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HYDRAULIC DEMAND CURVES FOR
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HYDRAULIC DEMAND CURVES FOR STANDARD BDF GEOMETRY
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By E. D. Waters and D. E. Fitzsimmons

INTRODUCTION

Information concerning the pressure-flow relations in reactor process tubes at very low heat generation rates is of value for determining flow requirements during shutdown conditions. Since such information is quite difficult to calculate when boiling occurs, a brief laboratory investigation was conducted to obtain experimental data. The data obtained for BDF geometry are recorded here for distribution to those persons having an interest in the application of the results to reactor operation.

SUMMARY

Hydraulic demand data were obtained in the 189-D Heat Transfer Laboratory for steady state conditions with tube powers of 50, 100, 200, and 300 KW. The experiments utilized a simulated I&E fuel charge and a standard BDF process tube and outlet fitting assembly. Inlet water temperatures of 11 to 14°C and a rear header pressure of 25 psig were selected to approximate normal reactor conditions.

Tube inlet pressure demand data are presented on Figures 1 and 2. Data which show the pressure drop across the active (heated) section are presented on Figure 3.

EXPERIMENTAL METHOD

The experiments were conducted with the 189-D Heat Transfer Apparatus which is a prototypical mock-up of a single process channel with nuclear heat being simulated by d.c. electrical heating in a metal "rod". The "heater rod" had outside and inside diameters equivalent to those of O-II-N I&E fuel elements and had a stepped cosine power distribution with a peak power to average power ratio of 1.39. The outlet fitting assembly utilized standard BDF type fittings.

Normal reactor conditions were approximated by holding the rear header pressure at 25 psig and maintaining the inlet water temperatures between 11 and 14 °C.

A series of data points were obtained for each tube power by recording data for steady state conditions at various flow rates. For each tube power one or two data points were obtained with a flow rate low enough to cause film boiling on the heater rod surface, as indicated by a large increase in the heater rod metal temperature with small flow reduction.

DISCUSSION OF RESULTS

Data are presented on Figure 1 for 50 and 100 KW and on Figure 2 for 200 and 300 KW tube powers. These figures show tube inlet pressure as a function of the square of the flow rate. The curves illustrate the increased pressures which are necessary to sustain flow

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as the flow rate is reduced and boiling occurs along the heated section. The maximum tube inlet pressure demand is 195 psig for 300 KW while the 50 KW case requires a maximum inlet pressure of about 35 psig to maintain the flow rate at a condition just out of film boiling. By plotting maximum tube inlet pressure versus tube power, one can interpolate to maximum pressures for intermediate tube powers. It is interesting to note that for the 50 KW case the heater rod thermocouples indicated a condition of film boiling on the top of the heater rod over the entire downstream half of the heated length when the flow rate was 0.29 gpm.

Data on Figure 3 show flow rate versus the pressure drop from the tube inlet to dummy (support charge) inlet - that is, the pressure drop along the active length of the simulated fuel charge. Of course, combination of these data with data of Figures 1 and 2 and rear header pressure of 25 psig allows one to determine either the dummy inlet pressure or pressure drop from dummy inlet to rear header if these values are of interest.

Since normal reactor tube powers are above 300 KW, these data are not generally useful for normal reactor operation. However, at shut down power levels the process tube flow rates are not large enough to monitor with the existing flow meters. These data may then be useful to select supply pressures which will assure adequate coolant flow to prevent excessive fuel temperatures at the low power levels.

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FIGURE 1

STEADY STATE TUBE INLET PRESSURE DEMAND
BDF WITH STANDARD REAR FITTINGS

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FIGURE 2

STEADY STATE TUBE INLET PRESSURE DEMAND
BDF WITH STANDARD REAR FITTINGS

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FIGURE 3

STEADY STATE PRESSURE DROP DATA
BDF WITH STANDARD REAR FITTINGS

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