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SUBJECT: Investigation of Effect of Seal Configuration on Mixing Flow and
Radiation Damage in HRT-Type Circulating Pumps - Supplement No. 1

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SUMMARY

The investigation of the effect of seal configuration on the rate of mixing flow between the impeller cavity and the motor cavity of a Westinghouse Model 400A pump was extended to include a configuration wherein the lower radial bearing acts as a secondary seal. A hot run with 0.04 M UO_2SO_4 solution at 250°C was also made to check the effects of the reduced cooling of the lower bearing in this configuration.

Mixing flow rates of less than 0.01 liter per hour were obtained with purge rates of 3.6 liters per hour and higher. These rates are somewhat lower than those obtained with previously tested configurations¹. However, the hot run indicated that bearing life would be greatly shortened due to higher operating temperatures.

INTRODUCTION

In the investigation by Rundell, et al, various configurations of the seal isolating the motor cavity from the hot impeller cavity of a Westinghouse Model 400A pump were tested to determine the mixing flow rates across the seal for various purge flows. None of the configurations tested materially changed the basic coolant flow path through the pump. This basic flow path consists of flow from the upper radial bearing region downward through the air gap, through and around the lower radial and thrust bearings, across the back of the thermal barrier and upward through the cooling coil to the upper bearing region. In addition, a small portion of the flow is picked up below the lower radial bearing and returned to the upper bearing region through the hollow rotor shaft. This small flow through the rotor shaft was blocked in some of Rundell's tests.

Two slurry pumps operated by the System Development Section which have motors identical to the Westinghouse Model 400A have a different coolant flow path through the motors. Their flow path consists of flow from the upper radial bearing region downward through the air gap, through and around the thrust bearing and upward through the cooling coil to the upper bearing region. Only the purge passes through the lower radial bearing. There is no flow upward through the rotor shaft. In this configuration, the lower radial bearing acts as a secondary seal. The space behind the thermal barrier provides a tranquil volume where any slurry flowing upward through the primary shaft seal may settle out.

It was felt that, for the investigation to be complete, tests should be made to determine the mixing flow rates in a pump with this alternate coolant path. A hot run was felt necessary to determine whether the reduced cooling provided for the lower bearing would be detrimental.

PROCEDURE

The Westinghouse Model 400A pump with modified hydraulic parts as employed by Rundell was used in the tests. The entry into the cooling coil from the region behind the thermal barrier was blocked. An entry was provided into the cooling coil from the region above the lower radial bearing. The ports in the lower end of the rotor shaft were blocked.

The testing and data analysis procedures for the mixing rate tests were identical to those developed by Rundell.

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Due to the lack of a high pressure purge supply system, no purge was introduced during the hot run.

RESULTS

Mixing test runs were made with purge flows of 0, 3.6 and 7.3 liters per hour. Larger purge flows could not be obtained due to the additional pressure drop through the lower radial bearing.

The calculated mixing flows for the various purge rates are as follow:

<u>Purge Rate, l/hr</u>	<u>Mixing Flow, l/hr</u>
0	.333
3.6	.003 < Flow < .01
7.3	.001

The hot run was terminated after 1033 hours of operation and the pump dismantled for inspection. The lower portion of the shaft and the back of the thermal barrier showed indications of abnormally high temperatures. The lower radial bearing Graphitar insert and Stellite journal (Figure 1) were burned and cracked. The end play had increased 0.027 inch during the run. This increase in end play was found to be mainly due to wear of the Stellite pins in the equalizer system of the thrust bearing. It is probable that this wear was a type of fretting corrosion which was accelerated by the high bearing temperature.

CONCLUSIONS

The mixing flow rates and resulting concentrations of radioactive material in the motor cavity of the pump are somewhat lower than the lowest values reported by Rundell. This would increase the life of the motor winding insulation to some extent.

However, it appears that the life of the lower radial and thrust bearings will be appreciably shortened due to the inadequate cooling provided in this configuration. This is substantiated by the repeated lower radial bearing failures experienced in the two slurry pumps operated by the System Development Section.

In view of these considerations, this method of reducing the mixing flow into the motor cavity is not recommended.

REFERENCES

1. H. A. Rundell, et al., "Investigation of Effect of Seal Configuration on Mixing Flow and Radiation Damage in HRT-Type Circulating Pumps," ORNL-CF-57-10-48.

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FIGURE 1 - Lower Journal Showing Burned and Cracked Area