The Experimental Research of the Droplets Combustion Oscillations in a Fine Straight Tube

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Abstract: Due to the perturbance of the fuel injection, periodic combustion oscillations take place in the combustion zone. In order to study the influence of fuel type and fuel flow rate on combustion instability, experimental researches on oscillation phenomenon and flame behaviors of droplets combustion in a fine straight tube are performed in this study. Experiments were carried out on micro-combustion system which can provide air/oxygen flow, continuous liquid fuel supply, temperature measurement and recording, and the experimental photos. The flame is intrinsically unsteady and oscillates periodically in response to the fuel injection in the combustor. The temperature history also shows the oscillation characteristics. The energy density and evaporator energy are the main evaporation performance parameters of fuel, which could be the influence factors for combustion oscillation. The power spectrum of temperature fluctuations of four fuels shows that the higher energy density and lower evaporator energy, the flame oscillation is less evident. This is because the fuel with higher energy density can release more heat as the same volume flow rate, and make the combustion more stability. The frequency is proportional to the evaporator energy, and inversely proportional to the energy density. The fuel with smaller evaporator energy can be easier to evaporate and less absorption of heat. This is good for instability. And the time of the droplet aggregation time is longer which lead to the frequency smaller. Fuel mass flow rate also is an important factor for oscillation. Temperature amplitudes as a function of frequency under different n-heptane flow rates are researched. And it is obvious that the dominant frequency and oscillation amplitude are affected by fuel flow rates. The frequency augments with the increase of the flow rate. For the oscillation amplitude, it decreases at first and then increases with the increase of the flow rate, get the minimum when the equivalent ratio is slightly larger than 1.

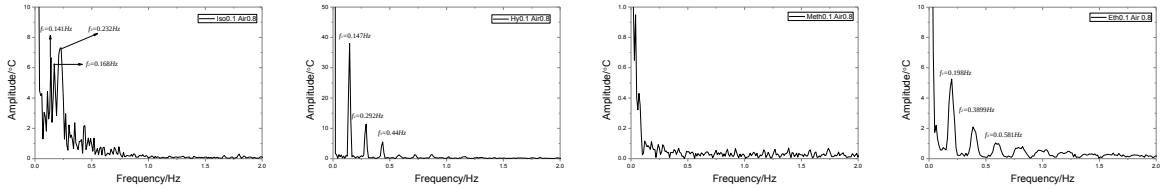
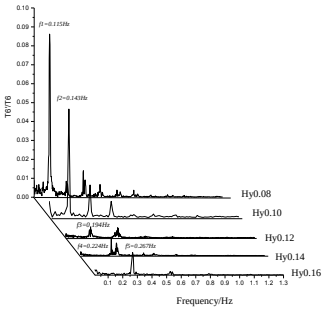
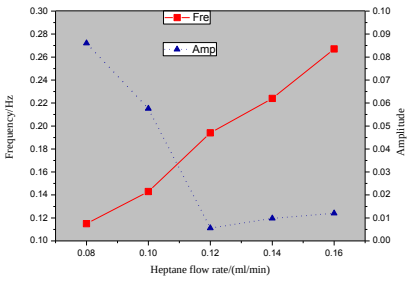


Fig.1 Power spectrum of temperature fluctuation of the four kinds fuels



(a) Power spectrum of temperature fluctuation of n-heptane combustion



(b) Temperature oscillation frequency and max non-dimensional amplitude variation with n-heptane volume flow rates

Fig.2 The oscillation phenomenon with n-heptane volume flow rates