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Study for the Analysis of the Performance of the Wolsong-1 PHT Upgrader

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1. Introduction

In the Wolsong Nuclear Power Plants, heavy water is used as moderator and coolant. Heavy water is costly, so that downgraded heavy water released from the plant system is recovered and upgraded to 99.9% by the heavy water upgrader. The Sulzer CY packings for the enhancement of the mass transfer were installed in the heavy water upgrader. However recent visual observation on the packing at the feedstage has been reporting that some spots owing to corrosion of the packing are visible especially in PHT (Primary Heat Transport Upgrader) Upgrader.

In this paper, the effect of the observed corrosion on the performance of the PHT Upgrader was studied through the comparison between an operational test and WS-UPGRADER simulation.

2. Operational Test and Analysis

2.1 Operational Test

The operational test was performed for 4 days in order to obtain the data for the analysis of the Wolsong-1 PHT-UPP performance. It is important that the columns are running at steady state conditions. So the PHT-UPP was operated according to the following steps:

- Day 1: Empty the head product tank and gather all operating data (temperatures, flow rates, pressures, etc.) for the two columns.
- Day 2: Gather operating data for the two columns.
- Day 3: Gather operating data for the two columns. Collect vapor condensates from sampling nozzles and analyze deuterium isotopic.
- Day 4: Gather operating data for the two columns.

Table 1. The operating data of the PHT Upgrader.

Parameter	Value	Unit
Operating Hour	84.00	hour
Feed Concentration	23.5	wt.%
Feed Section No.	11	-
Feed Tank Level (initial)	2,124	mm
Feed Tank Level (final)	552	mm
Distillate Concentration	0.04	wt.%
Bottom Concentration	99.99	wt.%
Boilup Rate	43	kmol/hr

Table 1 shows the operating conditions and the concentration of heavy water in the main streams.

2.2 Analysis

Figure 1 shows a simplified process flow diagram of the PHT Upgrader. For the sake of simplicity, only four streams are considered: (1) feed stream from EV12 to Col-12; (2) distillate from the top of Col-12 to TK13; (3) internal reflux from CD12 to the top of Col-12; (4) bottom stream from the Col-11. The heat and mass balances based on the four streams in figure 1 were used for the correction of the feed flow rates, heavy water concentrations and the reboiler duty. The correction data were used for the simulation, and the performance of the PHT Upgrader was analyzed by comparing the results of the operational test against the concentration and pressure profile obtained by the simulation.

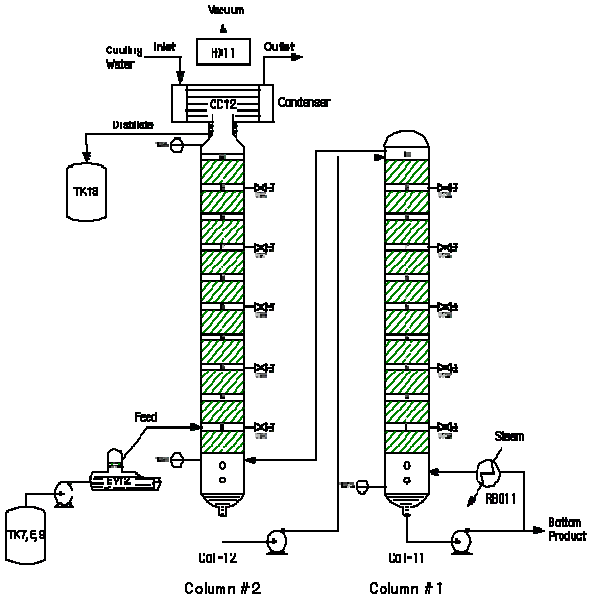

Figure 1. Process flow diagram of the PHT Upgrader.

3. Results and Discussion

The current performance of the PHT Upgrader was compared with the expected performance satisfying the design requirement. In order to obtain the expected performance, the simulation was performed with WS-UPGRADER, which was developed by KEPRI in 1999.

Figure 2 and 3 show the concentration profile and the pressure profile, respectively. If any corrosion had

deeply damaged the packing, then the large deviation of the concentration profile could be expected and more sections for upgrading the heavy water would be required.

In figure 2, the PHT Upgrader has margin of 2 sections in the bottom and 1 section in the top. The column efficiency of the PHT Upgrader is around 118%.

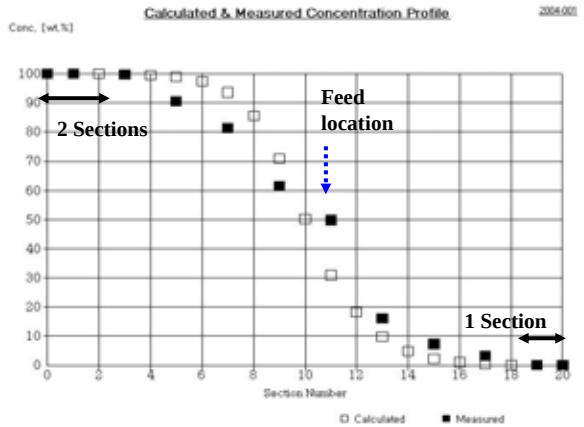

Figure 2. Concentration profile of the PHT Upgrader.

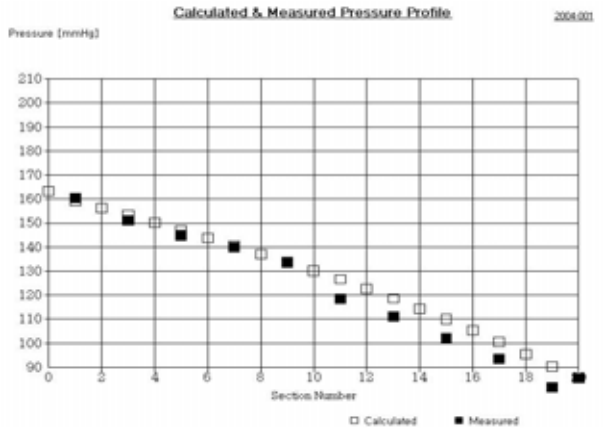

Figure 3. Pressure profile of the PHT Upgrader.

If any packing was damaged mechanically, some pressure drop would be occurred in the section with the damaged packing. In figure 3, however, it is shown that any unusual pressure drop can not be found in any section. The only small and uniform loss of pressure drop is shown in figure 3. This result means that the packing is most likely to be in a good mechanical shape and has good performance still.

4. Conclusion

The operating data for 4 days were collected to examine the performance of the PHT Upgrader. Based on these data, the concentration and pressure profiles of the Wolsong-1 PHT Upgrader at the same operating condition were simulated. The simulation results show that the column efficiency of the PHT Upgrader is approximately 118%. The corrosion of the copper packing does not impact currently on the performance of the column and the packing is most likely to be in a good mechanical shape.

REFERENCES

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