Development of Heat Exchanger Thermal Performance Monitoring Program

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1. Introduction

Through researches for the last three years, as a part of KNICS R&D program, we were able to identify current status and problems of thermal performance test, analysis, and diagnosis being performed in nuclear power plants, Korea. In the old nuclear power plants, performance analysis procedures of not only turbine cycle but safety-related heat exchanger in the primary system were being required. In particular, in the case of the Gori units 3,4 where periodic safety assessment(PSR) was performed recently, safety-related heat exchanger management program was required as follow-up measures of PSR. Performance analysis of safety-related heat exchangers is used to evaluate reliability of heat exchangers during long-term operation. The significance of this analysis lies in the fact that it can evaluate safety and viability at the same time. However, there exists discrepancy between conditions of normal operation and design, which makes it difficult to develop performance analysis procedure.

This study focused on development of performance analysis procedure of safety-related heat exchangers in primary system.

2. Scope and Contents of Project

○ Selection of target heat exchangers and collection of information from nuclear power plants
Identifying safety-related heat exchangers in Gori units 3,4, and reviewing design of target heat exchangers and detector implementation.
○ Development of heat exchanger analysis methodology
Identifying operation characteristics of safety-related heat exchangers of nuclear power plants, and developing detailed analysis methodology
○ Development of computer programs for heat exchanger analysis methodology

3. Development Strategy

3.1 Heat Exchanger Decision

We analyzed safety-related heat exchanger in the case of Gori units 3,4, and considered design parameter about heat exchanger. There are 7 safety-related heat exchangers. They are regenerative, letdown, spent-fuel storage, RCDT, reheated, moderating, letdown cooling heat exchanger. Among these heat exchangers, letdown heat exchanger has most enough data, we made procedure and computational program about this.

3.2 Analysis Method

a) Performance Analysis

Input data are inserted into computational algorithm and performance analysis is calculated. Heat calculation uses inlet/outlet conditions of heat exchanger, there are some parts which need to calculate steam table. This part was calculated by manually in the old program.

b) Correction calculation

Like other performance analysis procedure of nuclear power plants, In Gori units 3,4 after analysis, we perform correction calculation for the meaningful comparison with design parameter.

3.3 Performance Warning Module

By upper parameter, we can analyze the performance of heat exchanger. While monitoring fouling resistance every time gap, we could imagine the reduction of overall heat transfer coefficient. If the U is reduced to certain limit, we need to alarm to the system operator. But the fouling resistance we get by every estimation is experimental data, so we can not say the system is below the limit, even though one point shows below the limit. Then, how can we get the meaningful mean of the performance of heat exchanger?

For the solution, we decided to use statistical methods. Assuming that the data follows normal distribution, and we don't know system mean, we can use CUSUM (Cumulative-SUM control chart) or SPRT(Sequential Probability Ratio Test). We decided to use both of them to predict exact mean of the system. And we made an application that performs a prediction of system mean by using both methods.

4. Development of Monitoring Program

As discussed in methodology, we developed program. From the input data, we collected into one excel sheet, and made database. Following figure shows this.

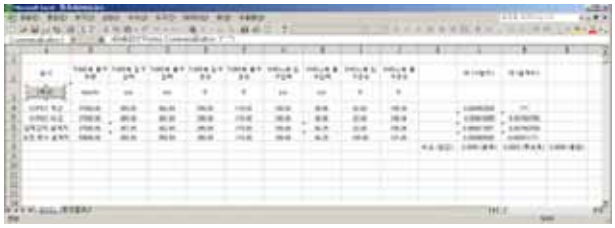

Fig 1. input database

5. Conclusion

Fouling causes significant effect of performance of the heat exchanger. By the accurate monitoring of fouling resistance, we can expect more economic and safety results. In this research, we designed a method which can estimate and predict performance of heat exchanger statistically by using CUSUM and SPRT.

REFERENCES

[1] Los Gatos, California, “Heat Exchanger Performance Monitoring Guidelines” EPRI NP-7552, Project 3052-1