Development of a Cyclone to Remove Hot Particulate inside Hot Cell

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1. Introduction

Generally, each nuclear hot cell at KAERI executes several different kinds of reaction processes, for example, oxidation and reduction reactions for DUPIC(Direct Use of spent PWR Fuel In CANDU reactors), spent fuel treatment such as an extension, destruction, pulverization and cutting, group separation, chemical convention processes etc., with high radioactive materials such as uranium and zirconium alloy. Due to the generation of hot particulate during these processes, the level of radioactivity becomes very high inside each hot cell. Therefore, it is necessary to remove hot particulates in a hot cell periodically for reduction of the radioactivity level.

2. Materials and methods

A novel cyclone filter train was designed and fabricated to be suitable for a decontamination and the structure characteristics of a hot cell, which has the dimensions of 0.7 x 0.55 x 0.55 m and a weight of 60 kg . The developed cyclone filter train can be easily operated by a manipulator. The operational parameters of the cyclone, especially, the vortex finder length and the inlet flow rates were varied to evaluate the performance of this cyclone filter train. Additionally, for a grasp of the effects by the temperature and mist, the relevant experiments were executed. A schematic diagram of the experimental setup is shown in Figure 1.
The inlet flow rates, which were initially set at 8 m/s, were increased to 12, 15, 18, and 20 m/s for subsequent tests. An Anemometer (TESTO 4510) measured the inlet flow rates to the cyclone. Magnehelic gauge (Dwyer Instruments Inc.) measured the pressure drops across the cyclone.

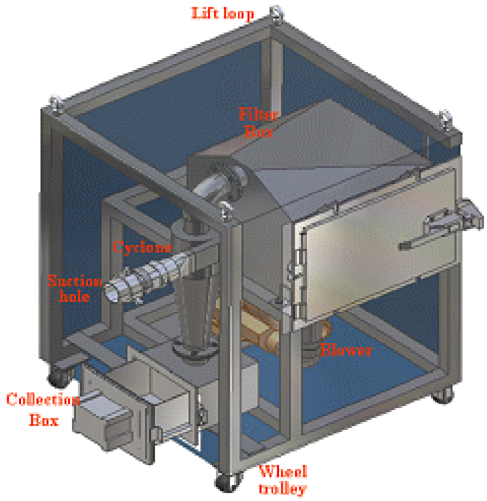
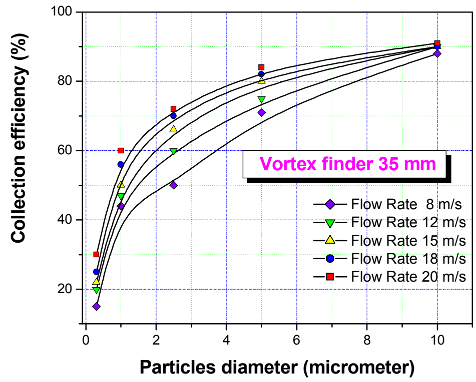


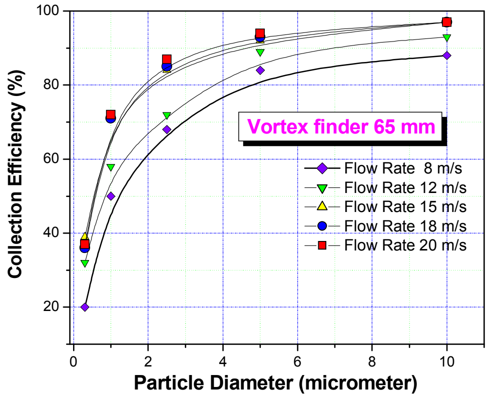
Figure 1. An actual view size of the fabricated cyclone train manufactured according to the design.

3. Results and discussions

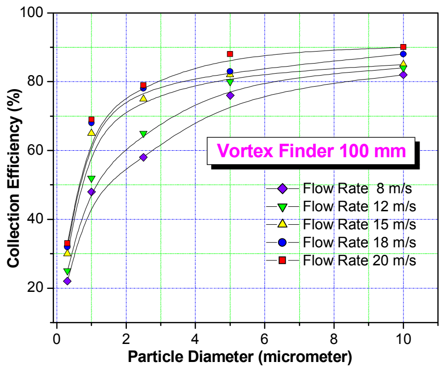
Figure 2 compares the collection efficiencies of the cyclones with different vortex finder lengths, at different inlet flow rates. The collection efficiencies of the cyclone changed with the vortex finder lengths. On the increase of the vortex finder length to the selected limit, the collection efficiency of the cyclone increases and the cut size diameter decreases. But over the limit of the vortex finder length, the collection efficiency begins to decrease. Namely, the collection efficiency in Figure 2b is higher than those shown in Figures 2a and 2c. A higher collection efficiency was measured with a vortex finder length of 65 mm, S/Dc=0.65. Therefore, the vortex finder



a)



b)



c)

Figure 2. Measured collection efficiency as a function of the particle size for a) vortex finder length: 35 mm, b) vortex finder length: 65 mm, and c) vortex finder length: 100 mm at different inlet flow rates.

length is very important to achieve a the higher particle collection efficiency for a cyclone. These Figures also illustrate the effect of the inlet flow rates on the collection efficiency. The collection efficiency of the cyclone increased with an increase of the particle size and the inlet flow rate. For the inlet flow rate range from 8m/sec to 20m/sec, the increased rate of the collection efficiency was not so much for the inlet flow rates faster than 15 m/sec. It was found that the inlet flow rate of 15 m/s was the best condition for this cyclone efficiency.

4. Conclusions

The cyclone was designed and manufactured to be suitable for contamination characteristics and the structural characteristics of a KAERI hot cell, which was made from stainless steel with the dimensions of 0.7x0.55x0.55m and a weight of 60kg, and can be operated by a manipulator. Collection efficiency of the cyclone was considerably affected by the vortex finder length and the corresponding inlet flow rates. A vortex finder length of 65 mm (S/Dc=0.65) and an inlet flow rate of 15 m/s were the best condition for the efficiency of the cyclone.

References

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