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TITLE

RESULTS OF TESTS INVESTIGATING PANELLIT PROTECTION TO A "O" PROCESS TUBE WITHOUT A REAR PIGTAIL

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RESULTS OF TESTS INVESTIGATING PANELLIT PROTECTION TO A "O" PROCESS TUBE WITHOUT A REAR PIGTAIL

G. M. Hesson and D. E. Fitzsimmons

PURPOSE

The purpose of this report is to present the results of a brief experimental program made to determine the adequacy of the Panellit protection procedures to guard against flow reductions to an "O" geometry tube which is being operated with a missing rear pigtail.

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INTRODUCTION

On occasion a rear pigtail of a reactor fails and is blown free from its connectors. The coolant water then discharges into the rear face area. This in itself is not a particularly hazardous condition and need not necessarily require a reactor shutdown. It would be desirable, then, to continue operating the reactor in this condition until a shutdown is convenient.

A question which does arise, however, is whether the Panellit protection procedures are adequate to guard against the hazards of an accidental flow reduction to a tube operating in this manner. The result of a loss of a rear pigtail is an increase in coolant flow rate and, consequently, a reduced Panellit pressure. Furthermore, with the rear pigtail missing, the coolant flow no longer discharges through the Parker fitting on the rear header. Critical flow through this Parker fitting strongly influences the course of events following an accidental flow reduction to a normal "O" geometry tube.

While it was strongly believed that the concepts developed^(1,2) and the Panellit procedures devised⁽³⁾ for a normal "O" geometry tube would apply to the case of a tube with a missing rear pigtail, evidence could only be obtained by transient experimentation. This document presents the results of a brief experimental program which supplies this evidence.

SUMMARY AND CONCLUSIONS

Plugs upstream of the Panellit tap, both sudden and gradual, were simulated to an electrically heated mockup of an "O" geometry process tube operating with a missing rear pigtail.

The results of the tests make evident that use of the present Panellit protection procedures provides adequate protection to the case in question. In particular, the pressurization due to steam formation and critical flow at the Parker fitting on the rear nozzle is so great that in event of a plug upstream of the Panellit tap, a safe high Panellit trip would occur should the low Panellit trip be missed.

EXPERIMENTAL APPARATUS AND PROCEDURES

The experimental apparatus and procedures used were, with a few exceptions, identical to those used in the normal geometry case^(1,2). The discharge of the tube was from the Parker fitting on the rear nozzle into a three-inch pipe. The pressure in the pipe was maintained at values low enough that critical flow conditions existed in the Parker fitting. The sudden plugs were simulated by use of an air operated valve which directed the flow through either of two parallel flow channels, one of which provided normal flow and the other a reduced flow.

DISCUSSION

The loss of a rear pigtail results in the discharge of the coolant water to atmospheric pressure through a reduced resistance to flow. This causes an increase in the coolant

- (1) HW-52424 A "Results of Experimental Tests Simulating Sudden Plugging of a BDF Process Tube", J.M. Batch, G.M. Hesson, W.L. Thorne, 9/23/57.
- (2) HW-52424 B "Results of Experimental Tests Simulating Slow Plugging of a BDF Process Tube:", G.M. Hesson, W.L. Thorne, 10/14/57.
- ✓ (3) HW-51659 "Specification A-020 Process Tube Instability Limits", K.W. Hess, 7/22/57.

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flow rate, and consequently a lower Panellit pressure. The lower Panellit pressure increases the sensitivity of the high Panellit trip but decreases the sensitivity of a low Panellit trip. The question of protection against a plug downstream of the Panellit tap is readily answered. With its increased high Panellit trip sensitivity, a tube operating with a missing rear pigtail has greater protection against plugs downstream of the Panellit tap than does normal tube.

The converse is true with regard to a low Panellit trip in the event of a plug upstream of the Panellit tap. However, in the case of a normal tube critical flow through the Parker fitting on the rear header resulted in a large pressurization of the tube. This large pressurization carried the Panellit pressure to a high trip for all cases except very large flow reductions. As a result, for any case for which a low Panellit trip was not secured a high Panellit trip was; and, in fact, for most cases the Panellit pressure passed through both trip pressures giving double protection. If the same pressurization occurs as a result of critical flow through the Parker fitting on the rear nozzle barrel of a tube with a missing rear pigtail as occurs through the Parker fitting on the rear header of a normal tube, concern about the lower sensitivity to a Panellit low trip would disappear.

The experimental results are presented in Table I. The results show a very large increase in Panellit pressure once critical flow starts in the rear nozzle barrel Parker fitting following a plug upstream of the Panellit tap. The pressurization is so large that a Panellit high trip would have been secured for plugging incidents upstream of the Panellit tap as severe as that resulting in a 95 per cent flow reduction to a tube operating at approximately 1000 KW and 125°C outlet water temperature.

It may be concluded, then, that a process tube operating with a missing rear pigtail has adequate Panellit protection against plugging incidents under the present Panellit protection procedures.

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TABLE I
EXPERIMENTAL RESULTS

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Run No.	Tube Power KW	Initial Conditions			Flow After Plug Gpm	Panellit Pressure, Psig				Time of Scram ^(a) Sec	Max. Rod Surface Temp °C
		Flow Gpm	Outlet Water Temp °C	Rod Surface Temp °C		Initial	Min.	Max.	3 Sec. Before Scram ^(a)		
1	980	36.2	125	212	20.0	182	105	500	485	28.5	330
2	985	36.3	125	200	20.0	180	110	500	500	31.0	330
3	990	36.3	127	208	9.7	183	95	410	330	7.0	315
4	985	36.3	128	200	3.0	180	50	250	250	7	450
5	985	36.3	127	215	~ 2.0	178	60	282	220	5.5	375
6	980	34.6	131	200	(b)	180	175	510	500	110	450
7	506	17.5	128	175	(b)	90	85	295	295	285	325
8(c)	504	17.5	128	174	8.3	86	40	260	250	211	225
9	504	17.7	128	166	2.0	86	30	225	225	212	272

Notes:

- (a) Time of scram for the cases of sudden plugs is the time from the insertion of the plug to the time of power reduction.

Time of scram for the cases of gradual plugs is the time from the start of self-induced flow reduction due to steam formation to the time of power reduction.

- (b) These runs were gradual plug runs. The flow was gradually reduced until self-induced flow reduction started.
- (c) This run reached a stable, boiling, non-burnout steady state condition.

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