Incineration of the diesel particulate matter using the dielectric barrier discharge on the electrostatic precipitator

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The particulate matters (PMs) emitted from marine diesel engine exhaust during the combustion process have low resistivity and extremely small in the range of 70-120nm. These particles cause a various human health and environment impacts. After MARPOL 73/78 Annex VI entered into force on 1st of July 2010, shipping-induced NOx and SOx, PM emissions are regulated stricter.

This research has been developed an after treatment system for removal of particulate matter (PM) emissions from a diesel engine. The PM was collected by electrostatic precipitator (ESP) using a high-frequency dielectric barrier discharge (DBD). In the DBD, the air is activated by discharge and produces ozone, oxygen radical and nitrogen radical. Therefore, the diesel particulates are oxidized and incinerated under low temperature condition.

A diesel engine generator, displacement volume of 435cc, using light oil was used. The particle size-dependent number densities before and after the ESP was determined by the Scanning Mobility Particle Sizer (SMPS, Model 3034) for the particle size ranged 20-800 nm and the particle counter (PC, Rion KC-01E) for the particle size of 300-5,000nm, respectively. The gas velocity was 13m/s. The ESP using DBD were composed by a parallel plate electrode. Both electrodes were covered by the dielectric glass plate. The discharge gap length was 3.5mm. The discharge power was measured by Lissajous method.

Particle-size dependent collection efficiency as a function of the discharge power of 5-20W was shown in Figure 1. The collection efficiency of large particles is higher than that of small particles. The collection efficiency increased with increasing the discharge power. The maximum collection efficiency was 22% at particle size of 3,200nm with 5W discharge power. The maximum collection efficiency was 68% at particle size of 1,400nm with 5W discharge power.

Figures 2 (a)-(b) show the pictures of the dielectric glass after 60min operation by DBD. In the discharge power of 5W, the dielectric glass surface has a lot of soot compared with 20W. However, the collection efficiency of high discharge power is higher than that of low discharge power as shown in Figure 1. It was clear that the collected particles were incinerated with ozone generated by DBD. The ESP using DBD has high potential especially for highly concentrated marine diesel engine emission control.

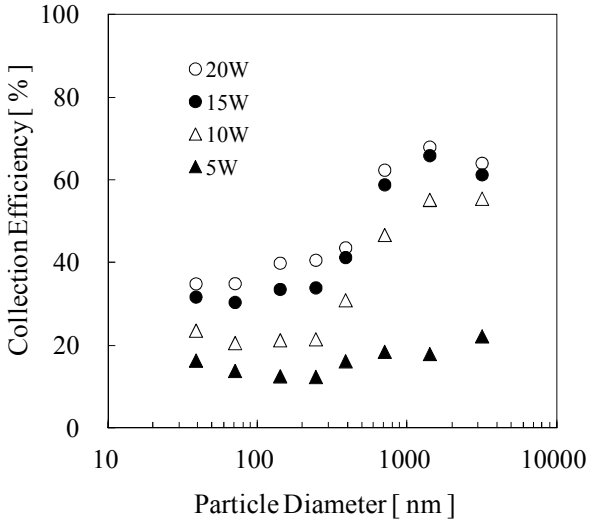
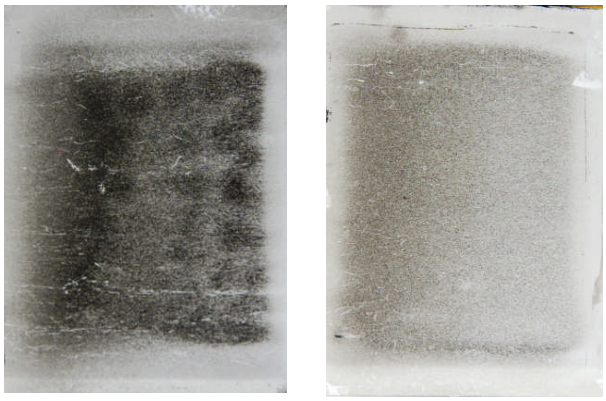


Figure 1. Particle-size dependent collection efficiency as a function of the discharge power of 5-20 W.



(a) 5 W (b) 20 W

Figure 2. The picture of the dielectric glass after 60 min ESP operation.

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