The Dynamic Behavior of Cellular Premixed Flames Generated by Hydrodynamic and Diffusive-Thermal Instabilities under the Low Temperature Conditions

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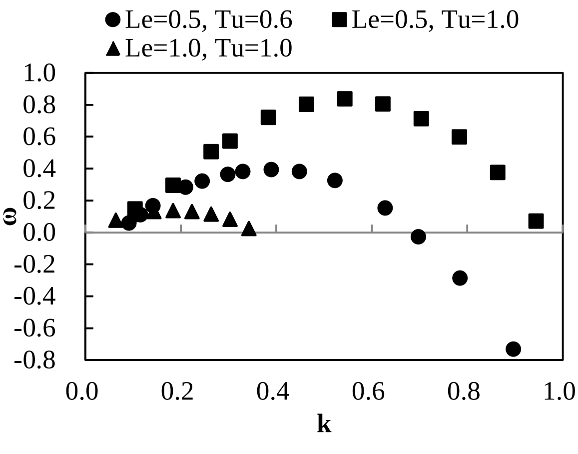
Abstract

The effects of unburned-gas temperature on the dynamic behavior of cellular premixed flames in large space were investigated. Unsteady reactive flow was calculated numerically, based on the compressible Navier-Stokes equation including chemical reaction. As the unburned-gas temperature became lower, the growth rate decreased and the unstable range narrowed, which was due to the reduction of the burning velocity of a planar flame. On the other hand, the normalized growth rate increased and the normalized unstable range widened under the low temperature conditions. This was due to the strength of thermal-expansion effects and to the enlargement of Zeldovich numbers. Furthermore, cellular flames appeared owing to hydrodynamic and diffusive-thermal instabilities. We found the dynamic behavior of cellular flames, i.e. the coalescence and divide of cells. The burning velocity a cellular flame changed drastically with time. The burning velocity of a cellular flame normalized by that of a planar flame increased as the unburned-gas temperature became lower. In addition, the burning velocity of a cellular flame generated by intrinsic instability depended strongly on the space size. As the space became larger, the burning velocity increased monotonously. This was because that the long-wavelength components of disturbances played a significant role in the dynamics of cellular flames.



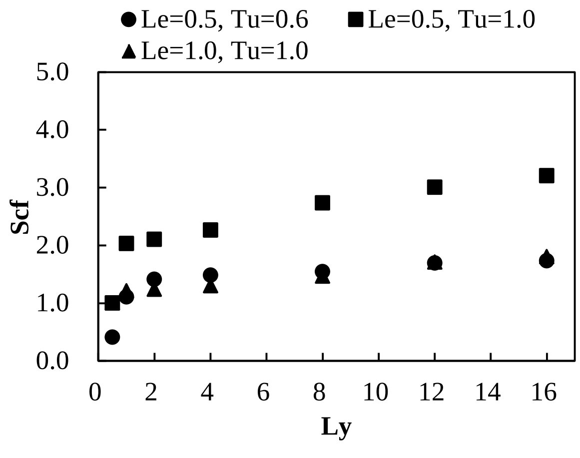


Figure 1. Dispersion relations and the burning velocities of cellular flames at the Lewis number Le = 0.5 & 1.0 and the unburned-gas temperature T_u = 0.6 &1.0.