Research on Radioactive Aerosol Control and Decontamination at Fukushima Daiichi Nuclear Power Station Decommissioning

(3) Development of the electro-scavenging technique using multi-scale charged spray droplets

*Ruicong Xu[1], Avadhesh Kumar Sharma[1], Shuichiro Miwa[1] and Shunichi Suzuki[1]

[1] Univ. Tokyo

To improve the aerosol scavenging efficiency during the Fukushima Daiichi (1F) decommissioning, experiments are performed in the UTARTS facility with several electrostatically-charged spray systems to charge the droplets for accelerating aerosol removal via electrical force. Results indicate that increased voltage improves removal efficiency, though benefits diminish at higher voltages. These findings are useful in optimizing spray system for 1F decommissioning.

Keywords: Aerosol removal, Spray scavenging, Droplet charging, Fukushima Daiichi decommissioning

1. Introduction

During the 1F decommissioning of, the debris should be cut into pieces for retrieval [1]. However, radioactive submicron aerosol particles (APs) will generate during this process, which are difficult to be removed by traditional spray method [8]. Electro-charging droplets is useful to improve their AP collection [3]. Thus, a series of spray-charging experiments are conducted in our UTARTS facility. Brass ring electrodes with different diameters are designed and studied.

2. Experimental

UTARTS facility is a SS cylindrical vessel with 3.92 m^3 in volume. Spray water is injected from a nozzle (GG-30) at 2 L/min. The electrodes are brass rings with distinct inner diameters (D, 25~200 mm). Electrode is connected to high voltage power supply (V, -0~-30kV) and placed near the nozzle outlet with variable distance (L_{en}, 20~50 mm) to charge the droplets with induction. ZrO_2 APs are used. Welas3000 is used for AP measurement. Totally, 13 experimental cases are performed at room temperature and atmospheric pressure. Fig. 1 illustrates the effect of voltage. Increased voltage improves removal efficiency, but benefits diminish at higher voltages due to the enhanced droplet deposition on the electrodes, corona discharge and space charging. Figs. 2-3 show the effects of nozzle-electrode distance and ring diameter, which affect the AP removal efficiency due to droplet deposition and density of spray area inside the ring.

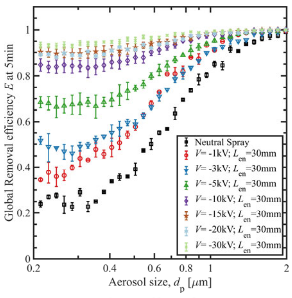

Fig. 1 Effect of V

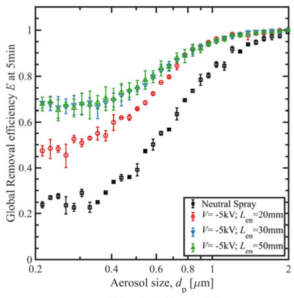

Fig. 2 Effect of L_{en}

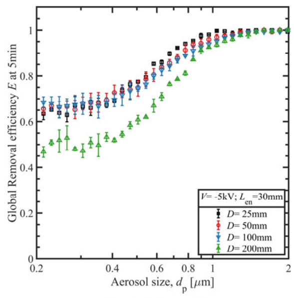

Fig. 3 Effect of D

3. Conclusion

To improve the AP removal efficiency in 1F decommissioning, we developed several electrodes to charge the spray droplets and attained valuable understanding of the effects of voltage, nozzle-electrode distance and ring diameter.

References

[1] Sharma A.K., et al., Nucl. Technol., 209(12) (2023) 2030-2043.

[2] Greenfield S.M. J. Atmos. Sci. 14(2) (1957) 115-125.

[3] Sharma A.K., et al., J. Aerosol Sci. 174 (2023) 106254.