Development Status of Full System Decontamination Technology by Reactor Types

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1. Introduction

KHNP prepared the technology development roadmap for PWR decommissioning as the design life of the NPPs operating in domestic reached [1, 2]. The main goal of this roadmap is to completely secure NPP decommissioning technology by 2022. However, after KHNP Board decided to permanently shut down Kori-1 NPP on June 16, 2015, the technology development roadmap was revised to secure commercial technologies for Kori-1 decommissioning. In the revised roadmap [3], 17 decommissioning technologies that have not yet been secured among the commercial technologies required for PWR decommissioning have been identified and one of these, the research for securing full system decontamination technology was completed at the end of September 2018. Through this study, the system decontamination process, CRI_RWDecom (Chemical Reagent Injection and RadWaste Decomposition& Treatment), and the basic design of commercial facility, CIDF (Chemical Injection and Decomposition& Treatment Facility), for the full system decontamination have been completed. The research for the detailed design and manufacturing of the system decontamination commercial facility was launched in October 2019.

Wolsong-1 NPP, the first PHWR in domestic, started construction in May 1977 and began commercial operation on 22 April, 1983. Its 30-year operating license expired in 2012. Prior to the expiration of Wolsong-1 NPP operation license, KHNP’s application for the 10-year life extension until November 2022 was approved by the regulator. But KHNP Board decided to permanently cease Wolsong-1 NPP on 15 June, 2018. KHNP plans to prepare the technology development roadmap for PHWR decommissioning and was started a research to secure the full system decontamination technology for PHWRs including Wolsong-1 based on the CRI_RWDecom in April 2019.

This paper describes the major characteristics of full system decontamination process, CRI_RWDecom, developed for PWRs and outlines the research plan for development of full system decontamination technology for PHWRs.

2. Full system decontamination process for PWRs

This process is an organic acid-based system decontamination process and basically consists of oxidation, reduction, decomposition & treatment and purification process. In oxidation process, chromium metal ions in oxide films are removed by using permanganic acid as an oxidizing agent. The concentration of oxidizing agent is lower than that of a competitive technology. In order to elute the chromium ions in oxide film, pH should be maintained at about 2 to 3. For this, pH adjuster is used to compensate for pH value resulting from lowering the permanganic acid concentration. In reduction process, iron and nickel metal ions in oxide film are removed by using oxalic acid as a reducing agent. The concentration of reducing agent is almost the same as that of a competitive technology. Decomposition & treatment process removes the suspended particles and metal ions in the chemical decontamination liquid waste and decomposes the oxalic acid to recycle it as the system decontamination process water. In this process, the H$_2$O$_2$ is used to improve the oxalic acid decomposition performance. Purification process removes the residual metal ions in chemical waste which is decomposed and treated in decomposition & treatment process. The characteristics of CRI_RWDecom are shown in Table I.

![Table I: Characteristics of CRI_RWDecom Process](image)

3. Research plan for development of PHWR full system decontamination technology

In PWRs decommissioning, various full system decontamination technologies have been developed and implemented worldwide. However, it is known that there is no full system decontamination for PHWR decommissioning. The deposit parameters and compounds of oxide film deposited in piping and systems of PHWRs are somewhat different from PWRs as shown in Table II and III [4]. Therefore, it seems to be a limitation in applying the full system...
The major objectives for each year of this project are as follows.

1. **1st year**
   - Establishment of simulated specimen manufacturing method
   - Evaluation of characteristics by system decontamination range

2. **2nd year**
   - Selection of chemical decontamination process by PHWR materials and chemicals
   - Selection of system decontamination range and establishment of operation control methods

3. **3rd year**
   - Process development of optimum system decontamination and chemical waste decomposition & treatment
   - Development of conceptual design and operation procedures

4. **Future plan**

KHNP plans to develop the PHWR decommissioning technology development roadmap including this research project for development of PHWR full system decontamination technology. This project will be completed in September 2021. After completion of this project, another project for the detailed design of system decontamination commercial facility will be carried out using commercial facility, CIDF, developed for PWRs and the results of these projects will be applied to Wolsong-1 NPP decommissioning.

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