A Two-Stage Electrostatic Indoor Air Purifier with Water-Film Collection Plates

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Indoor air purifier has been one of the active control technologies to removal of indoor air pollutants such as fine particles and odors. Most air purifiers use air filters composed of fiber media and they need periodic replacements of the filters and thus considerable maintenance fee. They can generate volatile organic compounds (VOCs) and odors from the microorganisms cultivated on the surface of the filters when the filters are not replaced at the right time.

In this study, to improve the maintenance of indoor air purifiers, a wet-type two-stage electrostatic air purifier has been developed. This purifier does not need filter replacements because it collects fine particles using electrostatic forces and cleans the collection plates with continuous water flow.

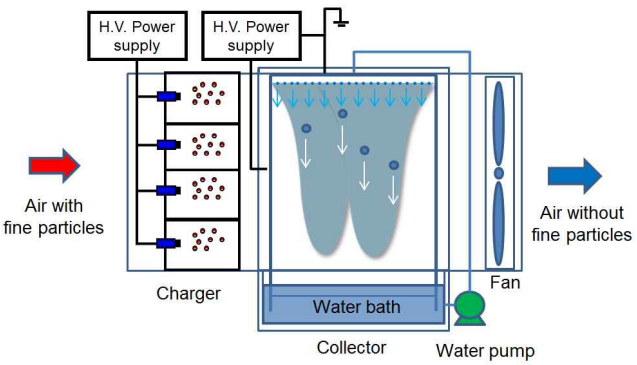

Figure 1. Experimental setup for a two-stage electrostatic indoor air purifier.

Figure 1 shows the experimental setup. Particle charger was a set of four carbon fiber ionizers with four rectangular ground ducts (65 mm x 75 mm x 50 mm). Carbon fibers as a discharging electrodes had a diameter of 7-8 μm and a carbon component of about 95%. Ozone was little generated due to the micro-sized electrodes with a level less than 10 ppb (Han et al., 2008; Kim et al., 2010). Collector was composed of a set of five polymer collection plates (160 mm x 300 mm x 2 mm) and metal counter electrodes. The polymer collection plates had a lot of nozzles at the top of the plates and barrier patterns on the surface of the plates to let water flow uniformly from top of the plates with a thin water film without any dry spot. High voltages of 5-10 kV were applied to the charger and collector, respectively. Fan equipped at the rear of the collector could adjust the air flow rate with a range of 1-2.5 m^3/min.

Increase of applied voltage to the charger from 7 kV to 10 kV at the 10 kV applied voltage to the collector led to the increase of CADR (0.3 μm) from 65 to 92 m^3/hr. The CADR could be reached to 129 m^3/hr at the particle size of 0.9 μm.

Figure 2 shows the relative particle concentrations of 0.3 μm particles under operations of conventional air washer with a lot of water film discs and the electrostatic air purifier developed in this work. The CADR of the electrostatic air purifier developed in this work was about 12.4 times higher than that of the commercial air washer.

Our system could supply humid air from 42 % R.H. to 56 % R.H. after one-hour operation at the 30 m^3 test chamber by the natural evaporation of water at the surfaces of the water-film collectors.

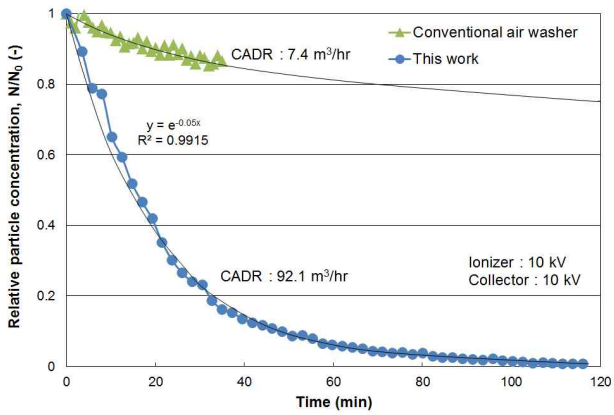

Figure 2. Changes of particle concentration by operation of conventional air washer and the developed one

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