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SUBJECT Final Report on Production

Test 105-8-P - Film Formation

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AUGUST 29, 1946

FINAL REPORT ON PRODUCTION TEST 105-8-P

FILM FORMATION

SPECIAL RE-REVIEW
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FINAL REPORT ON PRODUCTION TEST 105-8-P - FILM FORMATION

Introduction

Tests made prior to beginning operation of the 100 Areas showed that the cooling water had a tendency to deposit a film upon the slug and tube surfaces. This film would manifest itself as an increase in the pressure drop through the tubes and its most serious effect would be the resultant decrease in the slug to water heat transfer coefficient which would increase the slug surface temperature, causing greatly accelerated corrosion rates. A chemical treatment for the water was devised which would minimize this film formation, but it was evident that film might still form in important amounts.¹ Furthermore, no data on scale formation in tubes under the influence of high radiation levels were available.

It was thus proposed to study film formation as a production test to be conducted along the following lines in each 100 Area:

1. Monitor by means of sensitive instruments the pressure drop across eight selected tubes in the pile in order to detect any changes caused by film formation.
2. Monitor the Panellit Gauge readings of the pile tubes in order to determine changes caused by film formation in other sections of the pile.
3. Operate auxiliary tubes located in the Flow Laboratory of each area under as close conditions to those in the unit as possible in all respects except radiation. These tubes were intended to give additional data along two lines -
 - a. Actual measurement of the heat transfer coefficient of any film that might form and its correlation with the resulting increase in pressure drop.
 - b. The absence of radiation would facilitate visual and chemical examination of any film that might form.

Chemical and physical methods of removing this film had been devised and the data obtained from the above sources were to be used as the basis of recommendations for treatments to remove the film should it form. These data would also serve as a basis for recommendations to change the water treatment.

Summary

This program has, with some modifications, been carried out at the 100 Areas during all periods of operation with the following results:

1. As predicted, scale is continually formed in the cooling annuli during operation. The rate of deposition has varied over rather wide

1. CMX Final Report - 7-31-46 - 7-4444

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limits and is progressively higher in the zones of lower flow rates. The over-all average rates of increase of pressure drop in the eight selected tubes in the zone of highest flow rate have been 0.37, 0.30 and 0.35 lbs./sq.in.(day), respectively, at B, D and F Areas.

- 2 - Turbidity purging has proved to be a very satisfactory method of removing the film. This purging can be almost 100% effective in the zone of highest flow rate but is progressively less effective in the zones of lower flow rates. To date the chilled sections of the B, D and F Area units have been purged with turbidity 10, 12 and 12 times, respectively, that of B Area had one oxalic acid purge in addition.

Details

A considerable amount of work was done using an ultramicroscope to determine if this instrument would be useful in predicting film formation. Colloidal mobility measurements were found to roughly correlate with iron content of the water and film formation rate but it was concluded that use of an ultramicroscope for this purpose was impractical.²

Monitoring of Pressure Drops in Eight Selected Tubes

Eight tubes located near the center of the pile and in the zone of highest flow rate were selected in each area for monitoring. The observed pressure drops are corrected to standard conditions of flow rate and temperature by use of a formula³ and a nomograph based on this formula. This corrected figure for the increase in pressure drop is the most accurate measure of film formation in the pile process tubes. The pressure drop in these eight selected tubes was first measured every two hours that the piles were in operation. As more data were collected on these tubes, it became evident that the film formation rate was not so great but that the monitoring frequency could be reduced. This frequency was gradually reduced until at the present time the eight selected tubes are monitored once per week at D and F Areas. The low water flow rates used to cool the B Pile while it is shut down makes it impossible to monitor film formation by this pressure drop method. Film formation in this area is followed by examining slugs discharged from this pile for evidence of pressure drop film. Present indications are that negligible film is forming in this pile while it is shut down.

Monitoring of Panellit Pressures

Attempts to obtain measurements of scale formation from Panellit gauge readings were made in order to measure the relative rates of scale formation in the zones of different flow rates. The results were not completely satisfactory due to the inaccuracies of the Panellit gauges and inability to measure supply pressures downstream of the header screens in any header other than the one feeding the above-mentioned selected tubes. A system of tapping into additional selected supply headers and reading the Panellit pressures on more accurate gauges was therefore adopted. This system gives measurements of the increase in pressure drop in the zone of highest flow rate that compare favorably with those on the selected eight tubes, and

2. Film Formation Studies Using the Ultramicroscope - 7-18-46. Doc No. 7-4427
3. Derivation of a Formula for Correction of Observed Tube Pressure Drops to Standard Conditions - 12-18-44 - R. D. McCroskey to Hood Worthington.

show progressively higher rates of film formation in zones of lower flow rates. The frequency of monitoring these Panellit pressures under the new system was originally twice per week in each area. This has been reduced to a frequency of once per week per area.

Operation of Auxiliary Tubes in the Flow Laboratories.

Operation of the Flow Laboratory tubes in a manner that would give data comparable to that obtained from the pile tubes proved impossible. Changes in the design of some of the equipment were considered. However, since pressure drop monitoring proved to be a satisfactory method of measuring film formation in the pile tubes and turbidity purging proved to be a satisfactory method of removing this film, it was considered unnecessary to further operate these auxiliary tubes. A calculated correlation between heat transfer coefficient and pressure drop change was used in the calculation of pressure drop increase limits instead of the measured one which was to be established in these tubes.⁴ Consequently, operation of these auxiliary tubes was discontinued but the tubes at D Area are being held in an operable condition in case they be needed for future studies.

Film Removal

Tests made on the purging of individual tubes showed that purging with 100 ppm Super-Cel proved to be the best method of film removal under plant conditions.⁵ Some difficulty was experienced with plugging of the supply header screens during some solids purges but this plugging was found to be due mainly to the presence of foreign matter on the screens. Means of minimizing this foreign matter were installed and the 50-mesh header screens were replaced with 30-mesh screening. Since these changes, no difficulty has been experienced with header screen plugging.

Water Treatment

As a result of the low rate of film formation and the effectiveness of the solids purge in removing this film, no changes in treatment of the cooling water to the piles has been necessary.

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4. Pressure Drop Limits - Pile Building - 7-7-45 - 7-1964, 7-1965.

5. Determination of Efficacy of Cleaning Methods - 2-6-45 - 3-1966.

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