Review of Control Methods of Full System Decontamination Operation Temperature and Decontamination Facility Inlet Temperature

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1. Introduction

System decontamination applied after nuclear power plants are permanently ceased is the technology to remove contaminated metal oxide films, or metal oxide deposits from the interior surfaces of systems or equipment using the NPP facility and decontamination facility. Since full system decontamination operation is very different from normal operation of the NPP, various operating conditions required in the operation of the actual plant can be excluded. As shown in Fig. 1, the full system decontamination of Kori-1 NPP, which was the first permanently ceased in Korea, is planned to be carried out for Reactor Pressure Vessels (RPV), Pressurizer (PZR), Steam Generators (SG), Chemical & Volume Control System (CVCS), Residual Heat Removal System (RHRS), and Reactor Coolant System (RCS) piping and system decontamination facility is planned to be connected to the RHRS.

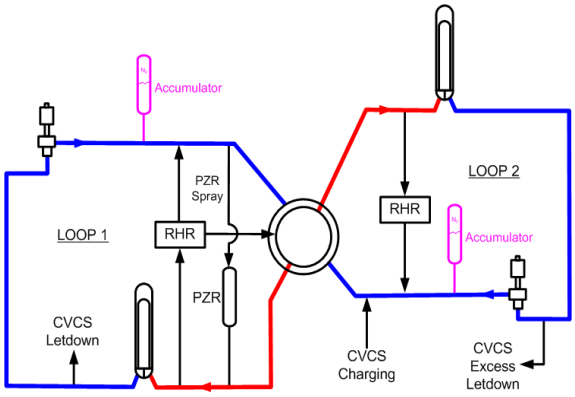

Fig.1. Schematic Diagram of WH-2 Loop PWR Reactor Coolant System.

The system decontamination operating conditions required to effectively decontaminate these systems and equipment are as follows.

- Facilities of Kori-1 NPP are operable
- Connected System decontamination facility to RHRS
- The range of system decontamination include RPV, PZR, SG, CVCS, RHRS and RCS piping
- Conditions of system decontamination operation temperature and pressure
  - Temp./Pressure in RCS : 95℃ / 25 bar
  - Inlet temperature of system decontamination facility : 40℃

This paper dealt with control method of full system decontamination operation temperature and decontamination facility inlet temperature.

2. Control Method of System Decontamination Operation Temperature

In the case of maintaining the system decontamination operating temperature at 95℃, it is possible to operate at atmospheric pressure because the operating temperature is much lower than that of normal operation of NPP. The temperature increase for the system decontamination operation can be achieved by using PZR heater and RHR heat exchanger. However, if the PZR spray flow rate is low, it may take a long time to control the temperature, and the required time can be calculate using Equation (1).

$$T(rcs) = Tin + \frac{Trcs0 - Tin}{\exp(\frac{Min}{Mrcs})} \quad (1)$$

where, Tin : RCS temperature
Trcs0 : RCS initial temperature, 20 ℃
Min : RCS flow rate, gpm
Mrcs : RCS volume

Fig. 2 shows the RCS temperature increase characteristics with the flow rate of auxiliary spray.

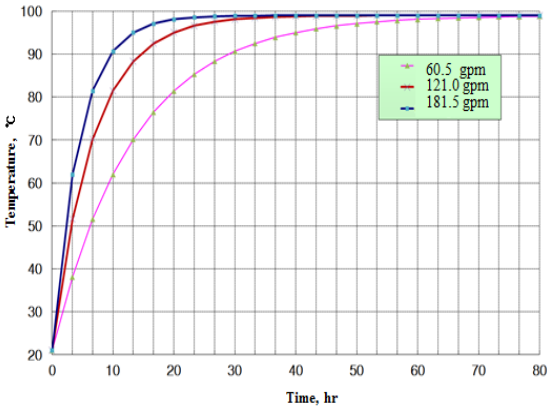

Fig. 2. RCS Temperature Increase Characteristics with Auxiliary Spray Flow Rate.

The RCS temperature characteristics are evaluated based on the PZR temperature is 99℃ and RCS temperature is 20℃. As shown in Fig. 2, it was estimated that it would take about 40 hours up to the system decontamination operation temperature, 95℃ for one charging pump operating, 20 hours for the two charging pumps, and 17 hours for the three

charging pumps. It takes a long time to increase RCS temperature to the system decontamination operation temperature but if the system decontamination operation temperature reaches, it is possible to control the system decontamination operation temperature using the PZR heater.

3. Control Method of System Decontamination Facility Inlet Temperature

The system decontamination facility consists of chemical injection system and chemical waste decomposition & treatment system to remove oxide film in the system decontamination range and to decompose the chemical waste. The temperature condition of the chemical waste flowing into the system decontamination facility after completion of the oxidation-reduction process in the RCS should be provided below 40℃ considering the operation efficiency of the UVC lamp in the chemical waste decomposition & treatment system. Fig. 3 shows the efficiency of organic acid decomposition with UVC operating temperature and Fig.4 shows the location where system decontamination facility is connected to the RHRS.

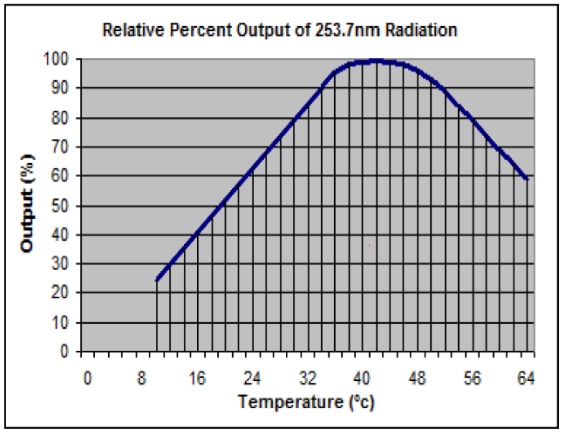

Fig. 3. Efficiency of Organic Acid Decomposition with UVC Temperature.

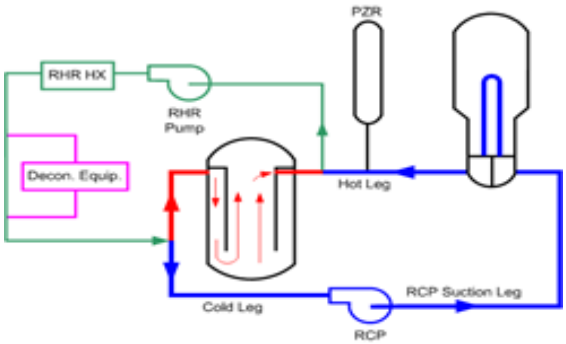

Fig. 4. Connection Location of System Decontamination Facility.

The actual operation of the RHR heat exchanger to maintain the system decontamination operation temperature, 95℃, can be expected as shown in Table 1.

Table 1. Temperature in RHR Heat Exchanger

Items	Shell side(CC)	Tube side(RHR)
Flow Rate	600 ㎥/hr	468 ㎥/hr
Inlet Temp.	26.8℃	95.0℃
Outlet Temp.	50.6℃	64.5℃

The data in Table 1 are obtained when the RHR heat exchanger is operating for cooling the RCS. It is possible to keep the inlet temperature of the system decontamination facility below 40℃ according to the current plant operation procedure. The flow rate to keep the RHR hear exchanger outlet temperature below 40℃ is about 260 ㎥/hr and since this flow rate is about 10 times larger than the treatment capacity of the system decontamination facility, it is expected that the temperature control can be achieved by adjusting the RHR flow rate and component cooling water flow rate.

4. Conclusions

This paper dealt with control method of full system decontamination operation temperature and decontamination facility inlet temperature to effectively decontaminate the full system decontamination range. As a result, it was confirmed that the temperature increase for the system decontamination operation can be achieved by using PZR heater and RHR heat exchanger and system decontamination inlet temperature can be achieved by adjusting the RHR flow rate and component cooling water flow rate.

ACKNOWLEDGMENT

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