

Numerical studies on ignition in counter flow

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Ignition in axisymmetric counter flow configuration are numerically studied and the combined effect of Lewis number and strain rate on minimum ignition energy are revealed. We use steady flame solutions to construct a cylindrical flame kernel called flame tube and describe the transient evolution and topological structure of triple flames after initiation for different representative strain rates. It is found that corresponding to each given strain rate and Lewis number, there exist a critical radius that separates the extinction and ignition edge. At this critical radius, the flame tube is unstable. Small perturbations lead to either extinction or ignition. The value of critical radius decreases monotonically with the increase of strain rate or Lewis number. This implies there exists a possible minimum ignition energy.

Furthermore, we use spherical hot inert gas as ignition kernel in stagnation plane to investigate the minimum ignition energy and describe the initiation and evolution of ignition edge flame. It is found that large strain rate influences premixed branches and leads to more heat loss due to convection. Therefore, it weakens the flame, and require larger minimum ignition energy. Besides, large Lewis number also weakens the flame due to leakages of reactants, and require larger minimum ignition energy. For non-unity Lewis number, edge flame first propagates to stoichiometric plane and then propagates to the whole plane. The diffusion branch of triple flames vanishes for small Lewis numbers.