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PCCF FLOW ANALYSIS - DR REACTOR

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PCCF FLOW ANALYSIS - DR REACTOR

J. F. Calkin

INTRODUCTION

In 1957 R. D. Waters of the Thermal Hydraulics Operation recommended an orifice to be used in the PCCF (Poison Column Control Facility) in DR Reactor. (Reference 2 in Bibliography) This orifice was selected with the object of giving at least 20 gpm flow to the tube to permit flush discharging and yet limit it to about 25 gpm to prevent vibration and chattering of the poison column pieces with a front header pressure of about 470 psig. A single primary orifice (0.236" I.D. with taper downstream) mounted in a pre-CG-558 nozzle accomplished this and operated in critical flow to limit the flow to about 25 gpm regardless of the length of poison column charge. Other reactors have since adopted this method of PCCF flow control and use similar fittings.

The following questions have been raised by reactor personnel concerning PCCF tubes: (1) What would be the flow increase through these PCCF tubes at higher front header pressures (up to 600 psig), and (2) What could be the maximum charge length without causing a decrease in flow. (This latter situation would be possible if the greater charge length would increase the back pressure on the orifice enough so that the orifice would not be operating in critical flow.)

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SUMMARY

This report contains an analysis of PCCF tube flow and Panellit pressure relations at DR reactor. Supply curves are presented at front header pressures from 480 to 600 psig using cold water and the standard 0.236" orifice with taper down stream and the pigtail valve (plug or ball) open. Demand curves are presented for slug column lengths of 200" to 400", using 1.44" O.D. solid poison pieces (either Al or Pb-Cd) and cold water with a rear header pressure of 50 psig. Figure 1 is a graph of Panellit pressure vs. flow with the above supply and demand curves and clearly shows the effect of front header pressure and charge length on flow.

DISCUSSION

Data for the demand curves were taken from laboratory data gathered in connection with references 3 and 4. Based on data taken with cold water for 37 slugs 6.5" long and 1.44" O.D., and upon the assumption that the pressure drop from the front nozzle barrel to the end of active section is approximately proportional to the length of the charge, pressure drops for the various charge lengths were calculated for various flows from 20 to 28 gpm. It was found from the data that the pressure drop from the Panellit tap to the front nozzle was nil. Pressure drops from the rear nozzle to the rear header were taken from the same data used for reference 1 and 2.

The supply curves were also calculated from data taken for references 1 and 2. Based on the fact that at a front header pressure of 530 psig a critical flow of 24.5 gpm exists and that a critical pressure drop is approximately proportional to the square of the critical flow, critical flows were calculated for various front header pressures. Supply curves were calculated using the same front header pressures and a calibration for the 0.236" I.D. orifice with taper downstream and with the pigtail ball or plug valve in the open or high flow position.

Use of Figure 1

To find the flow at which any particular tube will operate, find the supply curve and vertical critical flow line corresponding to the front header pressure of interest. Compute the length of charge in inches and find the corresponding demand curve. The intersection of the demand curve with any portion (sloping or vertical) of the supply curve determines the operating Panellit pressure and the operating flow. If a vertical portion of the supply curve is intersected by the demand curve then the tube will be operating in critical flow.

If front header pressures other than those plotted are desired it should be noted that the vertical spacing of the supply curves is 20 psi for every 20 psig front header pressure change. In like manner, if higher rear header pressures than 50 psig are used, the demand curves must be moved up a corresponding amount (10 psi for every 10 psig increase of rear

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header pressure). Lower rear header pressures would similarly require lower demand curves.

If orifices other than 0.236" with taper downstream are used, new supply curves must be drawn as well as new critical flow (vertical) lines.

Figure 1 has been drawn from values calculated from a small amount of laboratory data and are consequently extrapolations and interpolations and should be treated as such. They do, however, show the approximate relationship of supply and demand curves and may be used to further the understanding of these peculiar PCCF tubes.

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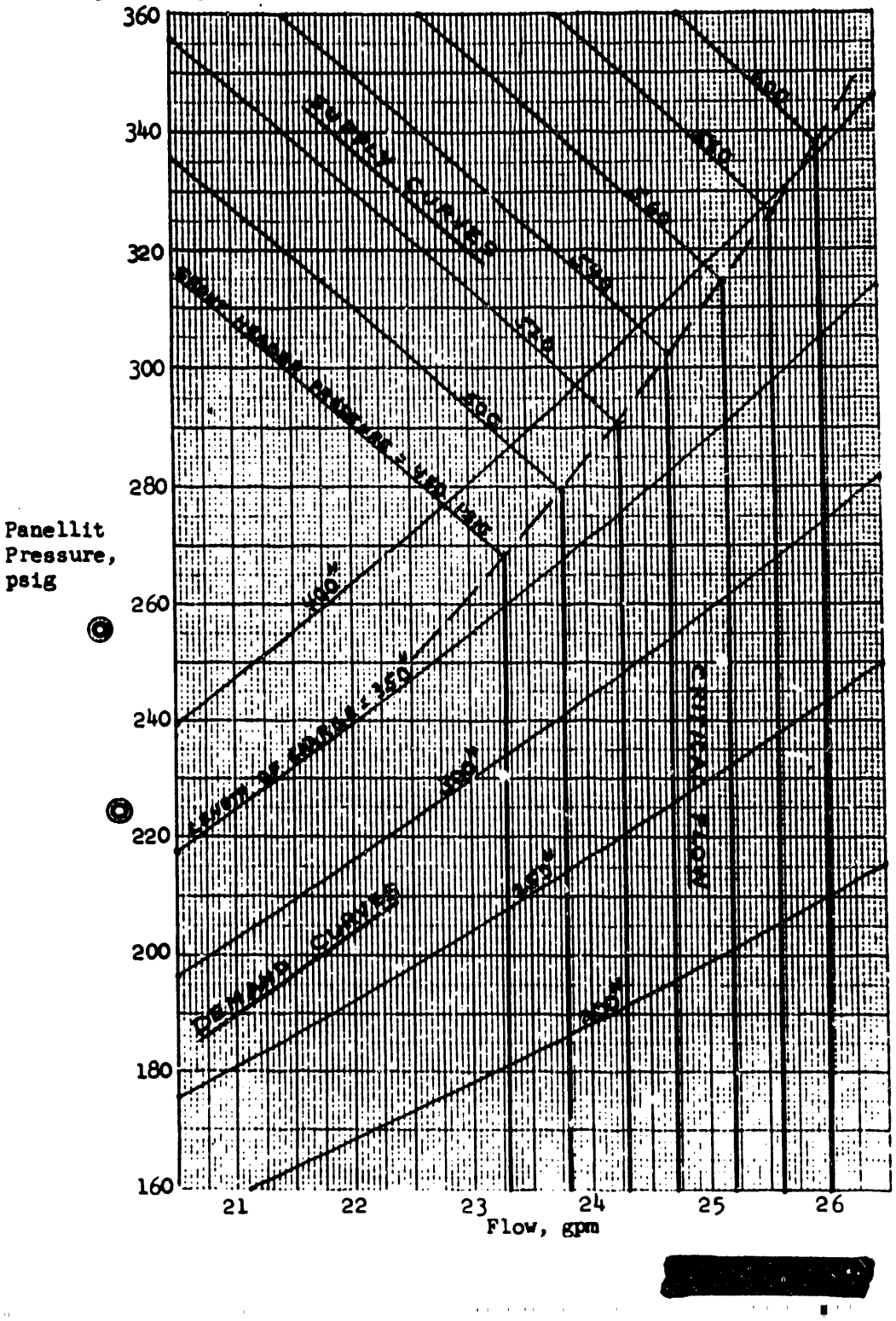
Figure 1. Supply and Demand Analysis for PCCF Ball Valve Tubes - DR Reactor

Rear Header pressure = 50 psig; cold water; 1.44" OD solid slugs; 0.236" ID orifice, taper downstream; pigtail plug valve open.



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(1) Letter from K. W. Hess to J. M. Batch, "Poison Column Orificing," May 15, 1957. (Unclassified)

(2) Letter from E. D. Waters to J. M. Batch, "Cavitating Orifice for Poison Columns," May 20, 1957. (Confidential Undocumented)

(3) Letter from F. J. VanWormer to J. M. Batch, "PCCF Tests," July 2, 1958. (Unclassified)

(4) Waters, E. D. Front Ball Valve Nozzle Pressures for a PCCF Tube (BDF), HW-56854. July 22, 1958. (Confidential Undocumented)

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