Pressure Water Jet Cleaning of Residue Inside Tank in Foam Decontamination

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1. Introduction

Foam decontamination process well developed and widely used, especially for large components with complex shapes or large volumes. It can be applied to surfaces in any orientation and produces low volumes of secondary waste. The equipment is cheap, simple and suitable for either manual or remote deployment [1]. This study was conducted to evaluate the cleanup of residue on the inside surface area of a tank using a pressure water jet technique with foam decontamination. Pressure water jet equipment for the tank was designed and manufactured, and some performance tests were conducted. Foam can be used to assist with the application of chemical decontamination agents onto various materials. In the finished foam decontamination of a large tank, residual materials, such as the chemical materials, SiO_2 nanoparticles, radionuclides, and many other materials will remain on the surface of the inside tank.

2. Cleaning system

2.1 Manufacture of cleaning system

A cleaning system of high pressure water spray method was manufactured to remove radioactive materials, nanoparticles, and foam decontamination chemicals remaining on the inner surface of a large tank after foam decontamination.

This is a demonstration cleaning system having a function of performing a cleaning process of four stages. In the first step, the washing solution is sprayed at 360° with four linear nozzles (injection angle: 90°/one nozzle) capable of automatically moving up and down. The residual material remaining on the inner surface of the tank is removed by spraying. The second step, the washing waste solution used in the first stage washing process is recycled and the washing process is repeatedly washed until the remaining material on the inner surface of the tank is completely removed. The third step is a rinsing step, which uses a fresh washing solution to clean and remove material remaining on the inner surface of the tank. The fourth step is the drainage of the solution from the bottom of the tank.

Table 1. Main specification of cleaning system

Part name	Quantity
Decontamination tank	1 set
Cleaning solution tank	1 set
Cleaning waste solution tank	1 set
Nozzle up and down moving device	1 set
Control panel	1 set
Structure frame	1 set

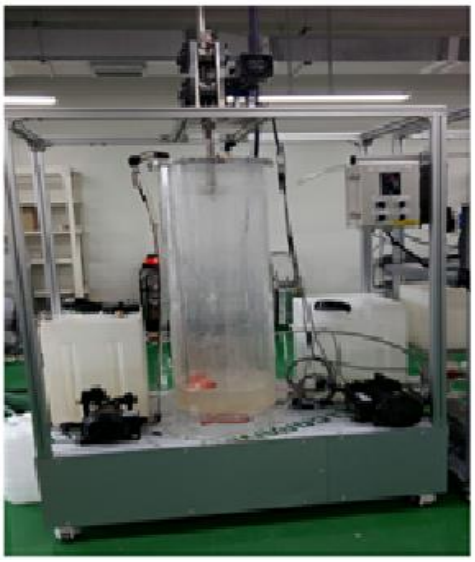

Fig. 1. Picture of cleaning system.

3. Results & discussion

It is important to consider the minimum production of secondary waste in foam decontamination technology. For the basic concept design and selection of suitable technology, we considered the safety, efficiency, cost effectiveness, waste management and feasibility of application. We selected the pressure water jet as a suitable technique among the chemical, physical, mechanical, and electrochemical methods. Recycling of a washing waste solution is crucial to avoid large secondary waste volume production. The flushing of water was operated at a low pressure of ~30 bars and a recycling system of a waste flushing solution was operated semi-automatically. This facility is operated with 4 steps. The first moving part is operated upward and downward vertically, and can be controlled by automatic or manual operation. The second part is the upper position, and the lower position was set up using limit sensors and controlled. Recycled washing solution was collected in a waste tank, and recycling then started using a pump. The final waste solution was transferred to the solid/liquid separation filter system.

The evaluation of this washing-cleaning facility was decided as based on the results of 5 cycles of washing with only a fresh washing solution, and the first and fifth cycles of washing with a fresh washing solution, and second through fourth cycle washings through a waste washing solution recycling operation. The removal percentage of SiO_2 nanoparticles is 96.4% in first cycle, 99.0% in the third cycle, and 99.2% in the fifth cycle. In the Recycling experiment of the washing solution, the removal percentage of SiO_2 nanoparticles is 96.4% in the first cycle and 99.1% in the fifth cycle. It was possible to reduce the considerable amount of secondary waste production in the recycling of the washing waste solution system.

4. Conclusions

Cleaning of the inside of a tank with a pressure water jet was proven with assured productivity, safety, environmental responsibility, cost, and versatility under our feasibility test conditions. We can find the possibility of a reduction of secondary waste production in the recycling of a washing waste solution system. In future studies, the cleaning of a larger scale tank contaminated with radionuclides will be conducted using a pressure water jet washing to remove the residue on the metal surface of inside the tank.

REFERENCES

[1] International Atomic Energy Agency, State of the art technology for decontamination and dismantling of nuclear facilities, Technical Report Series No. 395, IAEA, Vienna (1999).