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Emission reduction of non-degradable and non-CO_2 greenhouse gas: Efficient destruction of CF_4 in an excess enthalpy combustor

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Background: CF_4 (tetrafluoromethane) being widely used as a cleaning and etching agent in semiconductor or display industry has a large global warming potential. In addition, it is chemically stable so that it is hardly decomposed even below 1600 by thermal methods. As it is usually utilized together with other explosive or toxic gases, it is diluted to around several thousands of ppm by N_2 before being disposed of. This excessive dilution makes it difficult to destruct the waste gas effectively. In this study, we developed an energy-efficient method of CF_4 destruction in an excess enthalpy combustor.

Experiment: An excess enthalpy combustor is a sort of two-section porous medium burner; two silicon carbide honeycombs with different cell sizes but with the same cylindrical shape were axially stacked. The emulated waste gas (CF_4, N_2) and the fuel-oxidant (CH_4, O_2) were fully premixed before being supplied to the combustor. A reaction front of combustion was stabilized around an interface between two honeycombs and the CF_4 inlet and outlet concentrations were measured by FTIR to determine a destruction efficiency of CF_4.

Findings: As a representative result presented in Fig. 1 shows, 94.6% of CF_4 was destructed and chemically transformed to HF, CO_2, and H2O when the inlet CF_4 concentration was 2,150 ppm with the fuel usage of 18 LPM. This fuel usage in the destructing unit volume of CF_4 is much less than that of commercial abatement systems by about 30%. In addition, our combustor attained much higher CF_4 destruction efficiency than the commercial systems.

Conclusion: Our excess enthalpy combustor was found to have an advantage in reducing the greenhouse gas emissions, not only of CF_4 but also of CO_2 via reduced fuel usage.

Biography

Dae Keun Lee is a Principal Researcher at Korea Research Institute of Energy Research (KIER). He received his PhD degree from Korea Advanced Institute of Science and Technology (KAIST). His major concerns are fundamental understanding and practical applications of thermo-chemico and fluid dynamics, especially including combustion, by using mathematical and experimental methods.

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