AIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910

301/587-8202

Centimeter

Inches

MANUFACTURED TO AIM STANDARDS
BY APPLIED IMAGE, INC.

1 of 1

NOTICE

**CERTAIN DATA
CONTAINED IN THIS
DOCUMENT MAY BE
DIFFICULT TO READ
IN MICROFICHE
PRODUCTS.**

E. I. DU PONT DE NEMOURS & COMPANY
WILMINGTON, DELAWARE

EXPLOSIVES DEPARTMENT

- TMI

1- G.E.Kidd	6 - W.O.Simon
2- G.E.Kidd	7 - W.O.Simon
3- O.P.Kidder	8 - R.M.Evans-J.N.Tilley
4-File 1 (	9 - W.E.Kirst
CHG-GDG-KW-	10 - Master File
Hanford	11 - W.K.Woods
5-File 2	12 - Chronological
GDG-KW-Tech.	

May 5, 1944

Mr. G. E. Kidd, (2)
General Engineering Section
Technical Division
Metallurgical Laboratory
University of Chicago
Chicago 80, Illinois

Attention: G. F. Quinn

Dear Mr. Kidd:

Classification Cancelled and Changed To

COPY 1 OF 1, SERIES MA

DECLASSIFIED

By Authority of RM-Iten

CG-NMP-1, 5-12-94

By J. E. Savelly 5-12-94

Verified By J. E. Savelly

5-17-94

TUBULAR ALUMINUM DUMMY SLUGS

Ref: Quinn to Woods, 4/29/44

We are in receipt of your letter requesting any information available on the pressure drop through the tubular aluminum dummy slugs. Our method of calculating the pressure drop through a ribbed tube for the currently proposed loading is given in the attached appendix. This method of calculation indicates that the pressure drop in a standard W tube would be 166 lbs./sq. in. with a flow rate of 20 g.p.m. Friction in the active portion of the tube represents 82% of this total pressure drop.

Recent tests at S.M.I. indicate that with a flow rate of 20 g.p.m. the pressure drop through a standard W-tube is about 193 lbs./sq. in. when water is flowing isothermally at 150°F. Adjusting this pressure drop for the viscosities encountered in the plant, one obtains a value of 221 lbs./sq. in. as compared with the 166 lbs./sq. in. calculated. If this difference is ascribed exclusively to error in calculating the pressure drop external to the active zone, it is indicated that the pressure drop in the rest of the tube is about 3 times as large as calculated. Additional data are desired.

The header pressure of 350 lbs./sq. in. was established in the early days before the frictional resistance in the inactive zone of the tube was reduced. Although no detailed calculations have been made for the present arrangement, we are confident that a header pressure of 350 lbs./sq. in. is adequate to prevent boiling in the tubes at the currently contemplated heat loads.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

**MASTER
DECLASSIFIED**

G. E. Kidd

#2

DUH-74K

5/5/44

We understand that some ten perforated tubular dummies (24 S.T. aluminum) are being sent to Kireher via air express as soon as they have been manufactured. These dummies will not be satisfactory for corrosion observations but can be used for pressure drop studies. We shall be interested in any experimental data obtained on pressure drop phenomena.

Very truly yours,

TECHNICAL DIVISION

W. K. Woods

W. K. WOODS

WKW/11
Att.

DECLASSIFIED

LWH 100

APPENDIX

Calculation of Pressure Drop in Standard W Tube

Basis of calculation:

Flow rate = 22.8 g.p.m. (arbitrarily chosen)
Inlet temperature = 5°C.
Exit temperature = 65°C.

A. Active Zone of Pipe

$$\Delta P = (4f)(V^2/2g)(N/D)(62.3/144)$$

Average viscosity (based on average of 5th roots of inlet and exit viscosity) = 0.85 centipoise
Annular cross section = 0.351 sq. in.
Annular velocity = $(22.8/60)(1/7.48)(144/0.351) = 20.8$ ft./sec.
Equivalent diameter = 0.153 in.
Reynolds number = $DVP/\mu = (0.153/12)(20.8)(62.3)/(0.85)(.000672) = 29,000$
 $f = 0.0069 \times 120\%$
Length (N) = 23 ft.
Hence: $\Delta P = 173$ lbs./sq. in.

B. Pressure Drop Past Cylindrical Lead Slugs (1.360" diam.)

Increase in annular cross-section = $(\pi/4)(1.44 + 1.36)(1.44 - 1.36) = 0.176$ sq. in. = 50% of 0.351 sq. in.
For the same flow rate: $\Delta P \propto N/(S)^3$
Length of 6 slugs, 6" long = 3 ft.
Hence: $\Delta P = (173)(3/23)(1/1.5)^3 = 7$ lbs./sq. in.

C. Entrance and Exit Losses

At 3 places in the tube, a velocity of 20.8 ft./sec. is established. Entrance and exit losses are estimated at 1.5 velocity heads for each place.

$$\Delta P = (3)(1.5)(20.8)^2(1/64.4)(62.3/144) = 13 \text{ lbs./sq. in.}$$

D. Pipe Friction Inside Perforated Tubes

Assume (conservatively) that all the water flows inside of the perforated tubes. The inside diameter of the perforated tube is set at a nominal value of 0.97 in. for mechanical reasons.

Cross section = $(\pi/4)(.97)^2 = 0.739$ sq. in.
Length = 40' - 3' - 23' = 14 ft.
At constant flow rate: $\Delta P \propto N/(S)^{1.8}(p)^{1.2}$
Hence: $\Delta P = (173)(14/23)(.351/.739)^{1.8}(.153/0.97)^{1.2} = 3.0$ lbs./sq. in.

[REDACTED]

DECLASSIFIED

5/5/44

E. Pressure Drop During Entrance to Perforated Tubes

$$-dp = (A_p)(w)^n d(N) + A_K w d(w) \quad (1)$$

where p = pressure in annulus, lbs./sq. in.

w = flow in annulus, as a % of total flow

N = length

A_p = pressure drop/unit length due to friction, for full flow = 173/23

= 7.52

A_K = pressure drop due to kinetic energy effects for unit change in annular flow rate = $(2)(20.8)^2(1/64.4)(62.3/144)$

= 5.81

n = exponent which should have a value of 1.8 but which for simplicity is conservatively taken as unity.

$$\text{also: } -dw = B \sqrt{p - P_0} dN \quad (2)$$

Where B = change in w per unit length, for a unit pressure difference across the wall of the perforated tube.

P_0 = pressure inside perforated tube (assumed constant)

For a one foot length of tube we specified that there should be at least 3.0 sq. in. of unobstructed perforation. Assuming an orifice coefficient of 0.6, one calculates that:

$$B = \frac{(0.6)(3.0/144) \sqrt{(64.4)(1 \text{ lbs./sq.in.})(144/62.3)}}{(22.8/60)(1/7.48)} = 3.0$$

Eliminating dN between Equations (1) and (2), and integrating between the limits $p = P$ when $w = 1$ and $p = P_0$ when $w = 0$, one obtains: $P - P_0 = 0.2 \text{ lbs./sq.in.}$

F. Pressure Drop During Discharge from Perforated Tubes

Equation (1) of Section E is valid as given. In place of Equation (2) we use:

$$+dw = B \sqrt{P_0 - p} dN \quad (3)$$

Eliminating dN between Equations (1) and (3), and integrating between the limits $p = P_0$ when $w = 0$ and $p = P$ when $w = 1$, one obtains: $P_0 - P = 6.9 \text{ lbs./sq.in.}$

G. Overall Pressure Drop

$$\Delta P = 173 + 7 + 13 + 3.0 + 2(0.2 + 6.9) = 210 \text{ lbs./sq.in.}$$

$$\text{If flow rate} = 20 \text{ g.p.m., } \Delta P = 210(20/22.8)^{1.8} = 166 \text{ lbs./sq.in.}$$

For design pressure drop of 182 lbs./sq.in., design flow rate =

$$22.8(182/210)^{1/1.8} = 21.0 \text{ g.p.m.}$$

DECLASSIFIED

DATE

FILMED

8/18/94

END