Decontamination of Primary Heat Exchanger Heat Transfer Plate in HANARO

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1. Introduction

In HANARO[(1)], a multi-purpose research reactor, a 30 MWth open-tank-in-pool type, a plate type primary heat exchanger transfers the reactor core residual heat absorbed by a primary coolant to a secondary coolant. There was a leakage in the gasket of the no. one (1) heat exchanger after about five years of normal operation. The leaking heat transfer plate pack was replaced with a new one and decontaminated.

This paper describes the method of decontaminating the radioactivity of the no. 1 heat exchanger used plate pack and the results. A chemical treatment method was applied to the decontamination. This treatment method consists of cleaning the used plate with a hydro jet after properly depositing it in a scale agent.

2. Methods and results

2.1 Contaminated radioactivity

Two-50% capacity plate type heat exchangers are installed in parallel in the primary cooling system of HANARO. The heat transfer plates of the heat exchanger are inserted between a frame plate and a sliding plate tightened by tie bolts. A gasket is inserted in each plate to protect against leak and to allow a flow between the cold side and the hot side of the heat exchanger.

In February of 1995, as HANARO reached critical condition, the heat exchanger functioned normally. After about five years, in November of 1999, there was a leak in the gasket inserted in each plate of the heat exchanger no. 1. It is predicted that the leakage occurred from a flooding flow shock performed at pump start.

The manufacturer recommended that a valve be added upstream of the heat exchanger to adjust the inlet flow rate because the bolt tightening plate gasket is weak for a flooding flow shock. The used plate pack was replaced with a spare new plate pack and decontaminated for the gasket recondition. After a nuclide analysis for surface radioactivity of the used plate, the major nuclides were the same ones to be found in the primary coolant of HANARO

2.2. Decontamination requirements

For maintaining the structural integrity of the heat transfer plate, the thickness of the plate shall not get thinner than 0.5 mm after decontamination. For carrying out the used plate in order to recondition the gasket, the carrying out control limit shall not be higher than a tenth of the surface allowable contamination level of 400 Bq/m^2 for alpha nuclide and 4000 Bq/m^2 for beta nuclide[(2)]. As the secondary coolant is blown off, vaporized or released to the atmosphere, a nuclide shall not be detected in the cold side of the plate to protect from radioactivity contamination of the surroundings. And a chelate shall not be included in the liquid radioactive waste because it is unacceptable to treat chelate as liquid radioactive waste.

2.3 Decontamination

In October of 2001, for the first time, the used plates were decontaminated by a decontamination agent. At first,

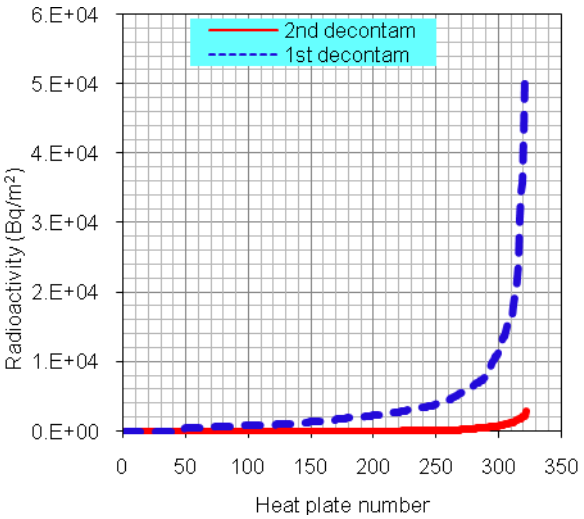

Fig. 1 Results of decontamination of the used heat transfer plate of primary heat exchanger no. 1

we sprayed the decontamination agent on the used plate and scrubbed it with only decontamination paper not using water to prevent radioactivity contamination of the surroundings. But the result was not satisfactory regarding the control limit as shown in Fig.1[3].

Secondary, in July of 2008, a chemical treatment was applied to the decontamination of the used plate. This treatment method consisted of cleaning the used plate with a hydro jet after properly depositing it in a scale agent. A temporary pump has been added to circulate the agent for filtering the scale and to reduce the liquid radioactive waste.

It was confirmed through the in-line removing scale on the cold side of the plate type primary heat exchanger that the agent of RII, is excellent to remove an organized scale[4]. But a chelate was included in the agent for an emulsifier.

A new scale removing agent, S-150[5] was produced excluding chelate from the agent of RII. According to the reference code[6], a Ca content variation test and a chelate transmittance test applied to confirming whether a chelate composition is maintained in the agent or not. It was confirmed through the verification test results[7] that a chelate or chelate composition was not detected in the agent [7].

When a corrosion effect test of the agent was performed, test pieces were soaked in 10%, 20% and 30% concentration agents for 24 hours, 48 hours and 72 hours respectively. And test end weight of each test piece was compared with the initial weight. It was confirmed through the tests that the 10% concentration of the agent was acceptable, but the soaking time was not affected.

To verify scale removable test, the used plates were soaked in 10% concentration of the agent for 24 hours, 48 hours and 72 hours. And the scale or deposits were washed out by a hydro jet. It was confirmed through the scale removable test that the soaking time was not affected, but about 30 minutes of wash-out time was acceptable for removing scale.

The decontamination was conducted in the Co-60 storage pool in HANARO to correct radioactive liquid waste. The decontamination process consists of a 24 hour soaking time, a hydro jet wash-out, a rinsing, a drying and a smear test. During the hydro jet wash-out, as we used the top water of the Co-60 storage pool that a scale or a foreign material is deposited by weight, it is available to reduce the amount of radioactive liquid waste.

After the decontamination, as shown in Fig.1, all the hot sides of the used plates were cleaned below the control limit. A radioactivty was not detected in the cold side of the plates. The clean plates were wrapped to protect from recontamination.

3. Conclusions

When we conducted decontamination by using the developed scale removing agent, we came to the following conclusions.

1. When we performed Ca content variation test and chelate transmittance test for scale removing agent, S-150, it was confirmed through the test results that the agent does not have a chelate.
2. When we performed a corrosion effect test of the agent, it is confirmed through the tests that a 10% concentration of the agent was acceptable, but the soaking time was not affected.
3. When we performed a scale removable test, it is confirmed through the test that the soaking time was not affected, but about 30 minutes of wash-out time is acceptable.
4. During a hydro jet wash-out of the decontamination process, as we used the top water of the Co-60 storage pool that a scale or a foreign material was deposited by weight, it was available to reduce the amount of liquid radioactive.
5. After the de-contamination, the all the hot sides of the used plates were cleaned below the control limit. And a radioactivity was not detected in the cold side of the plates.

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