The Water Quality Control of the Secondary Cooling Water under a Normal Operation of 30 MWth in HANARO

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1. Introduction

HANARO[1], a multi-purpose research reactor, a 30 MWth open-tank-in-pool type, has been under a full power operation since 2005. The heat generated by the core of HANARO is transferred to the primary cooling water. And the cooling water transfers the heat to the secondary cooling water through the primary cooling heat exchanger. The heat absorbed by the secondary cooling water is removed through a cooling tower.

The quality of the secondary cooling water is deteriorated by a temperature variation of the cooling water and a foreign material flowing over the cooling water through the cooling tower fan for a cooling. From these, a corrosion reduces the life time of a system, a scale degrades the heat transfer effect and a sludge and slime induces a local corrosion.

For reducing these impacts, the quality of the secondary cooling water is treated by a high ca-hardness water quality program by maintaining a super saturated condition of ions, 12 of a ca-hardness concentration[2],[3].

After an overhaul maintenance of a secondary cooling tower composed of a secondary cooling system in 2007, a secondary cooling water stored in the cooling tower basin was replaced with a fresh city water. In this year, a water quality deterioration test has been performed under a full power operation and a mode of a twenty three day operation and twelve day maintenance for setting a beginning control limit of the secondary cooling water.

This paper describes the water quality deterioration test for the secondary cooling system under a full power operation of 30 MWth including a test method, a test requirement and a test result.

2. Test method

Fig. 1 shows the schematic diagram of the water quality monitoring equipment[4]. The sampling water for the water quality test flows into the inlet valve and it flows out of the fouling meter through the bio-fouling meter, the corrosion meter and the flow transmitter. A scale is expressed as fouling factor, because the scale is made from a fouling effect.

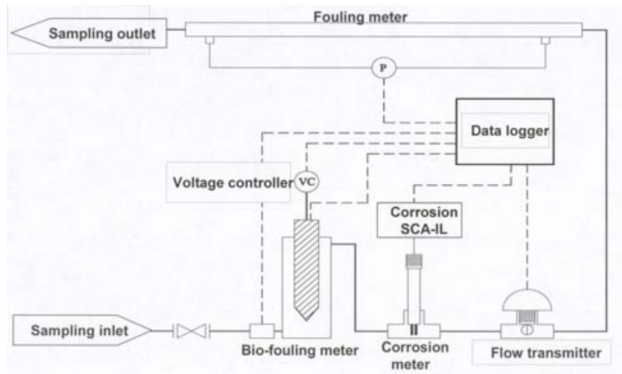

Figure 1 Schematic diagram of water quality monitoring equipment

In a clean heat transfer tube, a supplied heat is in proportion to the temperature difference, but in a scaled dirty heat transfer tube the temperature difference is low. Therefore, it is possible to estimate the fouling factor after measuring the temperatures of the clean condition and the scaled dirty condition respectively[4].

The corrosion is expressed as corrosion rate measured by a linear polarized resistance, because it expresses the corrosion rate by a ratio of the ampere and the voltage when a polar voltage (about 10 mV below)is energized to an anode and a cathode. Therefore it is possible to estimate the corrosion rate after measuring the ampere and the voltage[4].

Slime and sludge are expressed as bio-fouling factor. When cooling water flows in a pipe, a microbe is deposited to the wall of the pipe and it makes a film by reducing the section area of the pipe. The film induces a corrosion deposit and a pressure drop. This effect is expressed as a bio-fouling. Therefore it is possible to estimate the bio-fouling factor after measuring the flow rate and the pressure difference[4]

3. Test Results and Discussion

The test conditions are as follows,

-. The sampling water temperature is 60 ℃ and below
-. The flow rate is 300 liter/h and below

Table 1 Results of deterioration test of secondary cooling water

Description	Corrosion rate	Fouling factor	Bio-fouling factor
Unit	MDD	kcal/m^2-h-°C	-
Control limit	< 2E+01	< 5.00E-04	< 1.0E-02
MIN	7.0E-02	4.8E-06	5.4E-03
MAX	1.3E-01	9.7E-05	6.5E-03
AVG	9.8E-02	4.7E-05	5.8E-03
AVG in 2005	2.18	3.50E-05	7.50E-03

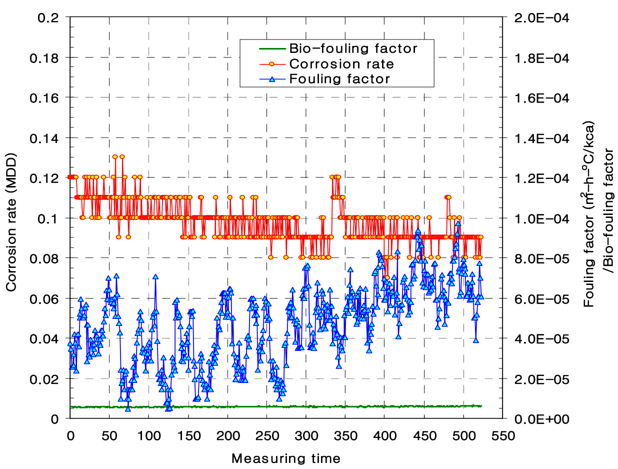

Figure 2 Test results for corrosion rate, fouling factor and bio-fouling

-. The test pressure is 5 kgf/cm^2 and below
-. The supply power is 220V AC and 60Hz

Table 1 shows each value of this test results when compared with those of the test results under a full power operation in 2005[5]. Fig. 2 shows the test results of the corrosion rate, the fouling factor and the bio-fouling factor.

The maximum and minimum corrosion rates are 7.0E-02 mdd and 1.3E-01 mdd respectively. And the average is 9.8E-02 mdd equal to about 0.5 % of the control limit of 20 mdd[6]. Therefore, it is confirmed through the test results that the secondary cooling water maintained a corrosion inhibition.

The figure indicates the minimum and the maximum of the fouling factor to be 4.8E-06 m^2h^oC/kcal and 9.7E-05 m^2h^oC/kcal respectively. And the average is about 4.7E-05 m^2h^oC/kcal equal to about 9.4% of the control limit of 5.0E-04 m^2h^oC/kcal[6]. It is very difficult for a ca-hardness water quality program to maintain a scaling inhibition together with a corrosion inhibition, because a potassium carbonate scaled film is inhibited by the corrosion, but this film is a scale.

The figure shows that the minimum and the maximum bio-fouling factor are 5.3E-03 and 6.5E-03 respectively. And the average is about 5.8E-03 equal to about 58% of the control limit of $1x10^{-2}$ [6].

After a fresh water is replaced in the cooling tower basin, it is confirmed through the test results that the secondary cooling water quality control program is not adversely affected under a full power operation of 30 MWth

4. Conclusions

After a fresh water is replaced in the cooling tower basin, it is confirmed through this test results that the valves are maintained below the control limits and that the high ca-hardness treatment program of the secondary cooling water quality control program is not adversely affected under a full power operation of 30 MWth. And through this test we got a beginning water quality condition to compare with a water quality deterioration control.

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