SO_2 Reduction by water condensation for marine diesel

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The exhaust gases emitted from marine diesel may cause the serious problem of pollution on the coast. Therefore, it has been regulated in MARPOL Treaty 73/78 Annex VI of IMO Air Pollution Control since 2005. The reductions of SOx, NOx and PM using plasma and chemical technologies have been investigated (Masuda, 1988, Yamamoto, 2002)

In this study, reduction of SO_2 for marine diesel was investigated using the electrostatic precipitator (ESP) with the heat exchanger. The experiments were carried out to reduce SO_2 due to condensation of water in the exhausted gas.

The schematic diagram of the experimental system is shown in Figure 1. The experimental system consists of the diesel engine (Denyo, DA-3100SS-IV, 400cc), the heat exchanger and the ESP. The exhausted gas at 180 ^{o}C of the temperature is cooled to 20 ^{o}C, and generated mist particles due to water condensation in the heat exchanger. The mist particles are collected in the ESP. The particle number concentrations are measured upstream and downstream the heat exchanger using the scanning mobility particle sizer (SMPS, TSI, 3936NL76) after hot dilution. SO_2 concentrations also measured by the SO_2 monitor using UV fluorescence (HORIBA, APSA-370) after hot dilution.

The particle size distribution downstream the heat exchanger for various gas temperatures is shown in Figure 2. The gas temperatures were regulated by the flow rate of the refrigerant. The particle size distributions have a peak at 70 nm of the particle diameter. The peak values between 120 to 50 ^{o}C are almost the same. However, the peak value increases with decreasing the gas temperature between 40 to 20 ^{o}C. In this experiment, the condensation water was sampled under 40 ^{o}C of the temperature. Therefore, this cause is the condensation due to cooling the gas temperature.

The SO_2 concentration and De-SO_2 rate as a function of the gas temperature is shown in Figure 3. The SO_2 concentration decreases with decreasing the gas temperature, and the De-SO_2 rate increases with decreasing the gas temperature. This result indicates that the SO_2 concentration in the exhausted gas emitted from marine engine is reduced due to decreasing the gas temperature using the heat exchanger. This cause is considered that SO_2 are absorbed to the condensation water.

As a result, it is indicated that SO_2 concentration decreases with decreasing the exhausted gas temperature due to the condensation. The collection of mist particles absorbed SO_2 will be investigated in the future.

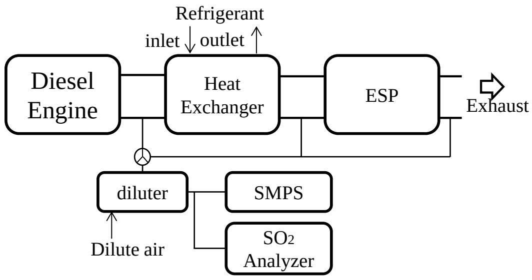

Figure 1. The schematic diagram of experimental system.

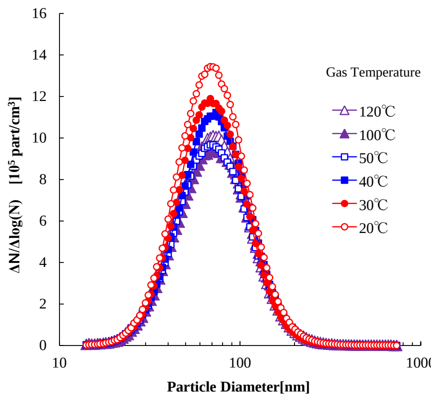

Figure 2. The particle size distribution downstream the heat exchanger as a function of the gas temperature.

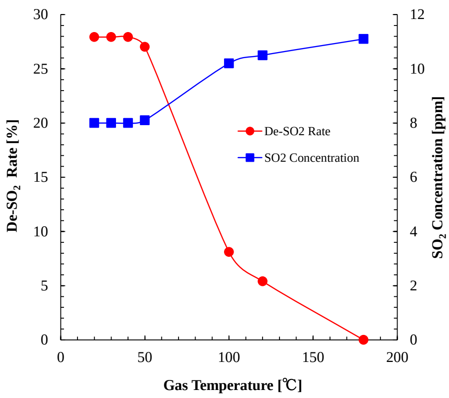

Figure 3. The De-SO_2 and SO_2 concentration as a function of the gas temperature.

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