970	0.2710	0.2700
0.339	*****	0.3180	0.3100	0.3020	0.2850
0.514	0.2070	0.2460	0.2440	0.2640	0.2440
0.810	0.2200	0.2310	0.2350	0.2420	0.2580
1.119	0.2310	0.2300	0.2370	0.2430	0.2470

HCN (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.075
0.130	92.0	111.0	272.0	334.0	304.0
0.200	1572.0	141.0	306.0	472.0	429.0
0.279	5014.0	314.0	131.0	327.0	374.0
0.339	0.0	713.0	144.0	224.0	366.0
0.514	1190.0	829.0	594.0	550.0	815.0
0.810	985.0	798.0	952.0	991.0	945.0
1.119	1537.0	1725.0	1455.0	1716.0	1460.0

NH3 (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.075
0.130	61.0	97.0	692.0	924.0	977.0
0.200	1253.0	215.0	596.0	797.0	780.0
0.279	631.0	371.0	167.0	754.0	800.0
0.339	0.0	429.0	329.0	510.0	905.0
0.514	592.0	666.0	842.0	773.0	1066.0
0.810	1039.0	1214.0	1178.0	1164.0	1190.0
1.119	1329.0	1339.0	1528.0	1430.0	1520.0

DATA SET E.1.1  
SOELBERG (70)

AXIAL POSITION (m)	NO (ppm)				
	0.000	0.020	0.040	0.060	0.075
0.130	495.0	1675.0	341.0	251.0	203.0
0.200	2375.0	2780.0	545.0	265.0	200.0
0.279	1675.0	2325.0	1175.0	603.0	450.0
0.339	0.0	0.0	1275.0	775.0	510.0
0.514	768.0	800.0	646.0	586.0	385.0
0.810	480.0	455.0	423.0	495.0	480.0
1.119	465.0	415.0	335.0	290.0	240.0

AXIAL POSITION (m)	CO2 (ppm)				
	0.000	0.020	0.040	0.060	0.075
0.130	7.0	69.0	133.0	124.0	122.0
0.200	13.0	13.0	127.0	135.0	141.0
0.279	68.0	69.0	93.0	132.0	127.0
0.339	0.0	54.0	70.0	125.0	129.0
0.514	118.0	122.0	137.0	135.0	145.0
0.810	139.0	131.0	131.0	128.0	129.0
1.119	136.0	138.0	129.0	129.0	125.0

AXIAL POSITION (m)	CS2 (ppm)				
	0.000	0.020	0.040	0.060	0.075
0.130	6.0	9.0	10.0	13.0	24.0
0.200	6.0	6.0	9.0	8.0	7.0
0.279	65.0	10.0	6.0	8.0	7.0
0.339	0.0	7.0	6.0	8.0	7.0
0.514	77.0	41.0	28.0	23.0	19.0
0.810	70.0	43.0	37.0	32.0	36.0
1.119	50.0	54.0	42.0	36.0	31.0

DATA SET E.1.1  
SOELBERG (70)

AXIAL POSITION (m)	SO2 (ppm)				
	0.000	0.020	0.040	0.060	0.075
0.130	1296.0	1214.0	350.0	351.0	450.0
0.200	3192.0	1658.0	601.0	636.0	509.0
0.279	1670.0	1503.0	712.0	577.0	413.0
0.339	0.0	1342.0	1093.0	701.0	598.0
0.514	521.0	604.0	453.0	445.0	503.0
0.810	252.0	261.0	263.0	195.0	194.0
1.119	218.0	208.0	232.0	181.0	205.0

AXIAL POSITION (m)	H2S (ppm)				
	0.000	0.020	0.040	0.060	0.075
0.130	100.0	41.0	975.0	917.0	831.0
0.200	200.0	43.0	813.0	960.0	1109.0
0.279	250.0	113.0	340.0	1130.0	1253.0
0.339	0.0	39.0	105.0	829.0	1008.0
0.514	735.0	925.0	1117.0	1096.0	1185.0
0.810	1271.0	1290.0	1370.0	1337.0	1438.0
1.119	1492.0	1439.0	1400.0	1578.0	1344.0

AXIAL POSITION (m)	N (mass frac.)				
	0.000	0.020	0.040	0.060	0.075
0.130	0.0123	0.0062	0.0045	0.0054	0.0056
0.200	0.0125	0.0074	*****	0.0028	0.0061
0.279	0.0128	0.0098	0.0055	0.0058	0.0058
0.339	*****	0.0069	0.0042	0.0043	0.0041
0.514	0.0132	0.0068	0.0091	0.0016	0.0070
0.810	0.0095	0.0083	0.0055	0.0049	0.0052
1.119	0.0072	0.0080	0.0081	0.0074	0.0078



DATA SET E.1.1  
SOELBERG (70)

		C (mass frac.)				
AXIAL POSITION (m)		RADIAL POSITION (m)				
		0.000	0.020	0.040	0.060	0.075
0.130	0.6930	C.5765	0.5609	0.6202	0.6432	
0.200	0.7082	C.7054	*****	0.4631	0.5984	
0.279	0.6516	C.6172	0.5900	0.5658	0.5927	
0.339	*****	C.6670	0.5530	0.5436	0.5822	
0.514	0.6823	C.6907	0.6485	0.6359	0.6667	
0.810	0.7342	C.7052	0.7009	0.7026	0.6858	
1.119	0.7054	C.7251	0.7115	0.6938	0.7287	

		H (mass frac.)				
AXIAL POSITION (m)		RADIAL POSITION (m)				
		0.000	0.020	0.040	0.050	0.075
0.130	0.C516	0.0081	0.0027	0.0057	0.0029	
0.200	0.C343	0.0180	*****	0.0020	0.0088	
0.279	0.C331	0.0153	0.0045	0.0016	0.0031	
0.339	*****	0.0191	0.0049	0.0017	0.0021	
0.514	0.C196	0.0083	0.0057	0.0033	0.0033	
0.810	0.C100	0.0078	0.0027	0.0027	0.0027	
1.119	0.C039	0.0031	0.0033	0.0023	0.0051	

		ASH (mass frac.)				
AXIAL POSITION (m)		RADIAL POSITION (m)				
		0.000	0.020	0.040	0.060	0.075
0.130	0.1333	0.3200	C.3226	0.2593	0.2718	
0.200	0.1565	0.2114	*****	0.2735	0.3077	
0.279	0.1748	0.2424	C.4000	0.4C59	0.3714	
0.339	*****	0.2580	C.4530	0.4182	0.3398	
0.514	0.2190	0.2255	C.3273	0.3173	0.2740	
0.810	0.2130	0.2385	C.2347	0.2519	0.2300	
1.119	0.2323	0.2330	0.2451	0.2673	0.2446	

DATA SET E.1.2  
BROWN (66)

DATA SET E.1.2  
BROWN (66)

GEOMETRY (m)                      MASS FLOW RATES (kg/s)

Primary tube ID 0 0131      Primary gas      0.00590  
Secondary tube ID 0 0287      Primary solids    0.00849  
Chamber ID 0 2000      Secondary gas    0.00000  
Chamber length 2 0000      Secondary solids 0.00000  
Pri. wall thick 0 0001  
Quarl half angle 0.0000  
(degrees)  
Quarl length 0.0510

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	367.0	450.C
Pressure (kPa)	101.0	101.C
Swirl number	0.0	0.0

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
O2	0.9180	0.0000
AR	0.0820	0.0000
H2O	0.0000	1.0000

COAL COMPOSITION

Ultimate Analysis (mass frac., dry)	Proximate Analysis (mass frac., as recd.)
C 0.6510	Moisture 0.1500
H 0.0450	Volatile matter 0.3820
O 0.2360	Fixed Carbon 0.4040
N 0.0110	Ash 0.0440
S 0.0050	
Ash 0.0520	
Heating Value (J/kg, daf)	2.1700E+07
Mean Particle Size (µ)	4.3000E-05
Bulk Particle Density (kg/m3)	1.3400E+03

AR (mole frac.)

	AXIAL POSITION (m)		RADIAL POSITION (m)						
	0.010	0.020	0.030	0.040	0.050	0.060	0.065	0.080	
0.210	0.0382	*****	0.0386	*****	0.0343	*****	*****	0.0278	
0.360	*****	0.0405	*****	0.0378	*****	0.0349	*****	0.0360	
0.510	*****	0.0391	*****	*****	0.0366	*****	0.0336	0.0329	
0.670	*****	*****	*****	0.0268	*****	*****	*****	0.0261	
0.820	*****	0.0313	*****	*****	0.0300	*****	0.0301	0.0314	
1.120	*****	0.0294	*****	*****	0.0291	*****	0.0279	0.0267	
1.730	*****	0.0267	*****	*****	0.0274	*****	0.0250	0.0233	

HE (mole frac.)

	AXIAL POSITION (m)		RADIAL POSITION (m)						
	0.010	0.020	0.030	0.040	0.050	0.060	0.065	0.080	
0.210	0.0000	*****	0.0000	*****	0.0000	*****	*****	0.0000	
0.360	*****	0.0000	*****	0.0000	*****	0.0000	*****	0.0000	
0.510	*****	0.0000	*****	*****	0.0000	*****	0.0000	0.0000	
0.670	*****	*****	*****	0.0000	*****	*****	*****	0.0000	
0.820	*****	0.0000	*****	*****	0.0000	*****	0.0000	0.0000	
1.120	*****	0.0000	*****	*****	0.0000	*****	0.0000	0.0000	
1.730	*****	0.0000	*****	*****	0.0000	*****	0.0000	0.0000	

CC (mole frac.)

	AXIAL POSITION (m)		RADIAL POSITION (m)						
	0.010	0.020	0.030	0.040	0.050	0.060	0.065	0.080	
0.210	0.3402	*****	0.3474	*****	0.3351	*****	*****	0.3780	
0.360	*****	0.3152	*****	0.3298	*****	0.3122	*****	0.2833	
0.510	*****	0.3383	*****	*****	0.3921	*****	0.3746	0.3714	
0.670	*****	*****	*****	0.4374	*****	*****	*****	0.4015	
0.820	*****	0.4722	*****	*****	0.4540	*****	0.4481	0.4540	
1.120	*****	0.4334	*****	*****	0.4313	*****	0.4375	0.4453	
1.730	*****	0.4537	*****	*****	0.4658	*****	0.4442	0.4492	

DATA SET E.1.2  
BROWN (66)

CO2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.010	0.020	0.030	0.040	0.050	0.060	0.065	0.080
0.210	0.4462	*****	0.4370	*****	0.4088	*****	*****	0.3106
0.360	*****	0.5347	*****	0.5040	*****	0.4896	*****	0.5152
0.510	*****	0.4454	*****	0.4038	*****	*****	0.4032	0.4115
0.670	*****	*****	*****	0.2905	*****	*****	*****	0.2359
0.820	*****	0.2894	*****	*****	0.2882	*****	0.2877	0.2939
1.120	*****	0.2960	*****	*****	0.3032	*****	0.2905	0.2890
1.730	*****	0.2948	*****	*****	0.2792	*****	0.2941	0.2645

CH4 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.010	0.020	0.030	0.040	0.050	0.060	0.065	0.080
0.210	0.0012	*****	0.0009	*****	0.0022	*****	*****	0.0129
0.360	*****	0.0001	*****	0.0001	*****	0.0007	*****	0.0001
0.510	*****	0.0020	*****	*****	0.0007	*****	0.0012	0.0015
0.670	*****	*****	*****	0.0020	*****	*****	*****	0.0020
0.820	*****	0.0027	*****	*****	0.0023	*****	0.0023	0.0025
1.120	*****	0.0029	*****	*****	0.0022	*****	0.0018	0.0021
1.730	*****	0.0036	*****	*****	0.0033	*****	0.0033	0.0035

H2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.010	0.020	0.030	0.040	0.050	0.060	0.065	0.080
0.210	0.1499	*****	0.1624	*****	0.1664	*****	*****	0.2199
0.360	*****	0.0955	*****	0.1184	*****	0.1420	*****	0.1248
0.510	*****	0.1680	*****	*****	0.1503	*****	0.1716	0.1767
0.670	*****	*****	*****	0.1901	*****	*****	*****	0.2096
0.820	*****	0.2021	*****	*****	0.2041	*****	0.2056	0.2147
1.120	*****	0.1916	*****	*****	0.1991	*****	0.1915	0.1976
1.730	*****	0.2085	*****	*****	0.2073	*****	0.2114	0.2065

DATA SET E.1.2  
BROWN (66)

O2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.010	0.020	0.030	0.040	0.050	0.060	0.065	0.080
0.210	0.0099	*****	0.0017	*****	0.0145	*****	*****	0.0150
0.360	*****	0.0025	*****	0.0010	*****	0.0023	*****	0.0102
0.510	*****	0.0000	*****	*****	0.0000	*****	*****	0.0000
0.670	*****	*****	*****	0.0000	*****	*****	*****	0.0000
0.820	*****	0.0000	*****	*****	0.0000	*****	*****	0.0000
1.120	*****	0.0000	*****	*****	0.0000	*****	*****	0.0000
1.730	*****	0.0000	*****	*****	0.0000	*****	*****	0.0000

N2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.010	0.020	0.030	0.040	0.050	0.060	0.065	0.080
0.210	0.0144	*****	0.0122	*****	0.0386	*****	*****	0.0357
0.360	*****	0.0116	*****	0.0090	*****	0.0183	*****	0.0306
0.510	*****	0.0072	*****	*****	0.0064	*****	*****	0.0158
0.670	*****	*****	*****	0.0064	*****	*****	*****	0.0060
0.820	*****	0.0022	*****	*****	0.0214	*****	*****	0.0262
1.120	*****	0.0448	*****	*****	0.0418	*****	*****	0.0507
1.730	*****	0.0128	*****	*****	0.0170	*****	*****	0.0530

NO (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.010	0.020	0.030	0.040	0.050	0.060	0.065	0.080
0.210	3400.0	*****	1250.0	*****	710.0	*****	*****	330.0
0.360	*****	1730.0	*****	1475.0	*****	1175.0	*****	1100.0
0.510	*****	1425.0	*****	*****	1125.0	*****	*****	910.0
0.670	*****	*****	*****	420.0	*****	*****	*****	227.0
0.820	*****	470.0	*****	*****	370.0	*****	*****	360.0
1.120	*****	220.0	*****	*****	208.0	*****	*****	168.0
1.730	*****	85.0	*****	*****	65.0	*****	*****	52.0

DATA SET E.1.2  
BROWN (66)

HCN (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.010	0.020	0.030	0.040	0.050	0.060	0.065	0.080
0.210	134.2	*****	224.3	*****	837.1	*****	*****	544.6
0.360	*****	79.2	*****	78.5	*****	178.8	*****	200.8
0.510	*****	242.5	*****	*****	313.8	*****	318.5	415.4
0.670	*****	*****	*****	298.3	*****	*****	*****	323.2
0.820	*****	580.3	*****	*****	557.3	*****	519.6	385.0
1.120	*****	599.3	*****	*****	565.3	*****	772.1	560.9
1.730	*****	476.6	*****	*****	422.7	*****	514.7	334.9

NH3 (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.010	0.020	0.030	0.040	0.050	0.060	0.065	0.080
0.210	250.4	*****	164.6	*****	500.4	*****	*****	433.8
0.360	*****	23.7	*****	11.2	*****	41.2	*****	45.7
0.510	*****	424.9	*****	*****	203.1	*****	170.1	146.2
0.670	*****	*****	*****	101.4	*****	*****	*****	110.3
0.820	*****	338.5	*****	*****	184.1	*****	208.9	239.1
1.120	*****	102.1	*****	*****	69.6	*****	86.3	55.4
1.730	*****	118.5	*****	*****	100.0	*****	121.9	194.6

H2S (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.010	0.020	0.030	0.040	0.050	0.060	0.065	0.080
0.210	402.2	*****	699.3	*****	1185.6	*****	*****	1277.0
0.360	*****	230.8	*****	273.0	*****	555.2	*****	455.7
0.510	*****	314.3	*****	*****	649.2	*****	946.2	457.0
0.670	*****	*****	*****	1045.4	*****	*****	*****	6436.4
0.820	*****	1702.4	*****	*****	2556.4	*****	2987.6	4110.3
1.120	*****	2057.0	*****	*****	2496.3	*****	2428.1	2033.6
1.730	*****	2966.8	*****	*****	3011.0	*****	2890.0	4702.0

DATA SET E.1.2  
BROWN (66)

COS (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.010	0.020	0.030	0.040	0.050	0.060	0.065	0.080
0.210	38.0	*****	68.0	*****	88.0	*****	*****	95.0
0.360	*****	32.0	*****	51.0	*****	54.0	*****	59.0
0.510	*****	70.0	*****	*****	88.0	*****	98.0	64.0
0.670	*****	*****	*****	157.0	*****	*****	*****	124.0
0.820	*****	165.0	*****	*****	169.0	*****	166.0	145.0
1.120	*****	189.0	*****	*****	175.0	*****	195.0	168.0
1.730	*****	180.0	*****	*****	165.0	*****	165.0	122.0

CS2 (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.010	0.020	0.030	0.040	0.050	0.060	0.065	0.080
0.210	17.0	*****	4.0	*****	6.0	*****	*****	13.0
0.360	*****	2.0	*****	1.0	*****	5.0	*****	0.0
0.510	*****	31.0	*****	*****	11.0	*****	10.0	10.0
0.670	*****	*****	*****	17.6	*****	*****	*****	10.0
0.820	*****	29.0	*****	*****	17.0	*****	12.4	9.0
1.120	*****	15.0	*****	*****	8.0	*****	5.0	5.0
1.730	*****	0.0	*****	*****	0.0	*****	0.0	0.0

SO2 (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)							
	0.010	0.020	0.030	0.040	0.050	0.060	0.065	0.080
0.210	1670.0	*****	1397.6	*****	561.6	*****	*****	0.0
0.360	*****	2833.9	*****	1245.8	*****	1295.4	*****	1380.2
0.510	*****	1292.7	*****	*****	1902.0	*****	1209.6	1020.8
0.670	*****	*****	*****	268.2	*****	*****	*****	19.0
0.820	*****	266.4	*****	*****	0.0	*****	0.0	0.0
1.120	*****	20.0	*****	*****	0.0	*****	0.0	0.0
1.730	*****	0.0	*****	*****	0.0	*****	0.0	0.0

DATA SET E.1.2  
BROWN (66)

DATA SET E.1.2  
BROWN (66)

AXIAL POSITION (m)	C (mass frac.)							
	0.010	0.020	0.030	0.040	0.050	0.060	0.065	0.080
0.210	0.5659	*****	0.4184	*****	0.2957	*****	*****	0.6004
0.360	*****	0.4148	*****	0.1224	*****	0.1652	*****	0.1170
0.510	*****	0.6405	*****	*****	0.4295	*****	0.3261	0.2161
0.670	*****	*****	*****	0.6469	*****	*****	*****	0.4261
0.820	*****	0.4295	*****	*****	0.4013	*****	0.2604	0.3261
1.120	*****	0.4393	*****	*****	0.3065	*****	0.3144	0.2022
1.730	*****	0.4570	*****	*****	0.4555	*****	0.5207	0.5749

AXIAL POSITION (m)	N (mass frac.)							
	0.010	0.020	0.030	0.040	0.050	0.060	0.065	0.080
0.210	0.0130	*****	0.0061	*****	0.0061	*****	*****	0.0099
0.360	*****	0.0221	*****	0.0066	*****	0.0044	*****	0.0071
0.510	*****	0.0108	*****	*****	0.0095	*****	0.0045	0.0030
0.670	*****	*****	*****	0.0074	*****	*****	*****	0.0061
0.820	*****	0.0106	*****	*****	0.0025	*****	0.0032	0.0083
1.120	*****	0.0076	*****	*****	0.0078	*****	0.0065	0.0029
1.730	*****	0.0032	*****	*****	0.0032	*****	0.0034	0.0054

AXIAL POSITION (m)	H (mass frac.)							
	0.010	0.020	0.030	0.040	0.050	0.060	0.065	0.080
0.210	0.0226	*****	0.0092	*****	0.0065	*****	*****	0.0181
0.360	*****	0.0133	*****	0.0060	*****	0.0054	*****	0.0040
0.510	*****	0.0248	*****	*****	0.0099	*****	0.0080	0.0284
0.670	*****	*****	*****	0.0135	*****	*****	*****	0.0137
0.820	*****	0.0084	*****	*****	0.0101	*****	0.0069	0.0057
1.120	*****	0.0127	*****	*****	0.0033	*****	0.0091	0.0042
1.730	*****	0.0083	*****	*****	0.0039	*****	0.0082	0.0083

AXIAL POSITION (m)	S (mass frac.)							
	0.010	0.020	0.030	0.040	0.050	0.060	0.065	0.080
0.210	0.0047	*****	0.0060	*****	0.0132	*****	*****	0.0130
0.360	*****	0.0071	*****	0.0038	*****	0.0042	*****	0.0046
0.510	*****	0.0054	*****	*****	0.0062	*****	0.0063	0.0070
0.670	*****	*****	*****	0.0083	*****	*****	*****	0.0168
0.820	*****	0.0106	*****	*****	0.0157	*****	0.0200	0.0073
1.120	*****	0.0098	*****	*****	0.0103	*****	0.0155	0.0078
1.730	*****	0.0234	*****	*****	0.0247	*****	0.0245	0.0315

AXIAL POSITION (m)	O (mass frac.)							
	0.010	0.020	0.030	0.040	0.050	0.060	0.065	0.080
0.210	0.1530	*****	0.1530	*****	0.0355	*****	*****	0.0639
0.360	*****	0.0823	*****	0.3743	*****	0.0764	*****	0.3240
0.510	*****	0.1628	*****	*****	0.0854	*****	0.0499	0.0565
0.670	*****	*****	*****	0.0994	*****	*****	*****	0.1103
0.820	*****	0.0707	*****	*****	0.0850	*****	0.1942	0.0686
1.120	*****	0.0630	*****	*****	0.0357	*****	0.0583	0.1885
1.730	*****	0.0781	*****	*****	0.1806	*****	0.0413	0.0310

AXIAL POSITION (m)	ASH (mass frac.)							
	0.010	0.020	0.030	0.040	0.050	0.060	0.065	0.080
0.210	0.1412	*****	0.4071	*****	0.6421	*****	*****	0.2946
0.360	*****	0.4304	*****	0.4865	*****	0.7440	*****	0.4835
0.510	*****	0.1557	*****	*****	0.4595	*****	0.6016	0.7094
0.670	*****	*****	*****	0.2245	*****	*****	*****	0.4272
0.820	*****	0.4701	*****	*****	0.4825	*****	0.5155	0.5841
1.120	*****	0.4677	*****	*****	0.6304	*****	0.5963	0.5943
1.730	*****	0.4800	*****	*****	0.3271	*****	0.4019	0.3488

DATA SET E.1.3  
BROWN (66)

DATA SET E.1.3  
BROWN (66)

GEOMETRY (m)		MASS FLOW RATES (kg/s)	
Primary tube ID	0.0131	Primary gas	0.00594
Secondary tube ID	0.0287	Primary solids	0.01153
Chamber ID	0.2000	Secondary gas	0.00000
Chamber length	2.0000	Secondary solids	0.00000
Pri. wall thick	0.0001		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.6510		

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	367.0	450.0
Pressure (kPa)	101.0	101.0
Swirl number	0.0	0.0

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
O2	0.8690	0.0000
AR	0.1310	0.0000
H2O	0.0000	1.0000

COAL COMPOSITION

Ultimate Analysis (mass frac., dry)		Proximate Analysis (mass frac., as recd.)	
C	0.5760	Moisture	0.1900
H	0.0420	Volatile matter	0.3380
O	0.2910	Fixed Carbon	0.3830
N	0.0100	Ash	0.0590
S	0.0120		
Ash	0.0690		
Heating Value (J/kg, daf)		1.7900E-07	
Mean Particle Size (m)		4.0000E-05	
Bulk Particle Density (kg/m3)		1.0000E-03	

		AR (mole frac.)				
AXIAL POSITION (m)		RADIAL POSITION (m)				
		0.000	0.020	0.040	0.060	0.080
0.210	0.1334	0.1356	0.0770	0.0708	0.0610	
0.360	*****	0.0775	0.0707	0.0689	0.0726	
0.510	*****	0.0683	0.0731	0.0707	0.0726	
0.670	0.0584	0.0634	0.0611	0.0632	0.0517	
0.820	0.0610	0.0595	0.0626	0.0644	0.0622	
1.120	0.0525	0.0528	0.0535	0.0524	0.0516	
1.730	0.0485	0.0511	0.0501	0.0524	0.0500	

HE (mole frac.)

AXIAL POSITION (m)		RADIAL POSITION (m)				
		0.000	0.020	0.040	0.060	0.080
0.210	0.0000	0.0000	0.0000	0.0000	0.0000	
0.360	*****	0.0000	0.0000	0.0000	0.0000	
0.510	*****	0.0000	0.0000	0.0000	0.0000	
0.670	0.0000	0.0000	0.0000	0.0000	0.0000	
0.820	0.0000	0.0000	0.0000	0.0000	0.0000	
1.120	0.0000	0.0000	0.0000	0.0000	0.0000	
1.730	0.0000	0.0000	0.0000	0.0000	0.0000	

CO (mole frac.)

AXIAL POSITION (m)		RADIAL POSITION (m)				
		0.000	0.020	0.040	0.060	0.080
0.210	0.1831	0.2228	0.3696	0.3794	0.3882	
0.350	*****	0.4473	0.4182	0.3830	0.4291	
0.510	*****	0.3977	0.3815	0.3910	0.3759	
0.670	0.4226	0.4394	0.4113	0.4315	0.3922	
0.820	0.4066	0.4156	0.4020	0.3896	0.3688	
1.120	0.4292	0.4338	0.4305	0.4100	0.4061	
1.730	0.3986	0.3945	0.3979	0.3885	0.3812	

DATA SET E.1.3  
BROWN (66)

CO2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.3251	0.3677	0.4023	0.3665	0.3412
0.360	*****	0.1832	0.2460	0.3245	0.2321
0.510	*****	0.3400	0.3859	0.3524	0.3492
0.670	0.3183	0.2773	0.3164	0.2668	0.2695
0.820	0.3309	0.3058	0.3341	0.3467	0.3667
1.120	0.2717	0.2699	0.2620	0.2952	0.3002
1.730	0.2577	0.2767	0.2633	0.2837	0.2970

CH4 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.0322	0.0031	0.0000	0.0004	0.0012
0.360	*****	0.0017	0.0014	0.0014	0.0014
0.510	*****	0.0029	0.0010	0.0005	0.0017
0.670	0.0046	0.0049	0.0031	0.0029	0.0029
0.820	0.0038	0.0050	0.0029	0.0022	0.0022
1.120	0.0074	0.0073	0.0067	0.0062	0.0057
1.730	0.0071	0.0069	0.0071	0.0067	0.0061

H2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.0708	0.0998	0.1264	0.1699	0.1934
0.360	*****	0.2464	0.2310	0.2024	0.2459
0.510	*****	0.1615	0.1436	0.1625	0.1646
0.670	0.1939	0.2158	0.1998	0.2319	0.2769
0.820	0.1857	0.1961	0.1881	0.1838	0.1856
1.120	0.2342	0.2277	0.2433	0.2335	0.2315
1.730	0.2513	0.2307	0.2468	0.2338	0.2325

DATA SET E.1.3  
BROWN (66)

O2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.2533	0.1735	0.0046	0.0021	0.0022
0.360	*****	0.0158	0.0098	0.0044	0.0054
0.510	*****	0.0000	0.0000	0.0000	0.0000
0.670	0.0000	0.0000	0.0000	0.0000	0.0000
0.820	0.0000	0.0000	0.0000	0.0000	0.0000
1.120	0.0000	0.0000	0.0000	0.0000	0.0000
1.730	0.0000	0.0000	0.0000	0.0000	0.0000

N2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.0321	0.0276	0.0201	0.0108	0.0107
0.360	*****	0.0281	0.0229	0.0154	0.0135
0.510	*****	0.0296	0.0148	0.0178	0.0290
0.670	0.0022	0.0000	0.0082	0.0000	0.0000
0.820	0.0120	0.0180	0.0104	0.0083	0.0146
1.120	0.0050	0.0086	0.0040	0.0048	0.0049
1.730	0.0368	0.0392	0.0347	0.0348	0.0330

N2 (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	16.0	43.0	320.0	104.0	60.0
0.360	*****	160.0	132.0	250.0	34.0
0.510	*****	170.0	520.0	250.0	147.0
0.670	550.0	570.0	510.0	80.0	113.0
0.820	600.0	675.0	495.0	340.0	270.0
1.120	195.0	175.0	140.0	112.0	92.0
1.730	41.0	54.0	49.0	56.0	76.0

DATA SET E.1.3  
BROWN (66)

H2N (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	287.7	429.9	66.6	15.6	26.8
0.360	*****	3156.3	1190.4	552.3	980.5
0.510	*****	16.8	87.4	51.5	23.0
0.670	167.8	446.1	95.5	314.5	616.2
0.820	165.9	222.3	134.7	91.6	76.3
1.120	4.7	250.3	183.9	113.0	134.3
1.730	159.5	138.5	357.1	257.0	227.7

H1B (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	516.5	1033.6	621.6	556.0	961.0
0.360	*****	4223.9	1646.8	511.2	809.6
0.510	*****	23.6	396.7	951.3	415.1
0.670	374.8	1129.0	555.8	134.3	1869.3
0.820	553.3	601.5	620.8	896.5	984.2
1.120	898.6	906.4	768.9	858.6	1196.7
1.730	1142.5	1223.7	1276.3	1235.1	2052.3

H2S (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	58.4	73.6	1365.5	2311.4	2866.6
0.360	*****	5375.9	2749.7	2415.1	2837.7
0.510	*****	3013.3	1413.5	1341.1	2665.0
0.670	3044.0	1403.0	2691.0	1507.3	1783.4
0.820	2865.2	3294.1	2891.7	2543.5	2583.8
1.120	3103.7	3196.3	2417.7	5231.3	2806.1
1.730	4451.6	2287.0	2584.5	2227.3	3000.2

DATA SET E.1.3  
BROWN (66)

COS (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	52.5	77.8	205.9	356.2	271.1
0.360	*****	133.8	161.4	192.0	95.2
0.510	*****	153.5	178.7	274.8	157.5
0.670	294.0	243.8	262.3	233.5	111.9
0.820	254.5	295.8	285.9	263.5	228.6
1.120	324.5	324.9	307.2	307.8	247.8
1.730	133.7	106.2	149.4	175.8	176.1

CS2 (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	9.2	10.8	0.1	0.1	0.1
0.360	*****	5.7	5.7	0.1	8.3
0.510	*****	1.1	7.6	6.2	4.6
0.670	41.1	37.1	89.3	9.1	8.9
0.820	14.2	25.5	12.8	7.2	0.1
1.120	36.6	32.5	31.6	27.1	21.3
1.730	26.8	30.1	30.4	28.4	25.6

SO2 (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.0	0.0	0.0	0.0	0.0
0.360	*****	0.0	0.0	0.0	0.0
0.510	*****	28.3	0.0	0.0	0.0
0.670	0.0	0.0	0.0	0.0	0.0
0.820	0.0	0.0	0.0	0.0	0.0
1.120	0.0	0.0	0.0	0.0	0.0
1.730	0.0	0.0	0.0	0.0	0.0



DATA SET E.1.3  
BROWN (66)

C (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.6366	0.6090	0.1898	0.0815	0.1668
0.360	*****	0.5226	0.4552	0.3032	0.3370
0.510	*****	0.6478	0.5717	0.5306	0.5667
0.670	0.6173	0.5467	0.5025	0.5296	0.5094
0.820	0.6473	0.6182	0.6086	0.5593	0.5499
1.120	0.5972	0.6150	0.4545	0.4130	0.5753
1.730	0.5650	0.5353	0.4847	0.5231	0.4999

H (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.0355	0.0336	0.0088	0.0061	0.0060
0.360	*****	0.0287	0.0162	0.0114	0.0172
0.510	*****	0.0393	0.0272	0.0192	0.0331
0.670	0.0296	0.0173	0.0188	0.0270	0.0346
0.820	0.0240	0.0314	0.0207	0.0135	0.0156
1.120	0.0248	0.0237	0.0163	0.0172	0.0108
1.730	0.0181	0.0121	0.0094	0.0111	0.0101

O (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.2194	0.2376	0.2678	0.0393	0.0443
0.360	*****	0.1388	0.1615	0.2053	0.1946
0.510	*****	0.1884	0.2033	0.2041	0.2174
0.670	0.1819	0.1596	0.1326	0.2656	0.2660
0.820	0.1756	0.2163	0.2141	0.1532	0.2259
1.120	0.2441	0.1533	0.3496	0.2570	0.1559
1.730	0.0828	0.1459	0.1122	0.1109	0.1635

DATA SET E.1.3  
BROWN (66)

N (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.0082	0.0080	0.0019	0.0009	0.0010
0.360	*****	0.0093	0.0057	0.0030	0.0062
0.510	*****	0.0120	0.0087	0.0072	0.0083
0.670	0.0081	0.0066	0.0055	0.0077	0.0091
0.820	0.0089	0.0089	0.0076	0.0082	0.0106
1.120	0.0082	0.0083	0.0052	0.0066	0.0066
1.730	0.0079	0.0059	0.0048	0.0058	0.0058

S (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.0077	0.0078	0.0136	0.0326	0.0081
0.360	*****	0.0125	0.0125	0.0125	0.0125
0.510	*****	0.0088	0.0128	0.0308	0.0185
0.670	0.0101	0.0118	0.0171	0.0276	0.0262
0.820	0.0121	0.0108	0.0124	0.0287	0.0296
1.120	0.0120	0.0156	0.0198	0.0293	0.0310
1.730	0.0324	0.0247	0.0302	0.0312	0.0301

ASH (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.1004	0.1117	0.5319	0.8723	0.7819
0.360	*****	0.3006	0.3614	0.4771	0.4450
0.510	*****	0.1125	0.1892	0.2389	0.1775
0.670	0.1631	0.2698	0.3406	0.1854	0.1857
0.820	0.1321	0.1252	0.1525	0.2658	0.2040
1.120	0.1265	0.1840	0.1813	0.3107	0.2579
1.730	0.2938	0.3042	0.3922	0.3552	0.3217

DATA SET E.1.4  
BROWN (66)

GEOMETRY (m)		MASS FLOW RATES (kg/s)	
Primary tube ID	0.0131	Primary gas	0.00863
Secondary tube ID	0.0287	Primary solids	0.01013
Chamber ID	0.2000	Secondary gas	0.00067
Chamber length	2.0000	Secondary solids	0.00000
Pri. wall thick	0.0001		
Quarl half angle (degrees)	0.0000		
Quarl length	0.0510		

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	367.0	450.0
Pressure (kPa)	101.0	101.0
Swirl number	0.0	0.0

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
O2	0.8910	0.0000
AR	0.1070	0.0000
H2O	0.0000	1.0000

COAL COMPOSITION

Ultimate Analysis (mass frac., dry)		Proximate Analysis (mass frac., as recd.)	
C	0.6670	Moisture	0.0670
H	0.0470	Volatile matter	0.3940
O	0.1150	Fixed Carbon	0.4350
N	0.0140	Ash	0.1040
S	0.0430		
Ash	0.1120		
Heating Value (J/kg, daf)		2.7400E+07	
Mean Particle Size (µ)		4.3000E-05	
Bulk Particle Density (kg/m³)		1.3400E+03	

DATA SET E.1.4  
BROWN (66)

AXIAL POSITION (m)	AR (mole frac.)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.0493	0.0512	0.0677	0.0634	0.0618
0.360	0.0651	0.0608	0.0768	0.0714	0.0738
0.510	0.0513	0.0581	0.0643	0.0641	0.0647
0.670	0.0579	0.0574	0.0633	0.0640	0.0627
0.820	0.0581	0.0581	0.0617	0.0609	0.0601
1.120	0.0595	0.0551	0.0625	0.0609	0.0597
1.730	0.0523	0.0549	0.0553	0.0568	0.0545

AXIAL POSITION (m)	HE (mole frac.)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.0014	0.0058	0.0030	0.0042	0.0040
0.360	0.0000	0.0000	0.0000	0.0027	0.0029
0.510	0.0014	0.0013	0.0013	0.0018	0.0018
0.670	0.0022	0.0020	0.0000	0.0044	0.0022
0.820	0.0000	0.0000	0.0000	0.0000	0.0000
1.120	0.0000	0.0000	0.0000	0.0000	0.0000
1.730	0.0000	0.0000	0.0000	0.0000	0.0000

AXIAL POSITION (m)	CO (mole frac.)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.3751	0.2020	0.3908	0.3952	0.4053
0.360	0.3445	0.4264	0.3431	0.3742	0.4113
0.510	0.4441	0.4427	0.4558	0.4356	0.4354
0.670	0.4316	0.4381	0.4415	0.4389	0.4411
0.820	0.4442	0.4454	0.4450	0.4419	0.4354
1.120	0.4314	0.4031	0.4410	0.4298	0.4372
1.730	0.4135	0.4214	0.4191	0.4206	0.4176

DATA SET E.1.4  
BROWN (66)

CO2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.030	0.020	0.040	0.060	0.080
0.210	0.2939	0.5962	0.3855	0.3593	0.3452
0.360	0.3874	0.2859	0.4335	0.4033	0.3393
0.510	0.2516	0.3031	0.3333	0.3420	0.3382
0.670	0.2878	0.2789	0.3080	0.3086	0.3090
0.820	0.2880	0.2869	0.3031	0.3061	0.3123
1.120	0.2793	0.2618	0.2861	0.2809	0.2743
1.730	0.2787	0.2683	0.2858	0.2804	0.2865

CH4 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.0075	0.0000	0.0000	0.0000	0.0000
0.360	0.0045	0.0073	0.0012	0.0000	0.0000
0.510	0.0180	0.0031	0.0000	0.0000	0.0000
0.670	0.0051	0.0065	0.0022	0.0007	0.0006
0.820	0.0048	0.0071	0.0037	0.0017	0.0019
1.120	0.0072	0.0072	0.0071	0.0061	0.0064
1.730	0.0066	0.0071	0.0067	0.0069	0.0071

H2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.2294	0.0680	0.1356	0.1605	0.1678
0.360	0.1570	0.2059	0.1284	0.1312	0.1529
0.510	0.2274	0.1862	0.1381	0.1493	0.1498
0.670	0.2262	0.2081	0.1746	0.1746	0.1767
0.820	0.1944	0.1937	0.1809	0.1799	0.1817
1.120	0.2109	0.2625	0.2000	0.2101	0.2137
1.730	0.2209	0.2198	0.2014	0.2027	0.1988

DATA SET E.1.4  
BROWN (66)

O2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.0009	0.0363	0.0025	0.0024	0.0024
0.360	0.0074	0.0035	0.0031	0.0022	0.0000
0.510	0.0000	0.0000	0.0000	0.0000	0.0000
0.670	0.0000	0.0000	0.0000	0.0000	0.0000
0.820	0.0000	0.0000	0.0000	0.0000	0.0000
1.120	0.0000	0.0000	0.0000	0.0000	0.0000
1.730	0.0000	0.0000	0.0000	0.0000	0.0000

N2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.0358	0.0202	0.0150	0.0151	0.0134
0.360	0.0241	0.0101	0.0138	0.0149	0.0128
0.510	0.0057	0.0054	0.0072	0.0072	0.0102
0.670	0.0092	0.0089	0.0103	0.0083	0.0077
0.820	0.0101	0.0087	0.0056	0.0095	0.0086
1.120	0.0118	0.0103	0.0033	0.0121	0.0088
1.730	0.0276	0.0285	0.0318	0.0327	0.0335

N (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.0	2315.0	460.0	160.0	145.0
0.360	3190.0	2991.0	2195.0	1200.0	610.0
0.510	1150.0	1125.0	1100.0	760.0	415.0
0.670	940.0	1100.0	980.0	680.0	530.0
0.820	590.0	640.0	530.0	500.0	500.0
1.120	490.0	495.0	485.0	500.0	510.0
1.730	158.0	165.0	170.0	175.0	153.0

DATA SET E.1.4  
BROWN (66)

HCN (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	1127.8	217.5	1274.1	2138.2	4341.2
0.360	1357.9	1065.2	258.6	41.6	242.6
0.510	2708.8	851.8	496.4	349.5	1410.4
0.670	1034.9	760.0	697.9	1078.3	1610.9
0.820	1762.2	2057.1	3326.4	1916.7	863.1
1.120	7373.3	5875.2	9144.6	5693.9	6093.5
1.730	534.6	4235.8	4189.4	3858.9	2322.7

NH3 (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.0	1225.8	217.7	273.5	273.9
0.360	328.9	257.6	953.5	106.0	256.0
0.510	745.0	277.0	347.3	226.0	293.1
0.670	504.6	392.2	705.2	415.5	497.3
0.820	406.8	413.5	626.5	253.2	426.4
1.120	554.6	462.5	559.5	535.3	805.4
1.730	276.4	765.9	783.4	554.7	439.8

H2S (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	6174.0	1377.7	*****	*****	*****
0.360	3636.2	4598.5	817.6	3328.1	*****
0.510	*****	9435.6	3268.0	9267.6	*****
0.670	2877.4	3760.0	3539.5	4189.1	6670.2
0.820	6770.4	6977.9	7488.4	7693.4	7581.2
1.120	*****	*****	*****	*****	*****
1.730	*****	6412.3	*****	*****	*****

DATA SET E.1.4  
BROWN (66)

COS (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	223.0	246.0	809.0	1004.0	1038.0
0.360	302.0	402.0	198.0	316.0	922.0
0.510	500.0	515.0	364.0	519.0	1066.0
0.670	301.0	375.0	235.0	418.0	621.0
0.820	632.0	675.0	702.0	786.0	828.0
1.120	304.0	896.0	858.0	919.0	918.0
1.730	361.0	634.0	842.0	839.0	876.0

CS2 (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	222.0	0.0	31.0	45.0	44.0
0.360	805.0	1862.0	246.0	15.0	0.0
0.510	2280.0	1180.0	856.0	80.0	57.0
0.670	1514.0	1877.0	665.0	453.0	480.0
0.820	1569.0	1758.0	1331.0	970.0	877.0
1.120	2256.0	885.0	1916.0	1859.0	1716.0
1.730	1497.0	956.0	1404.0	1357.0	1408.0

SO2 (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	3473.6	6504.0	1552.4	360.9	0.0
0.360	7175.4	6654.7	*****	4803.3	2684.0
0.510	4521.2	4918.3	6520.6	2181.4	1469.8
0.670	5411.3	3865.2	3147.1	1696.8	1839.0
0.820	2851.7	1835.2	2986.4	1281.0	2642.1
1.120	1181.3	1125.5	1224.8	1026.7	2007.2
1.730	728.6	5257.4	3836.2	1753.8	1400.8

DATA SET E.1.4  
BROWN (66)

C (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.6965	0.4130	0.2203	0.2979	0.3061
0.360	0.6179	0.6437	0.5371	0.2829	0.2352
0.510	0.6536	0.5906	0.4338	0.2942	0.2826
0.670	0.6039	0.6343	0.5489	0.4527	0.4276
0.820	0.5829	0.5876	0.5791	0.5041	0.5470
1.120	0.6296	0.5762	0.5440	0.5917	0.5084
1.730	0.5163	0.5112	0.5514	0.5651	0.5737

H (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.0306	0.0143	0.0032	0.0024	0.0029
0.360	0.0278	0.0267	0.0225	0.0052	0.0055
0.510	0.0327	0.0198	0.0119	0.0037	0.0032
0.670	0.0286	0.0314	0.0177	0.0102	0.0053
0.820	0.0251	0.0252	0.0175	0.0064	0.0050
1.120	0.0253	0.0207	0.0136	0.0133	0.0080
1.730	0.0112	0.0110	0.0106	0.0104	0.0096

O (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.0747	0.0220	0.0064	0.0000	0.0000
0.360	0.0864	0.0642	0.0935	0.1280	0.0170
0.510	0.0267	0.0405	0.0720	0.0429	0.0000
0.670	0.0788	0.0841	0.0420	0.0390	0.0361
0.820	0.0573	0.0742	0.0424	0.0273	0.0348
1.120	0.0000	0.0063	0.0458	0.0240	0.0081
1.730	0.0193	0.0124	0.0115	0.0000	0.0000

DATA SET E.1.4  
BROWN (66)

N (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.0112	0.0062	0.0055	0.0034	0.0041
0.360	0.0065	0.0085	0.0041	0.0011	0.0013
0.510	0.0115	0.0107	0.0057	0.0011	0.0010
0.670	0.0146	0.0126	0.0084	0.0059	0.0037
0.820	0.0104	0.0107	0.0086	0.0052	0.0035
1.120	0.0160	0.0127	0.0069	0.0074	0.0061
1.730	0.0076	0.0076	0.0069	0.0091	0.0078

S (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.0357	0.0172	0.0357	0.0387	0.0339
0.360	0.0340	0.0384	0.0295	0.0215	0.0514
0.510	0.0402	0.0338	0.0283	0.0423	0.0531
0.670	0.0400	0.0372	0.0372	0.0409	0.0604
0.820	0.0483	0.0407	0.0385	0.0438	0.0541
1.120	0.0410	0.0421	0.0385	0.0426	0.0413
1.730	0.0383	0.0371	0.0377	0.0330	0.0351

ASH (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.020	0.040	0.060	0.080
0.210	0.1870	0.5272	0.7289	0.6765	0.6561
0.360	0.2273	0.2185	0.3133	0.5634	0.6897
0.510	0.1990	0.3047	0.4484	0.5735	0.6746
0.670	0.2342	0.2005	0.3458	0.4513	0.4670
0.820	0.2764	0.2616	0.3139	0.4132	0.3555
1.120	0.3146	0.3419	0.3513	0.3202	0.4281
1.730	0.4073	0.4208	0.3703	0.3922	0.4211

DATA SET E.1.5  
AZUHATA ET AL. (65)

DATA SET E.1.5  
AZUHATA ET AL. (65)

GEOMETRY (m)                      MASS FLOW RATES (kg/s)

Primary tube ID	0.0131	Primary gas	0.01075
Secondary tube ID	0.0287	Primary solids	0.00010
Chamber ID	0.2000	Secondary gas	0.00417
Chamber length	1.7300	Secondary solids	0.00000
Pri. wall thick	0.0002		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.0592		

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	367.0	450.0
Pressure (kPa)	413.7	413.7
Swirl number	0.0	0.0

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
O2	0.7770	0.0000
AR	0.2001	0.0000
H2O	0.0295	0.0000
N2	0.0000	1.0000

COAL COMPOSITION

Ultimate Analysis (mass frac., dry)	Proximate Analysis (mass frac., as recd.)
C 0.6679	Moisture 0.0597
H 0.0524	Volatiles matter 0.3836
O 0.0986	Fixed Carbon 0.4053
N 0.0142	Ash 0.1514
S 0.0049	
Ash 0.1620	
Heating Value (J/kg, daf)	2.7800E+7
Mean Particle Size (m)	5.0000E-5
Bulk Particle Density (kg/m <sup>3</sup> )	1.3400E+3

AR (mole frac.)

	AXIAL POSITION (m)						RADIAL POSITION (m)					
	0.000	0.010	0.020	0.040	0.060	0.080						
0.060	0.0419	0.0647	0.0622	0.0480	0.0545	0.0648						
0.210	*****	*****	0.0487	0.0498	0.0521	0.0583						
0.370	*****	*****	0.0589	0.0487	0.0486	0.0550						
0.520	0.0543	*****	0.0549	0.0548	0.0531	0.0543						
0.520	0.0428	*****	0.0475	0.0509	0.0361	0.0240						
0.820	0.0469	*****	0.0504	0.0490	0.0503	0.0495						
1.730	0.0394	*****	0.0472	0.0567	0.0521	0.0557						

H2 (mole frac.)

	AXIAL POSITION (m)						RADIAL POSITION (m)					
	0.000	0.010	0.020	0.040	0.060	0.080						
0.060	0.1191	0.1143	0.1678	0.1731	0.1561	0.2334						
0.210	*****	*****	0.1793	0.1744	0.1737	0.1712						
0.370	*****	*****	0.1375	0.1540	0.1588	0.1708						
0.520	0.1936	*****	0.1931	0.1885	0.1929	0.1954						
0.520	0.1701	*****	0.1848	0.1876	0.2180	0.2130						
0.820	0.1674	*****	0.1828	0.1822	0.1792	0.1837						
1.730	0.2235	*****	0.2115	0.1998	0.2074	0.2096						

O2 (mole frac.)

	AXIAL POSITION (m)						RADIAL POSITION (m)					
	0.000	0.010	0.020	0.040	0.060	0.080						
0.060	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000						
0.210	*****	*****	0.0000	0.0000	0.0000	0.0000						
0.370	*****	*****	0.0000	0.0000	0.0000	0.0000						
0.520	0.0000	*****	0.0000	0.0000	0.0000	0.0000						
0.520	0.0000	*****	0.0000	0.0000	0.0000	0.0000						
0.820	0.0000	*****	0.0000	0.0000	0.0000	0.0000						
1.730	0.0000	*****	0.0000	0.0000	0.0000	0.0000						

DATA SET E.1.5  
AZUHATA ET AL. (65)

DATA SET E.1.5  
AZUHATA ET AL. (65)

N2 (mole frac.)

CO2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)					
	0.000	0.010	0.020	0.040	0.060	0.080
0.060	0.4003	0.0375	0.0223	0.0225	0.0136	0.0252
0.210	*****	*****	0.0498	0.0396	0.0203	0.0160
0.370	*****	*****	0.0205	0.0208	0.0285	0.0072
0.520	0.0052	*****	0.0077	0.0097	0.0036	0.0110
0.520	0.0249	*****	0.0225	0.0215	0.0235	0.0236
0.820	0.0104	*****	0.0014	0.0198	0.0134	0.0208
1.730	0.0154	*****	0.0300	0.0290	0.0154	0.0259

AXIAL POSITION (m)	RADIAL POSITION (m)					
	0.000	0.010	0.020	0.040	0.060	0.080
0.060	0.1058	0.1865	0.0932	0.1000	0.1035	0.0873
0.210	*****	*****	0.0867	0.0969	0.0892	0.0886
0.370	*****	*****	0.1068	0.1103	0.1142	0.1125
0.520	0.0987	*****	0.0961	0.0927	0.0916	0.0906
0.520	0.1109	*****	0.1215	0.1365	0.1418	0.1158
0.820	0.0983	*****	0.1021	0.0948	0.1058	0.0921
1.730	0.1031	*****	0.1045	0.1004	0.1032	0.1075

CH4 (mole frac.)

H2O (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)					
	0.000	0.010	0.020	0.040	0.060	0.080
0.060	0.0142	0.0000	0.0000	0.0000	0.0000	0.0000
0.210	*****	*****	0.0006	0.0000	0.0000	0.0000
0.370	*****	*****	0.0000	0.0000	0.0000	0.0000
0.520	0.0043	*****	0.0016	0.0006	0.0003	0.0003
0.520	0.0052	*****	0.0023	0.0013	0.0012	0.0003
0.820	0.0013	*****	0.0014	0.0010	0.0007	0.0005
1.730	0.0026	*****	0.0019	0.0019	0.0016	0.0015

AXIAL POSITION (m)	RADIAL POSITION (m)					
	0.000	0.010	0.020	0.040	0.060	0.080
0.060	0.0500	0.2160	0.1718	0.1733	0.1918	0.1513
0.210	*****	*****	0.1746	0.1893	0.1803	0.1807
0.370	*****	*****	0.2066	0.2012	0.1892	0.1953
0.520	0.1406	*****	0.1572	0.1496	0.1479	0.1432
0.520	0.2487	*****	0.1909	0.1756	0.1500	0.1533
0.820	0.2058	*****	0.1730	0.1800	0.1794	0.1779
1.730	0.1171	*****	0.1182	0.1278	0.1307	0.1208

CO (mole frac.)

HCN (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)					
	0.000	0.010	0.020	0.040	0.060	0.080
0.060	0.2482	0.3762	0.4826	0.4831	0.4806	0.4687
0.210	*****	*****	0.4603	0.4500	0.4643	0.4852
0.370	*****	*****	0.4696	0.4650	0.4607	0.4592
0.520	0.5033	*****	0.4893	0.5040	0.5056	0.5051
0.520	0.3975	*****	0.4304	0.4265	0.4293	0.4689
0.820	0.4698	*****	0.4888	0.4733	0.4661	0.4755
1.730	0.4989	*****	0.4867	0.4845	0.4896	0.4850

AXIAL POSITION (m)	RADIAL POSITION (m)					
	0.000	0.010	0.020	0.040	0.060	0.080
0.060	*****	49.0	331.0	194.0	158.0	204.0
0.210	*****	*****	491.0	313.0	218.0	225.0
0.370	*****	*****	124.0	94.0	135.0	175.0
0.520	1155.0	*****	848.0	432.0	310.0	336.0
0.520	112.0	*****	160.0	408.0	431.0	1183.0
0.820	497.0	*****	450.0	434.0	359.0	378.0
1.730	814.0	*****	935.0	984.0	860.0	722.0

DATA SET E.1.5  
AZUHATA ET AL. (65)

NH3 (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)					
	0.000	0.010	0.020	0.040	0.060	0.080
0.060	*****	397.0	1500.0	527.0	653.0	807.0
0.210	*****	*****	1185.0	1463.0	1122.0	1165.0
0.370	*****	*****	458.0	515.0	619.0	773.0
0.520	849.0	*****	906.0	690.0	690.0	674.0
0.520	413.0	*****	629.0	1445.0	1045.0	1912.0
0.820	1054.0	*****	907.0	932.0	800.0	869.0
1.730	1365.0	*****	1456.0	*****	1244.0	1179.0

NO (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)					
	0.000	0.010	0.020	0.040	0.060	0.080
0.060	3226.0	1152.0	233.0	4.2	2.8	2.0
0.210	*****	*****	16.5	8.8	1.7	0.2
0.370	*****	*****	81.0	25.0	13.0	10.0
0.520	40.0	*****	26.0	15.0	8.0	4.0
0.520	72.0	*****	55.0	30.0	13.0	8.0
0.820	9.0	*****	6.0	4.0	3.7	3.1
1.730	2.3	*****	2.4	2.5	2.6	2.8

ClS (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)					
	0.000	0.010	0.020	0.040	0.060	0.080
0.060	25.0	137.0	177.0	176.0	157.0	155.0
0.210	*****	*****	212.0	187.0	193.0	128.0
0.370	*****	*****	192.0	200.0	201.0	197.0
0.520	196.0	*****	211.0	210.0	206.0	213.0
0.520	166.0	*****	173.0	178.0	167.0	180.0
0.820	196.0	*****	186.0	207.0	168.0	163.0
1.730	188.0	*****	193.0	*****	159.0	160.0

DATA SET E.1.5  
AZUHATA ET AL. (65)

CS2 (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)					
	0.000	0.010	0.020	0.040	0.060	0.080
0.060	0.0	0.0	0.0	0.0	0.0	0.0
0.210	*****	*****	0.0	0.0	0.0	0.0
0.370	*****	*****	6.0	0.0	0.0	0.0
0.520	65.0	*****	26.0	23.0	5.0	0.0
0.520	71.0	*****	26.0	5.0	0.0	0.0
0.820	13.0	*****	15.0	8.0	0.0	0.0
1.730	0.0	*****	0.0	*****	0.0	0.0

H2S (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)					
	0.000	0.010	0.020	0.040	0.060	0.080
0.060	66.0	786.0	2080.0	2147.0	1637.0	2010.0
0.210	*****	*****	1333.0	1570.0	1478.0	1225.0
0.370	*****	*****	2131.0	2518.0	2574.0	2472.0
0.520	2020.0	*****	2228.0	2121.0	2138.0	2375.0
0.520	1844.0	*****	1856.0	2415.0	2010.0	2074.0
0.820	1605.0	*****	1730.0	1905.0	1854.0	1791.0
1.730	2219.0	*****	2149.0	*****	1475.0	1513.0

SO2 (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)					
	0.000	0.010	0.020	0.040	0.060	0.080
0.060	*****	1342.0	461.0	119.0	121.0	150.0
0.210	*****	*****	304.0	572.0	0.0	193.0
0.370	*****	*****	131.0	70.0	0.0	105.0
0.520	162.0	*****	78.0	109.0	11.0	96.0
0.520	400.0	*****	232.0	331.0	89.0	13.0
0.820	0.0	*****	0.0	87.0	95.0	82.0
1.730	230.0	*****	138.0	75.0	258.0	214.0



DATA SET E.1.5  
AZUHATA ET AL. (65)

DATA SET E.1.5  
AZUHATA ET AL. (65)

C (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)					
	0.000	0.010	0.020	0.040	0.060	0.080
0.060	*****	0.4124	0.4078	0.4249	0.4557	0.5558
0.210	*****	*****	0.4825	0.5092	0.5688	0.5206
0.370	*****	*****	0.5664	0.4949	0.5248	0.3800
0.520	0.5125	*****	0.5945	0.5343	0.5288	0.5206
0.520	0.6810	*****	0.6126	0.5722	0.5567	0.5610
0.820	0.6047	*****	0.4238	0.5425	0.5310	0.5630
1.730	0.5249	*****	0.4968	0.4720	0.47E2	0.4925

S (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)					
	0.000	0.010	0.020	0.040	0.060	0.080
0.060	*****	0.0082	0.0070	0.0073	0.0072	0.0071
0.210	*****	*****	0.0069	0.0067	0.0080	0.0058
0.370	*****	*****	0.0071	0.0072	0.0075	0.0082
0.520	0.0039	*****	0.0057	0.0064	0.0075	0.0065
0.520	0.0045	*****	0.0075	0.0066	0.0093	0.0096
0.820	0.0094	*****	0.0128	0.0124	0.0125	0.0124
1.730	0.0049	*****	0.0056	0.0060	0.0050	0.0056

H (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)					
	0.000	0.010	0.020	0.040	0.060	0.080
0.060	*****	0.0030	0.0021	0.0035	0.0029	0.0042
0.210	*****	*****	0.0049	0.0064	0.0058	0.0046
0.370	*****	*****	0.0036	0.0032	0.0032	0.0031
0.520	0.0354	*****	0.0317	0.0351	0.0300	0.0318
0.520	0.0096	*****	0.0064	0.0045	0.0062	0.0056
0.820	0.0065	*****	0.0054	0.0048	0.0040	0.0048
1.730	0.0295	*****	0.0313	0.0270	0.0230	0.0281

ASH (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)					
	0.000	0.010	0.020	0.040	0.060	0.080
0.060	*****	0.5280	0.5560	0.5550	0.5230	0.4210
0.210	*****	*****	0.4338	0.4278	0.3396	0.3527
0.370	*****	*****	0.4120	0.5020	0.4590	0.5970
0.520	0.3405	*****	0.3265	0.3681	0.4380	0.4056
0.520	0.2180	*****	0.3260	0.3980	0.3770	0.4430
0.820	0.3660	*****	0.4080	0.3880	0.4240	0.4120
1.730	0.4470	*****	0.4500	0.4700	0.4620	0.4670

N (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)					
	0.000	0.010	0.020	0.040	0.060	0.080
0.060	*****	0.0071	0.0048	0.0020	0.0052	0.0083
0.210	*****	*****	0.0066	0.0077	0.0034	0.0081
0.370	*****	*****	0.0079	0.0059	0.0051	0.0084
0.520	0.0051	*****	0.0039	0.0038	0.0031	0.0048
0.520	0.0137	*****	0.0061	0.0300	0.0038	0.0085
0.820	0.0110	*****	0.0069	0.0089	0.0052	0.0332
1.730	0.0032	*****	0.0024	0.0051	0.0031	0.0047

DATA SET F.1.1  
RAWLINS 72)

DATA SET F.1.1  
RAWLINS (72)

GEOMETRY (m)		MASS FLOW RATES (kg/s)	
Primary tube ID	0.0032	Primary gas	0.00669
Secondary tube ID	0.1450	Primary solids	0.02375
Chamber ID	0.3500	Secondary gas	0.04608
Chamber length	2.1000	Secondary solids	0.00000
Pri. wall thick	0.0428		
Quarl half angle	0.0000		
(degrees)			
Quarl length	0.1190		

GAS PROPERTIES

	Primary	Secondary
Temperature (K)	294.0	700.0
Pressure (kPa)	85.5	85.5
Swirl number	0.0	1.5

GAS COMPOSITION (mole fraction - dry basis)

Species	Primary	Secondary
N2	0.730	0.7310
O2	0.1910	0.0221
Ar	0.0950	0.0290

COAL COMPOSITION --- COAL WATER SLURRY

Ultimate Analysis (mass frac., dry)		Proximate Analysis (mass frac., as recd.)	
C	0.8240	Moisture	0.3000
H	0.0520	Volatile matter	0.2200
O	0.0406	Fixed Carbon	0.4370
N	0.0138	Ash	0.0432
S	0.0076		
Ash	0.0517		

Heating Value (J/kg, daf)	3.3680E+04
Mean Droplet Size (μ)	0.0000E+00
Bulk Droplet Density (kg/m3)	0.0000E+00

		AR (mole frac.)				
AXIAL POSITION (m)		RADIAL POSITION (m)				
		0.000	0.035	0.070	0.105	0.140
0.180	*****	*****	0.0183	0.0148	0.0151	
0.280	0.0148	0.0186	0.0182	0.0187	0.0195	
0.380	0.0213	0.0202	0.0199	0.0191	0.0199	
0.480	0.0202	0.0200	0.0199	0.0191	0.0199	
0.580	0.0205	0.0202	0.0203	0.0204	0.0204	
0.680	0.0209	0.0201	0.0203	0.0203	0.0206	
0.880	0.0196	0.0197	0.0197	0.0198	0.0196	
1.480	0.0196	0.0198	0.0194	0.0195	0.0196	
2.080	0.0200	0.0199	0.0198	0.0198	0.0200	

O2 (mole frac.)

AXIAL POSITION (m)		RADIAL POSITION (m)				
		0.000	0.035	0.070	0.105	0.140
0.180	*****	*****	0.1929	0.1894	0.1342	
0.280	0.1425	0.1294	0.1533	0.1508	0.1550	
0.380	0.1235	0.1157	0.1163	0.1327	0.1328	
0.480	0.0968	0.1169	0.1034	0.1096	0.0970	
0.580	0.0750	0.0866	0.0955	0.0890	0.1053	
0.680	0.0768	0.0929	0.1025	0.1045	0.1965	
0.880	0.0702	0.0704	0.0696	0.0744	0.0752	
1.480	0.0600	0.0624	0.0611	0.0607	0.0622	
2.080	0.0575	0.0555	0.0646	0.0593	0.0571	

N2 (mole frac.)

AXIAL POSITION (m)		RADIAL POSITION (m)				
		0.000	0.035	0.070	0.105	0.140
0.180	*****	*****	0.7642	0.7690	0.7688	
0.280	0.7779	0.7810	0.7771	0.7773	0.7762	
0.380	0.7817	0.7848	0.7847	0.7827	0.7830	
0.480	0.7819	0.7807	0.7836	0.7826	0.7852	
0.580	0.7847	0.7834	0.7825	0.7836	0.7811	
0.680	0.7825	0.7829	0.7811	0.7815	0.7806	
0.880	0.7851	0.7851	0.7856	0.7857	0.7856	
1.480	0.7862	0.7871	0.7854	0.7870	0.7854	
2.080	0.7862	0.7871	0.7854	0.7870	0.7854	

DATA SET F.1.1  
RAWLINS (72)

CO2 (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.035	0.070	0.105	0.140
0.180	*****	*****	0.0200	0.0231	0.0239
0.280	0.0573	0.0688	0.0482	0.0495	0.0452
0.380	0.0697	0.0766	0.0774	0.0534	0.0614
0.480	0.0997	0.0803	0.0922	0.0878	0.0972
0.580	0.1189	0.1089	0.1007	0.1064	0.0923
0.680	0.1193	0.1034	0.0952	0.0928	0.0913
0.880	0.1252	0.1249	0.1251	0.1200	0.1186
1.480	0.1347	0.1327	0.1333	0.1333	0.1319
2.080	0.1363	0.1376	0.1302	0.1340	0.1366

CO (mole frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.035	0.070	0.105	0.140
0.180	*****	*****	0.0045	0.0038	0.0080
0.280	0.0034	0.0023	0.0033	0.0037	0.0041
0.380	0.0039	0.0028	0.0018	0.0022	0.0030
0.480	0.0014	0.0021	0.0010	0.0008	0.0007
0.580	0.0010	0.0008	0.0010	0.0006	0.0010
0.680	0.0004	0.0007	0.0009	0.0009	0.0011
0.880	0.0000	0.0000	0.0000	0.0000	0.0000
1.480	0.0000	0.0000	0.0000	0.0000	0.0000
2.080	0.0000	0.0000	0.0000	0.0000	0.0000

NO (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.035	0.070	0.105	0.140
0.180	*****	*****	*****	64.0	62.0
0.280	180.0	235.0	160.0	160.0	160.0
0.380	285.0	325.0	285.0	220.0	190.0
0.480	300.0	280.0	290.0	270.0	250.0
0.580	385.0	495.0	465.0	420.0	395.0
0.680	415.0	440.0	365.0	365.0	345.0
0.880	750.0	465.0	480.0	430.0	475.0
1.480	520.0	515.0	550.0	545.0	555.0
2.080	590.0	585.0	595.0	585.0	585.0

DATA SET F.1.1  
RAWLINS (72)

SO2 (ppm)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.035	0.070	0.105	0.140
0.180	*****	*****	*****	87.0	25.0
0.280	29.0	101.0	43.0	27.0	7.0
0.380	96.0	91.0	201.0	26.0	0.0
0.480	161.0	73.0	150.0	134.0	104.0
0.580	325.0	283.0	263.0	244.0	219.0
0.680	382.0	313.0	304.0	284.0	239.0
0.880	295.0	295.0	287.0	348.0	366.0
1.480	381.0	361.0	381.0	390.0	371.0
2.080	381.0	411.0	442.0	462.0	452.0

C (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.035	0.070	0.105	0.140
0.180	*****	*****	*****	0.7468	0.7259
0.280	0.7121	0.8052	0.7908	0.7519	0.7399
0.380	0.7301	0.7920	0.7687	0.7459	0.7251
0.480	0.7579	0.7752	0.7535	0.7118	0.7194
0.580	0.7411	0.7381	0.7150	0.6782	0.6871
0.680	0.7220	0.7393	0.7145	0.6893	0.6821
0.880	0.5252	0.4510	0.5017	0.5003	0.5463
1.480	0.3849	0.3720	0.3744	0.3395	0.4350
2.080	0.2371	0.2425	0.2747	0.2904	0.3177

H (mass frac.)

AXIAL POSITION (m)	RADIAL POSITION (m)				
	0.000	0.035	0.070	0.105	0.140
0.180	*****	*****	*****	0.0308	0.0266
0.280	0.0432	0.0476	0.0425	0.0303	0.0271
0.380	0.0427	0.0435	0.0402	0.0321	0.0270
0.480	0.0361	0.0364	0.0312	0.0278	0.0258
0.580	0.0308	0.0235	0.0177	0.0130	0.0129
0.680	0.0232	0.0273	0.0204	0.0149	0.0153
0.880	0.0137	0.0086	0.0113	0.0080	0.0096
1.480	0.0095	0.0087	0.0066	0.0052	0.0064
2.080	0.0041	0.0035	0.0041	0.0035	0.0042

DATA SET F.1.1  
RAWLINS (72)

DATA SET F.1.1  
RAWLINS (72)

		N (mass frac.)				
AXIAL POSITION (m)	RADIAL POSITION (m)					
	0.000	0.035	0.070	0.105	0.140	
0.180	*****	*****	*****	0.0149	0.0045	
0.280	0.0135	0.0162	0.0156	0.0155	0.0151	
0.380	0.0142	0.0152	0.0152	0.0150	0.0142	
0.480	0.0150	0.0151	0.0150	0.0139	0.0136	
0.580	0.0121	0.0121	0.0117	0.0106	0.0107	
0.680	0.0134	0.0135	0.0135	0.0123	0.0129	
0.880	0.0093	0.0080	0.0091	0.0090	0.0093	
1.480	0.0073	0.0059	0.0059	0.0053	0.0075	
2.080	0.0042	0.0047	0.0046	0.0045	0.0059	

		ASH (mass frac.)				
AXIAL POSITION (m)	RADIAL POSITION (m)					
	0.000	0.035	0.070	0.105	0.140	
0.180	*****	*****	*****	0.1307	0.1561	
0.280	0.1442	0.0666	0.0850	0.1248	0.1386	
0.380	0.1290	0.0850	0.1067	0.1330	0.1532	
0.480	0.1214	0.1191	0.1620	0.1890	0.1740	
0.580	0.1585	0.1596	0.2041	0.2370	0.2316	
0.680	0.1782	0.1554	0.1964	0.2064	0.1989	
0.880	0.4167	0.5043	0.4440	0.4711	0.3973	
1.480	0.5779	0.5911	0.5997	0.6424	0.5108	
2.080	0.7233	0.7135	0.7004	0.6812	0.6297	

		O (mass frac.)				
AXIAL POSITION (m)	RADIAL POSITION (m)					
	0.000	0.035	0.070	0.105	0.140	
0.180	*****	*****	*****	0.0702	0.0707	
0.280	0.0300	0.0572	0.0587	0.0708	0.0730	
0.380	0.0778	0.0570	0.0632	0.0679	0.0645	
0.480	0.0625	0.0481	0.0725	0.0520	0.0630	
0.580	0.0512	0.0612	0.0666	0.0566	0.0532	
0.680	0.0576	0.0592	0.0504	0.0721	0.0862	
0.880	0.0308	0.0248	0.0705	0.0082	0.0341	
1.480	0.0177	0.0197	0.0109	0.0054	0.0074	
2.080	0.0295	0.0340	0.0146	0.0186	0.0467	

		S (mass frac.)				
AXIAL POSITION (m)	RADIAL POSITION (m)					
	0.000	0.035	0.070	0.105	0.140	
0.180	*****	*****	*****	0.0067	0.0059	
0.280	0.0070	0.0073	0.0075	0.0067	0.0063	
0.380	0.0062	0.0066	0.0060	0.0060	0.0061	
0.480	0.0071	0.0062	0.0058	0.0056	0.0056	
0.580	0.0061	0.0055	0.0051	0.0047	0.0045	
0.680	0.0057	0.0052	0.0048	0.0050	0.0045	
0.880	0.0041	0.0034	0.0036	0.0034	0.0034	
1.480	0.0027	0.0027	0.0025	0.0022	0.0029	
2.080	0.0000	0.0018	0.0017	0.0019	0.0019	