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HW-66773

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October 19, 1960

To: D. L. Renberger

From: J. F. Calkin JFC

Subj: New Inlet Nozzle Assembly - C Reactor

HW-66773 reported the calibration for a new inlet nozzle assembly for C Reactor. Since then the venturi has been modified to include a cross-wire screen just upstream of the venturi. This modification has been checked in the hydraulics laboratory and it was found that the calibration was altered. The following equations apply to the modified assembly.

$\Delta P \text{ (psi)} = 0.0645 \, (F, \text{ gpm})^{2.004}$, Front header to venturi throat loss

$\Delta P = 0.0408 \, (F)^{2.026}$, Venturi throat to tube inlet recovery

$\Delta P = 0.0241 \, (F)^{1.957}$, Front header to tube inlet loss

Please file this with HW-66773.

JFC:leb

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September 15, 1960

FLOW TEST RESULTS FOR NEW INLET NOZZLE ASSEMBLY - C REACTOR

by E. D. Waters

INTRODUCTION

The use of self-supported fuel elements in ribless Zircaloy-2 tubes at C-reactor requires some inlet nozzle modification to allow charging of the larger overall diameter fuel pieces. A new nozzle assembly has been developed (by Equipment Development Operation - IPD) which will allow the use of the new fuel pieces and at the same time increase the reliability of the header-to-tube piping and reduce pumping power losses. Flow test data were requested for the new assembly and the results of these tests are presented herein. This report also presents a comparison of the header to tube energy losses for the various reactor inlet nozzle assemblies which are currently used on the Hanford production reactors.

[redacted]

It is understood by the author that further modifications to the nozzle assembly are planned and that the calibration data of this report are mainly for use in Production Test IP-351-AP as discussed in HW-66336.*

SUMMARY

Flow calibration data for a prototype inlet nozzle assembly are presented on Figure 1 to show ΔP (front header - Panellit) for a 0.386" venturi size. Data are included to show the effect of a reduced size front header fitting if this condition is found to occur on the reactor.

Laboratory tests showed that the Panellit pressure at incipient critical flow and the minimum Panellit pressure on cap failure would both be less than zero psig for this new assembly.

Data are presented on Figure 2 to show the pressure recovery from Panellit to tube inlet and to show the overall pressure loss from front header to tube inlet for the new assembly with a 0.386" venturi size.

Figure 3 illustrates the overall pressure loss for various inlet nozzle assemblies and also shows to some extent the effect on overall loss of changing the venturi size in the various assemblies. The overall loss for the new assembly is about 35 per cent of that for the present C reactor assembly.

DISCUSSION

Equipment Development Operation personnel have found that reaming of the present inlet nozzle of C-reactor for acceptance of self-supported fuel elements would leave a nozzle wall thickness of questionable integrity. Thus a new nozzle assembly has been developed which incorporates several mechanical and hydrodynamic improvements. Such an assembly is shown on drawing SK-1-4112.

Flow tests were conducted in the Hydraulics Laboratory of Thermal Hydraulics Operation using one such assembly with a venturi size of 0.386 inch I.D. The assembly was mounted on a C tube and attached to a C front header fitting. This header fitting was measured and found to be 0.450 inch I.D. after the first test was made rather than the standard size 0.469 inch I.D. (It undoubtedly was in this condition prior to installing the new assembly because of repeated attachment and detachment of the various caps and pigtails used on the experimental apparatus from time to time.) The header fitting was then reamed to the standard size - 0.469 inch I.D. - and the test was re-run. The results of both test runs are shown on Figure 1. They show that a 0.019 inch decrease from standard size in the header fitting might cause about 5 to 6 psi (or about 1 gpm) difference in the header-to-Panellit calibration curve at normal central zone flow conditions. Until some measurements of

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* HW-66336 - "Production Test IP-351-AP, New Inlet Nozzle For 105-C Reactor" by P. B. McCarthy and O. E. Adams

actual header fittings on the reactor are available, one should probably assume that the calibration on the reactor would fall some place between the two curves on Figure 1.

Data were also obtained to investigate the Panellit (venturi throat) pressure at a condition of incipient critical flow and at a condition simulating front nozzle cap failure. For each condition, it was found that the Panellit pressure would be less than 0 psig for front header pressures of 400 and 445 psig.

Data on Figure 2 show the pressure recovery from Panellit to tube inlet and also the total pressure loss from front header to tube inlet for the two conditions of front header fitting.

Other data were obtained while using a 0.453 inch venturi with the 0.450 inch header fitting. However, the pressure tap at the throat of the venturi was about 0.4 inch I.D. Such a large pressure tap would surely disturb the flow pattern in the venturi and hence invalidate a rigorous comparison. Qualitatively, the header-to-Panellit calibration for the 0.453 inch venturi was about 60 per cent of that for curve E, Figure 1. The overall loss from header-to-tube fell about midway between curves D and F of Figure 2.

Figure 3 presents a rough compilation of information which has been gathered over the past three years or so. The pressure loss from front header to tube inlet is presented for the various nozzle inlet assemblies in use on the present production reactors (Zone 1, only). It is emphasized that the information is of a qualitative nature and is not intended to show the same degree of accuracy as Figures 1 and 2.

The shaded band for any given assembly indicates the variation in loss which will occur as the venturi throat diameter is changed, except for the new C reactor assembly where the variation shown is due to header fitting size difference. (Header fitting size variations would also affect the CG-558 assembly loss, but to a lesser extent.) From this figure, it is evident that this new C nozzle assembly compares well with the K reactor assembly as far as overall loss is concerned.

Considering the new inlet assembly strictly as a venturi flow meter, it is not very efficient. The permanent loss is about 27 per cent of the ΔP from upstream to venturi throat whereas a venturi meter most generally operates in the range of 10 to 20 per cent permanent loss. However, the necessity for making a 180° return in the flow path and confining this to a rather limited space would undoubtedly account for the 'apparent' inefficiency of this assembly.

The calibration data presented in Figure 1 have special application to Production Test IP-351-AP as discussed in HW-66336. It is understood that further modifications will be made to the new inlet assembly before full reactor usage. Hence, additional flow calibration tests should be performed after final modifications are made.

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[redacted]

Figure 1

<u>Calibration Data for New C Reactor</u>
<u>Inlet Nozzle Assembly With 0.386" Venturi</u>

Curve A - Standard 0.469" ID front header fitting
Curve B - Front header fitting reduced to 0.450" ID by repeated usage

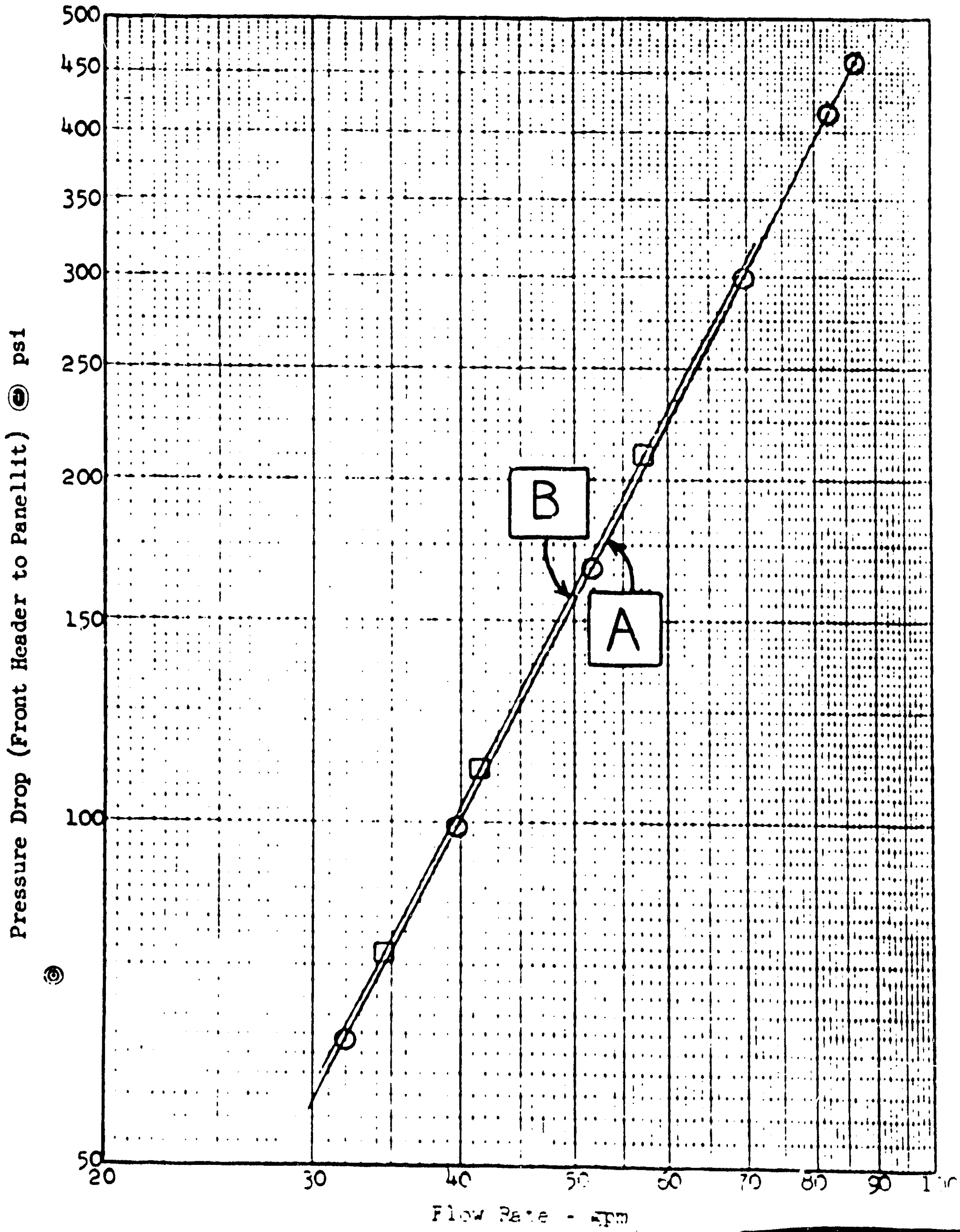

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Figure 2

Data for New C Reactor
Inlet Nozzle Assembly With 0.386" Venturi

Curves C, D - Standard 0.469" ID front header fitting
Curves E, F - Front header fitting reduced to 0.450" ID by repeated usage

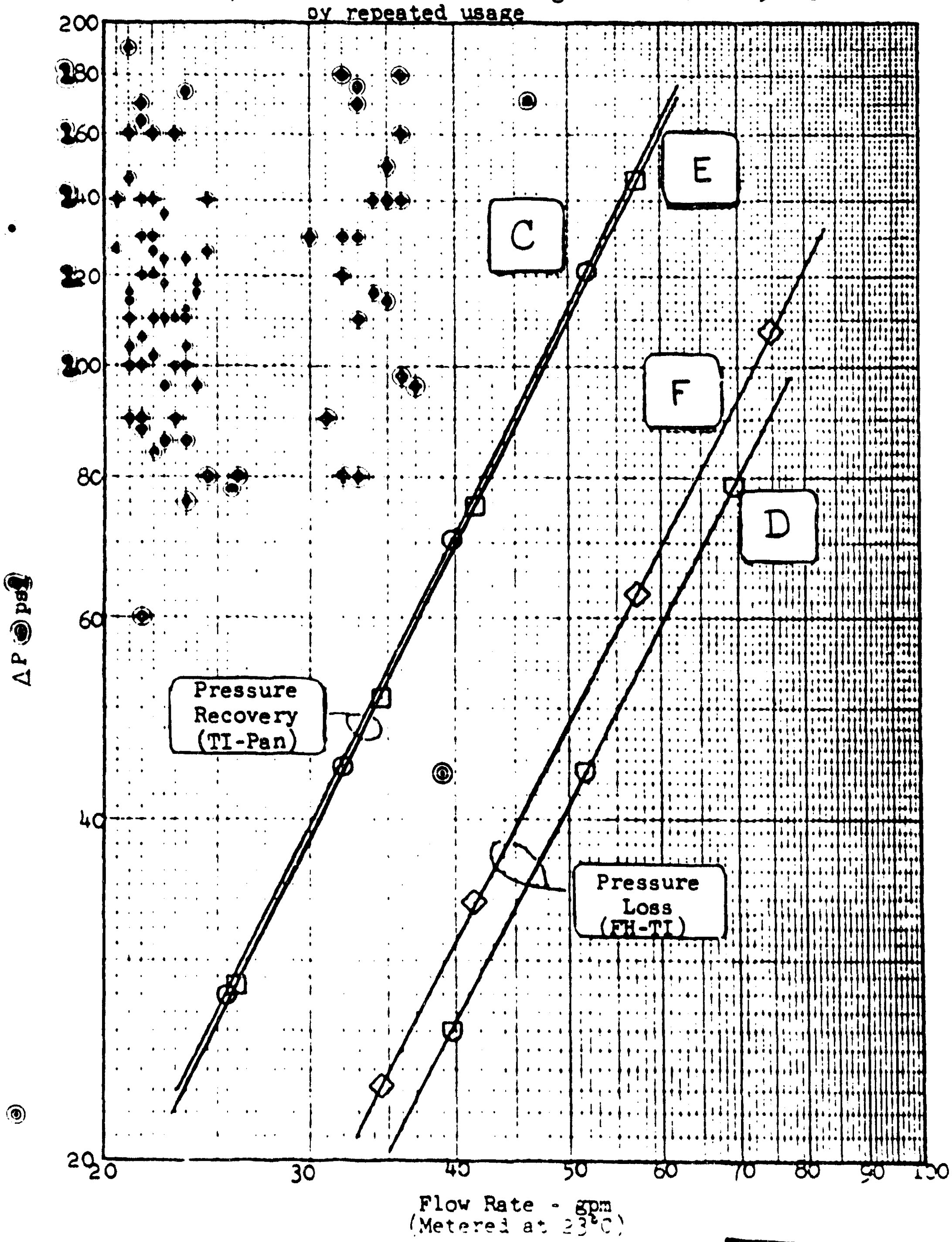

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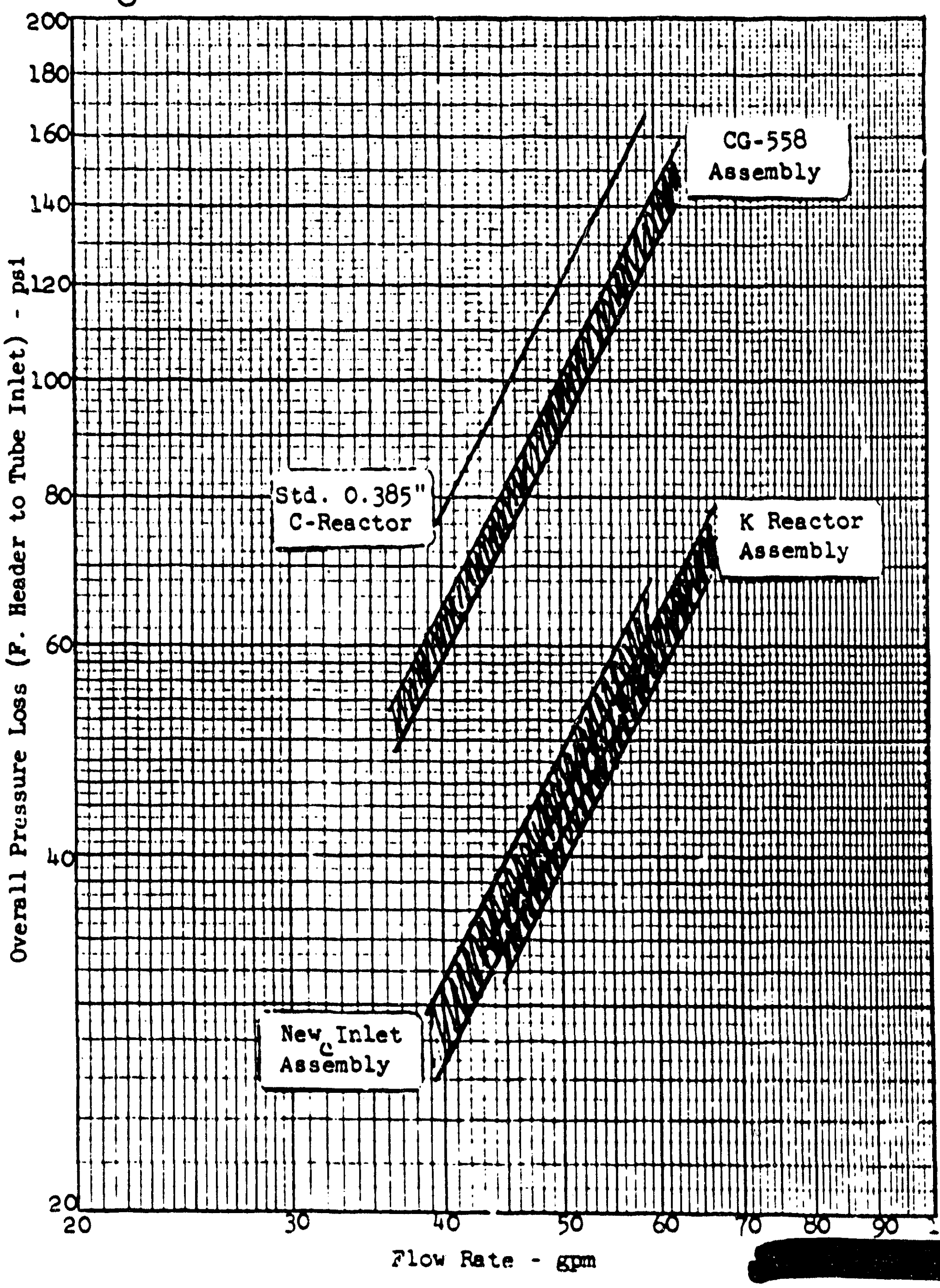
Figure 3

Comparison of Overall Pressure Losses
For Venturi Zone Inlet Nozzle Assemblies



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