Geometry effect of a novel two-stage ESP with indirect charging method on collection efficiency against ultrafine particles

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Keywords: indirect, charging, electrostatic precipitation, ultrafine, collection.
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A novel two-stage ESP for industries such as chemicals, IT etc using highly corrosive and explosive gases developed that uses an indirect charger to generate negative ions at outside of a gas duct and put them into a main gas flow by using additional electric field (Kim et al., 2015). In this study, an indirect charging stage (100 x 100 x 200 mm^3) is composed of brush type charger located at outside of upper part of the charging stage and two parallel plates to which high voltage and ground were connected to generate electric field. At downstream of the charging stage, a collection stage was located with a collection area of 0.1 m^2 at 50 L/min. Electrical and particle removal characteristics of the ESP were evaluated with ultrafine particles by varying the geometry of the ionizer, applied voltage and polarity of the power source. The total air flow rate for the test were approximate 55 L/min with 10 : 1 ratio of main and mixing flows in the ESP. With our novel concept of indirect charging stage, when high voltage of – 5 kV between a brush charger and a bottom plate was applied, electric potential between upper and bottom plates was generated automatically due to induction between tip of the charger and upper plate, and the potential was changed by varying geometry of the upper plate such as thickness and size. The maximum collection efficiencies with different geometries in the first stage of the ESP was not changed, and achieved 90% against ultrafine particles with mode diameter of 60nm. The Figure 2 shows the collection efficiency of the ESP with change of applied voltage between upper and bottom plates. With only 1st stage, the efficiency was approximately 50%, and enhanced up to 90% with applied voltage to the 2nd collection stage because charged particles escaped from the 1st stage were efficiently collected in the collection stage. However, when we increased voltage between upper and bottom plates in the 1st stage over automatic induction voltages to increase additional electric field in the 1st stage, collection efficiencies were dramatically decreased to almost zero with increase of several kilo voltages between upper and bottom plates. These results indicate that in our ESP additional enhancement of the collection efficiency is impossible with change of geometries of the 1st stage because of existence of automatic induction voltage.

In this study, we conclude that an ESP without any contact of a corona charger with dirty exhaust explosive and corrosive gases from industries could be possible, and needs to study how to enhance its collection efficiency.

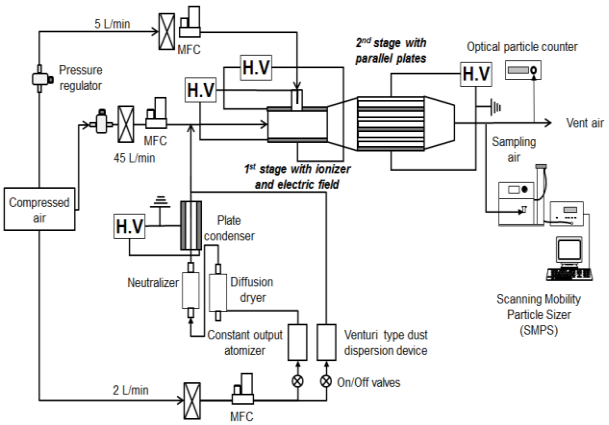

Figure 1. Experimental set up in this study.

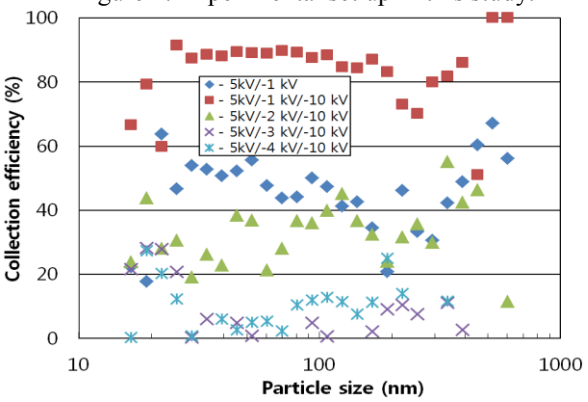

Figure 2. Size-dependent collection efficiency of the ESP with change of applied voltage between upper and bottom plates.

This work was partially supported by the Eco-Innovation project (GG2660) of the Ministry of the Environment, Republic of Korea, and also supported by the Basic Research Fund of KIMM (SC1180).

Kim, H.J., Han, B., Woo, C.G., Kim, Y.J., Park, S.J., Yoon, J.P. (2015), Proceedings of the 2015 IEEE IAS Annual meeting, #2015-EPC-0492, 1-7.