

Thermophoretic Effects on Soot Particles in Combustion Field

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Keywords: Soot Particle, Thermophoresis, Microgravity-Measurement, Thermophoretic Velocity

Abstract

Soot is one of the main pollutants emitted from combustion devices. It is important for appropriate emission control from combustion devices to understand behavior of soot particles in combustion field. In a field with a temperature gradient, small particles experience a force toward colder region. This phenomenon called thermophoresis, which is mass transfer phenomenon induced by temperature gradient. Soot is very small particle and formed near combustion field, where very steep temperature gradient exists. In order to appropriately understand the soot formation process in combustion field, the effect of thermophoresis must be taken into account. It is known that thermophoresis has significant effect on soot formation process, however, the effect cannot be analyzed in detail because of the lack of basic information and data concerning the thermophoretic effect on soot particles.

In this study, the measurements of thermophoretic velocities of soot particles sampled from flames were performed under microgravity conditions. It was found that the thermophoretic velocities of soot particles in combustion field scarcely depend not on the aggregate sizes (whole size of the soot particle) but on the primary particle sizes, and the velocities can be evaluated by the theory for the free-molecular regime (the equation proposed by Waldmann; thermophoretic velocity $U_T = -\frac{3\nu}{4(1+\pi/8\alpha_m)} \cdot \frac{\nabla T}{T}$, where ν is the kinetic viscosity, T is the temperature of surrounding gas, and α_m is the accommodation factor.). The effects of particle morphologies on thermophoretic velocity were also examined. If the soot particle has the closely packed structure of primary particles, the thermophoretic velocity becomes smaller.

Acknowledgments: This work was performed under the management of the JSUP (Japan Space Utilization Promotion Center) as a part of the R&D project "Development of Advanced Combustion Technologies for Fuel Diversification Utilizing Microgravity Condition" supported by NEDO (New Energy and Industrial Technology Development Organization).