Effect of aperture rate on improving collection efficiency in hole-type electrostatic precipitator

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Keywords: electrostatic precipitator, collection efficiency, re-entrainment, marine diesel
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The exhaust gases included the particulate matter (PM) emitted from marine diesels may cause the serious problem of pollution on the coast. Electrostatic precipitators (ESPs) have been used to decontaminate polluted exhaust gases emitted from industrial plants, etc.. However, the collection of low resistivity particles, such as PM emitted from marine diesel, is known to be difficult to precipitate.

In this study, the new hole-type ESP, which has hole-punched ground electrode, was developed to overcome the re-entrainment and increase the collection efficiency. We investigated the effect of the aperture rate of the hole-punched electrode on improving the collection efficiency.

The electrode structure of hole-type ESP is shown in Figure 1. The hole-type ESP consists of the grounding case, multiple hole-punched inner ground electrode and the high voltage center electrode. The hole diameter is 1 mm and the aperture rate is between 22.6 to 40.2% on the hole-punched ground electrode. The upstream and downstream portions of the space between the hole-punched ground electrode and the grounding case are closed. The flue gas is connected to the upstream portion between the high voltage center electrode and the hole-punched ground electrode (H.Kawakami, 2012). PM was emitted from the diesel engine (Yanmer, YDG200A-5E, 200cc), the gas velocity in the ESP is 1.5 m/s. DC -8 kV was applied to the high voltage center electrode, and the discharge current was 0.5 mA. The particle number concentrations are measured using the scanning mobility particle sizer (SMPS, TSI, Model 3080) and the particle counter (RION, KC-01E) after hot dilution.

The particle size distribution is shown in Figure 2. The gas temperatures were 130 ^{o}C, the high voltage was not applied to ESP. The particle size distributions have a peak at 70 nm of the particle diameter. It is clear that the ultra-fine particles, which are extremely harmful to human health, are included in the exhaust gas.

The collection efficiency as a function of particle diameter for various aperture rates at 1mm of hole-punched diameter is shown in Figure 3. The result at plate ground electrode, which does not have hole-punch, is also indicated in Figure 3. The collection efficiency between 20 to 1000 nm is approximately 80 % at plate ground electrode. The collection efficiency lager than 1000 nm decreases with increasing the particle diameter due to particle re-entrainment (A. Zukeran, 1999). The collection efficiency between 20 to 1000 nm increases with decreasing the aperture rate. The collection efficiencies lager than 1000 nm are significantly improved in comparison with that at plate ground electrode. This result indicates the effect of preventing particle re-entrainment in the hole-type ESP. The collection characteristics at high gas velocity, which is between 10 to 30 m/s, will be investigated in the future.

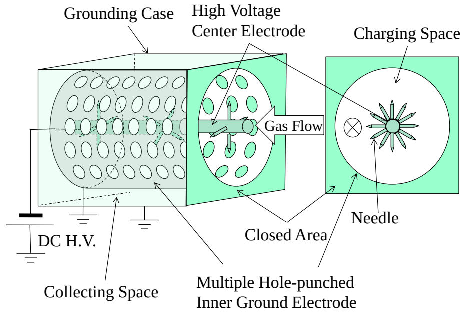

Figure 1. The electrode structure of hole-type ESP

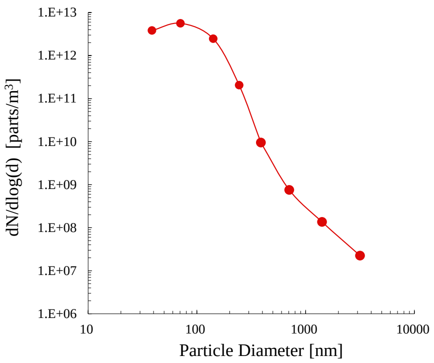

Figure 2. The particle size distribution.

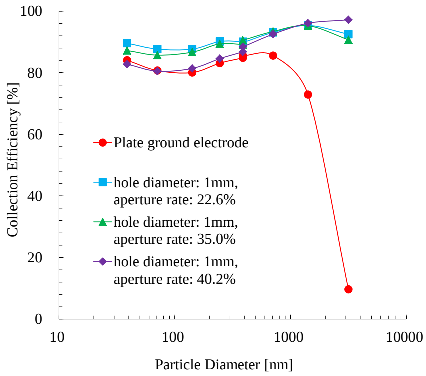

Figure 3. The collection efficiency as a function of particle diameter for various aperture rate.

H.Kawakami *et al* (2012) *International Journal of Plasma Environmental Science & Technology*, 6, 2, 104-110

A. Zukeran *et al* (1999) *IEEE Trans. on Ind. Appl*. 35, 2, 346-351