APCOM & ISCM
11-14th December, 2013, Singapore

Numerical Simulation on Mechanism of Flame Acceleration and Transition from Deflagration to Detonation for Combustible Gas

***C. Wang, W. H. Han, and J. G. Ning**

State Key Laboratory of Explosion Science and Technology, Beijing Institute of Technology, Beijing, China

*Corresponding author: wangcheng@bit.edu.cn

This paper establishes the reacting flow governing equations with viscous diffusion and heat conduction, and the reaction model to describe energy release characteristics in the different stages of flame acceleration and deflagration-to-detonation transition (DDT). A high-resolution parallel code is developed by using 5-th order weighted essentially non-oscillatory WENO scheme to handle strong discontinuous with a chemical reaction. It is employed to simulate the whole process from ignition, flame acceleration and DDT in the narrow and smooth duct. The numerical results show that DDT results from the interaction of boundary layer with compression wave in front of flame. Then we study the effect obstacles on flame acceleration. The results display that increasing of spacing between obstacles results in velocity fluctuating and intense turbulence, which makes up the effect of gas compression on flame acceleration ratio, and reveal that hot spot, turbulence and combustion reaction band play an important role in the formation of DDT. It is found that DDT distance in the duct with obstacle becomes shorter than in the smooth duct. Based on this, the acceleration mechanism of 3D laminar flame is simulated. It is revealed that the third dimensional turbulent effect in boundary layer leads to increase in flame acceleration ratio. These results have an important application value for the design of explosion disaster prevention and detonation propulsion.

Keywords: Flame, Flame acceleration, DDT, High-resolution computing