様式

論　文　内　容　の　要　旨

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The effects of unburned-gas temperature and heat loss on the intrinsic instabilities of premixed flames were studied numerically based on the diffusive-thermal model equation and compressible Navier-Stokes equation. The characteristics of cellular premixed flames generated by intrinsic instability, i.e. the burning velocity, unstable behavior and flame structure, were examined. The instability intensity became stronger (weaker) as the unburned-gas temperature became lower (higher). This was due to thermal expansion and apparent activation energy. When radiative heat loss was considered, the normalized burning velocity of a cellular flame increased at small Lewis numbers. This was because of the destabilizing influence of heat loss on small Lewis number flames. The dissertation consists of five chapters:

Chapter 1 describes the introduction about the importance of energy from combustion for environment and human, and the background of research study field. After that, related works are reviewed. In a wide range of the application of combustion processes, to reduce the pollutant emissions from the combustion of fossil fuel is essential. The research in the field of finding the possible ways in the reduction of emissions while increasing the efficiency of combustion processes has been carried out since many decades. This research is one of the contributing works not only for finding the available energy source in low temperature environment but also for reduction of pollutant emissions from combustion process.

Chapter 2 presents the numerical calculation procedures in detail consisting of theoretical model, assumptions, governing equations and numerical method to elucidate the characteristics of the intrinsic instabilities of premixed flames.

Chapter 3 describes the results of numerical calculations based on the diffusive-thermal model equation on the elucidations of the characteristics of diffusive-thermal instability which is dominant in hydrogen-air or methane-air premixed combustion at sufficiently small Lewis numbers. At first, high-temperature unburned gas is considered for adiabatic and non-adiabatic premixed flames, and then premixed flames with low-temperature unburned gases are simulated. The results include the effects of unburned-gas temperature and heat loss on the characteristics of the premixed flames, such as burning velocities of planar and cellular flames, unstable behavior and structure of cellular flame fronts.

Chapter 4 presents the investigations on both diffusive-thermal and hydrodynamic instabilities especially for premixed flames with low-temperature

unburned gases under the adiabatic and non-adiabatic conditions at Lewis numbers equal to and less than unity. The numerical calculation is based on the compressible Navier-Stokes equation with chemical reaction. The numerical results include the characteristics of premixed flames, such as burning velocities, unstable behavior and formation of cellular flame fronts. The analytical and numerical results for burning velocity of planar flames and dispersion relations at Lewis number unity are also compared in this chapter.

Chapter 5 consists of the conclusions on the research calculations, and the future work including the different methods for the extensive studies to evaluate the characteristics of the lean premixed flames of hydrogen-air or methane-air or hydrogen-hydrocarbon-air with various equivalence ratios and different unburned-gas temperatures.