Activated carbon coated electrode for simultaneous dust and VOCs removal in a pilot-scale electrostatic precipitator

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Fine dust in Korean peninsular has become a serious issue regarding its adverse effect on human health. It is understood that not only respiratory problems but hyperpiesia, cardiac disorder, and also stroke can be caused from a contaminated air with heavy dust. Electrostatic precipitator is a common device that removes either solid particles or liquid droplets especially from industial processes, and also used for air pollution control. From the studies in advance (Kim et al., 2015), techniqe for the electrode coating with activated carbon (AC) powder was developed. The surface coating resulted in the even distriburion of electric power density and lowered electric resistance so that successsfuly improved dust removal efficiency. As its porous characteristics remains after the coating procedure, AC functioned as an excellent adsorbent for volatile organic gases also present in contaminated air. This abstract aims to introduce first result of pilot scale AC-coated electrostatic precipitator (ACE) performance which was conducted as a preliminary test for field trial to remove dust and VOCs simultaneously in an urban road tunnel.

ACE was composed of six chambers installed with AC coated electrodes. Front four chambers has 23 electrode plates and 22 insulating panels of same size. The electrodes and insulating panels were arranged in turn, to restrain the back discharge phenomenum which can deteriorate removal efficiency by resuspended dust. The chambers were supplied with 5kV electric power. Two additional chambers in the rear part were to support VOC adsorption by AC coated on the electrode surface, and electric power was not connected. Therefore in these chambers only AC-electrodes were used (Fig. 1).

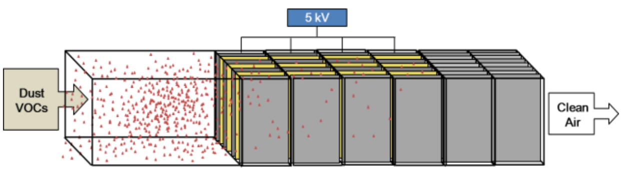

Fig. 1 Schematic of ACE electrostatic precipitator

Continuous dust removal performance was monitored for the air flow rate 72, 144, 216 and 288 m^3/h, each containing 600-1000 ppm dust concentrations. Reagent grade JIS test powder (Test powder 1, class 11) was used as a PM10 dust and supplied through a dust generator (Model 3211, Kanomax). Dust concentration was monitored with particle counters (dust monitor, Model 3442, Kanomax) at the inlet, after second chamber, forth chamber, and the outlet of the plant.

Under the same operational condition, VOCs removal was tested using benzene, toluene, ethyl benzene and m-xylene(BTEX) gas mixture of each 1ppm inflow concentration. Samples were collected from the inlet, after forth chamber and the outlet into tedlar bags, and analyzed by a gas chromatogrphy (ThermoFisher Trace 1310 GC System).

Average dust removal efficiencies after 30 minutes operation at each condition were found 97, 98, 98 and 99% at 72, 144, 216 and 288 m^3/h flow rate, respectively. It is likely that flow rate did not influence on the removal efficiency but it rather showed good dust removal performance consistantly. It appeared most of dust removed within the front two chambers as the efficiencies were 93, 88, 90 and 89 already at second chamber, under the 72, 144, 216 and 288 m^3/h conditions. Application the experimental data to Mett-ohnfeldt model equation revealed that the data fitted well with the model at k value 0.5 (Matts and Ohnfeldt, 1964).

Regarding VOCs removal, BTEX gases were removed 100% except toluene at all four-different flow rate conditions. The three gases were not detected in the outlet gas samples. In case of toluene, however, final removal efficiencies were 66, 67, 81 and 48%. The relatively low efficiency should be evaluated again. Previous adsorption isotherm study with the gases showed benzene and toluene were the least adsorbed into the AC coating mixture as an adsorbent.

Pilot-scale ACE test revealed that the system successfully removed both dust and VOCs regardless of air flow rate, although it needs the verification process especially for touene removal.

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