PIV Measurement of Particle Behavior in Hole type Electrostatic Precipitator

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The diesel engine is used for the ship. However, the air pollutant is exhausted by the diesel engine. IMO MARPOL ANNEX VI has entered into force by the IMO (International Maritime Organization) in 2005. The air pollutant was severely limited by the agreement. The electrostatic precipitator (ESP) is a means to collect PM. They are characterized by a high particle collection efficiency with low pressure drop. The particle behavior in ESP depends on the particle characteristic, electric field, space charge and flow pattern. Moreover, re-entrainment phenomenon is caused according to the condition. The new hole-type ESP was developed to overcome the re-entrainment in the ESP. The particle flow into the hole by ionic wind. The Electric field of a collecting zone in the hole is zero. Therefore, it can be expected that suppression of the re-entrainment.

It is important to understand the particle behavior in ESP. Particle image velocimetry (PIV) was used to grasp the particle behaviour in ESP. In this study, the particle behavior, the particle velocity, and the influx rate of particle in the hole were investigated.

The experimental system is shown in Fig. 1. The system composed of the needle discharge electrode and plate electrode. The needle discharge electrode was set up right above the hole. The negative DC voltage was applied to the needle-electrode. The hole of φ20mm was opened to the plate electrode. The particles were visible to irradiate with the laser sheet. The movement velocity distribution of particle was requested by analysing the image acquired with a high-speed camera.

The particle velocity in ESP is shown in Fig. 2. Tracer particles are talc, copper powder (Cu) and particles of ethylene glycol (EG). Primary flow velocity is an average speed when the particle flows from the upstream to the downstream. Primary flow velocity was measured with PIV. As a result, the particle velocity increase with increasing primary flow velocity. The particle velocity of Cu was the fastest. Cu is the most suitable for the collection.

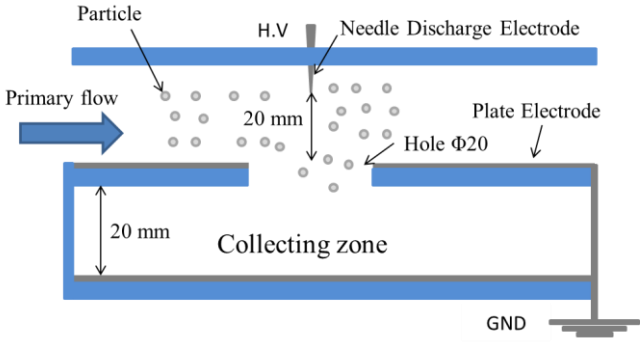

Fig1. Hole type Electrostatic Precipitator

Influx rate of particle in the hole was quantitatively judged. The influx rate of particle in the hole is shown in fig. 3. The influx rate of particle in the hole measured by the number of pixels of inlet and collecting zone. The influx rate of particle in the hole increase with increasing discharge current. This is attributed to increase in ionic wind. It also confirmed that the particle flowed in the hole by ionic wind. Therefore, it can be expected that suppression of the re-entrainment.

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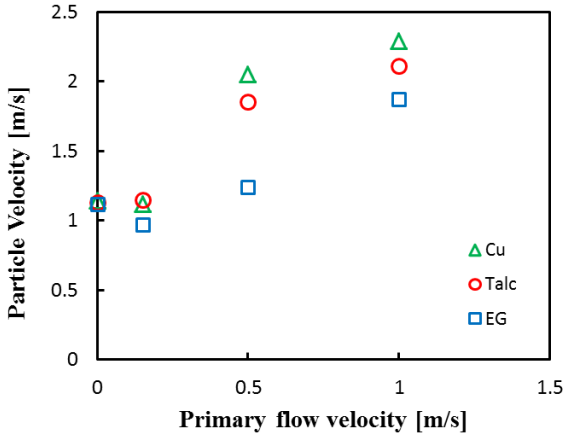

Fig2. Particle velocity as a function of primary flow velocity (3μA)

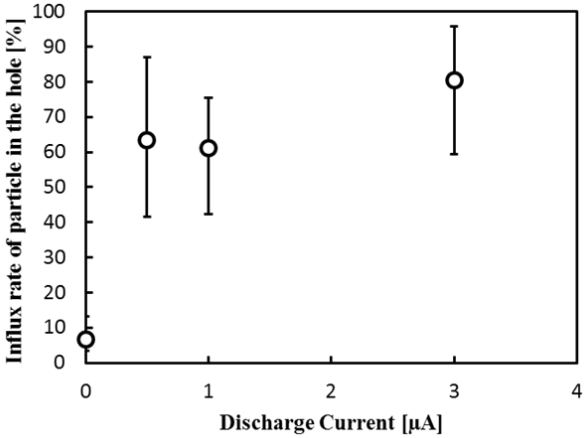

Fig3. Influx rate of particle in the hole as a function of discharge current (Talc, 0.15m/s)