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Efficiency of a Air Filtering System at Post-Irradiation Examination Facility

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1. Introduction

Nuclear air filtering system is installed at a post irradiation examination facility (PIEF) to maintain the optimized operating condition of a facility. It is important to reduce the amount of radioactive materials released to the environment by using an air filtering system in a PIEF. In this paper, the problems in operating very high-efficiency air cleaning systems were discerned. For the optimal operation of a PIEF, reasonable operation procedure manuals as well as a periodical maintenance schedule are necessary. Inspections on each system, such as filter leak tests and other related tests need to be periodically performed to increase the operational efficiency and safety [1].

2. Performance tests of the Exhaust Air Filtering System

2.1 Media design of the v-pleats type filter and the efficiency characters

High efficiency particular air (HEPA) filters are classified into two different types such as a separator type and a v-pleats (or separator-less) which is used mainly in atomic fields. HEPA filters designed as v-pleats type are operating in the exhaust filtering systems of PIEF in KAERI. V-pleat type filter is known to considerably extend the exchange period compared to a separator type one.

This type was selected because of the stiff structures reinforced by a uniformly-arrayed steel frame and much more quantities of filter media than a separator type in the restrictive spaces. Accordingly, V-pleats type filters had advantages of a lower resistance of an air flow and a lower differential pressure.

2.2 Filtration system of Radioactivity HEPA filters and filtrated efficiency

In the exhaust air filtration system, one stage filter banks were installed at the low radioactivity working zone as a MUP (Medium Under Pressure), and two stage serial ones were installed at a DUP (Deep Under Pressure) zone as a hot-cell exists with a high radioactivity.

Performance tests of the HEPA filter is recommended to have a value greater than a 99.95% efficiency a DOP (di-octyl phthalate) particle with a 0.3 ㎛ size at a design velocity within 5 fpm(2.5cm/sec) by ANSI N-509 and N510. Field leak tests checked for damages of the filter (pin-hole, crack, gasket, pleat and seal etc.) and the penetration rate shows the following by using equation (1) [2-3].

$$\text{Percent Penetration: } \%P = \frac{C_d}{C_u} \times 100 \qquad (1)$$

$P = Percent\ Penetraion$
$C_d = Dowstream$
$C_u = Upstream$

The concentration ratio and efficiency are measured by a light-scattering photometer attached detector which is connected to the up and downstreams of a filter with a tube gathering air samples.

For the performance test using the instruments (NUCON F-1000-DG, DD), a thermal generator has been charged with an aerosol at the upstream side of the filter with a DOP average concentration with particle sensitivities of the 50×10^2. A sample of smog passed through the downstream side of filter was 12×10^{-2} of a DOP average concentration. Figure 1 shows the results of the tests at 20 HEPA filter banks. Because the penetration rates appeared to have average sensitivities of 0.0015, the efficiencies are thought to keep over 99.99% at all the filter banks.

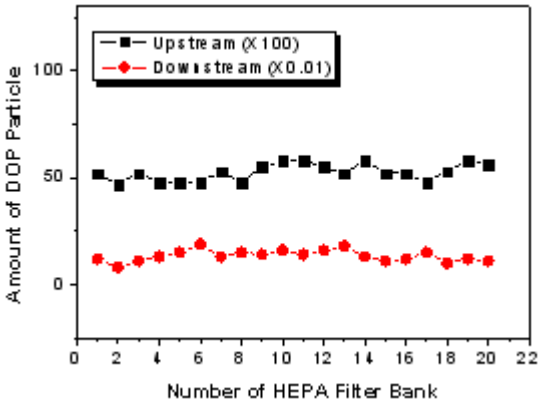

Figure 1. Particle counts of upstream and downstream at HEPA Filter (V-pleats type)

2.3 Initial differential pressure of the HEPA filter and exchange period

Differential pressure and working life of the filter are closely related to the dusting of the gas to be filtered, working conditions, particle size and cleaning conditions of the facility. Figure 2 shows that the new HEPA filter of a v-pleats type has an initial differential

pressure of less than 25 mmH_2O (1inch) during a rising air flow slow from 0 to 3,000 m^3/H. Considering the damage of filter supports and a lowering efficiency, it is suggested that an exchange period is at the manometer indicator of 60mm H_2O as a final differential pressure for the safety and prevention of a filter damage. Differential pressure appeared to increase linearly above the final differential pressure. And here, filters can be broken or it is difficult to pass air within an allowed limit.

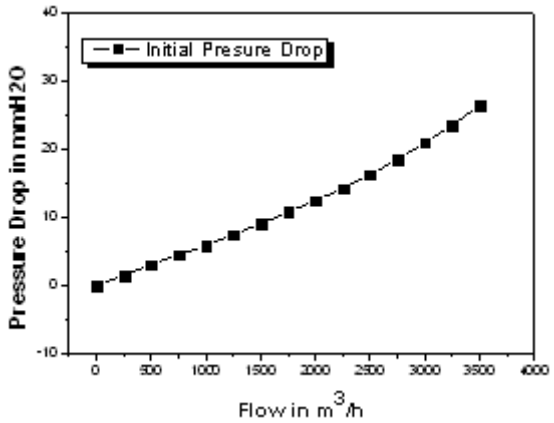

Figure 2. Resistance and clogging of HEPA filter(V-pleats type)

3. Conclusion

HVAC and radioactive filtering equipment at the PIEF can be maintained during the optimal operating conditions through periodic performance tests, equipment inspections and repair works. Skillful experience is required in the field tests because measurement errors exist during tests. The filtered efficiency of the PIEF's filtering system is greater than 99.95%.

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