講演番号 388

Soot Emission Characteristics of Three-Component Gasoline Surrogate/Ethanol Blended Fuels

Jun Hashimoto[1] **Kazumasa Ito**[2] **Shunya Matsumae**[3]

1) Oita University, Faculty of Science and Technology,
700 Dannoharu, Oita-shi, 870-1192, Japan (E-mail: hashimoto-jun@oita-u.ac.jp)
2) Graduate School of Engineering, Oita University, 700 Dannoharu, Oita-shi, 870-1192, Japan

KEY WORDS:**heat engine, Alternative fuel, Emissions gas,** Soot, Oxygenated fuel, Gasoline surrogate [A1]

In the transition toward a carbon-neutral society, effective utilization of biofuels is increasingly anticipated. Ethanol has been widely implemented and can be supplied sustainably. Although ethanol blending is generally expected to reduce soot emissions, recent studies have shown that the effect depends strongly on combustion conditions and fuel composition, and soot may increase at blending ratios around 20%. Despite its importance, systematic studies for gasoline fuels remain limited.

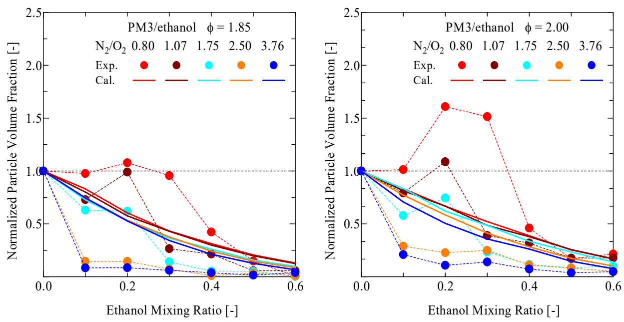
The authors have previously proposed gasoline surrogate fuels with properties similar to commercial gasoline and demonstrated that they can reproduce soot emission characteristics with good accuracy using engine experiments. In this study, combustion experiments were conducted using a burner flame for blended fuels of ethanol and PM3, one of the proposed surrogates. By varying the blending ratio, equivalence ratio, and nitrogen-to-oxygen ratio, soot formation in fuel-rich premixed flames was systematically investigated. In addition, a detailed soot model developed by Politecnico di Milano was evaluated.

Experiments were performed using a burner-stabilized stagnation flame with a fixed distance H = 1.2 cm between the nozzle and stagnation plate. The soot volume fraction was measured by laser extinction, and particle size distributions were obtained using an SMPS (TSI model 3938, 2–64 nm). The test fuel consisted of PM3 (65% iso-octane, 10% n-heptane, 25% toluene) blended with ethanol. The ethanol fraction ranged from 0 to 60 vol.%, the equivalence ratio from 1.78 to 2.00, and the nitrogen-to-oxygen ratio from 0.80 to 3.76.

Figure 1 shows the normalized soot volume fraction as a function of ethanol blending ratio. Figures 1(a) and 1(b) correspond to equivalence ratios of 1.85 and 2.00, respectively. At both conditions, soot decreases markedly with ethanol blending at high nitrogen-to-oxygen ratios, while the reduction becomes weaker as the ratio decreases. At an equivalence ratio of 2.00 and around 20% ethanol, soot increases under low nitrogen-to-oxygen ratio conditions.

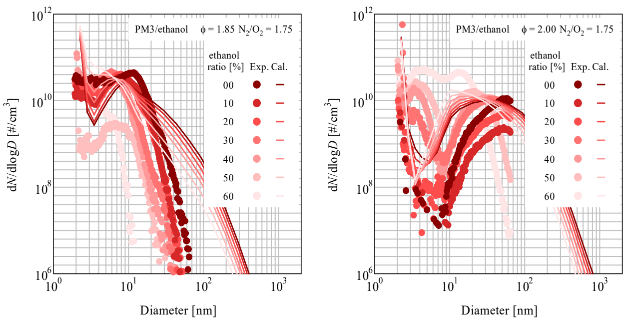
Figure 2 shows the particle size distributions. Measurements were conducted at a nitrogen-to-oxygen ratio of 1.75 based on preliminary tests. The distribution shifts toward larger particle sizes with increasing equivalence ratio. With ethanol blending, little change is observed up to ~20%, followed by a shift toward smaller sizes. At an equivalence ratio of 2.00, although large particles exceed the measurement range, the peak size remains nearly unchanged between 0% and 20% ethanol, while the peak number concentration is higher at 20% than at 10%. These results are consistent with the trends observed in soot volume fraction.

The model predicts a monotonic decrease in both soot volume fraction and particle size with increasing ethanol blending and fails to reproduce the weakened reduction or soot increase observed experimentally. Although the reduced sensitivity at lower nitrogen-to-oxygen ratios is qualitatively captured, the effect is underestimated. For neat PM3, the particle size distribution, including the peak in the aggregation regime, is reasonably reproduced. These results indicate that further improvement of the model is required to accurately predict ethanol blending effects.



(a) ϕ = 1.85 (b) ϕ = 2.00

Fig. 1 Normalized particle volume fraction



(a) ϕ = 1.85 (b) ϕ = 2.00

Fig. 2 Particle number distribution