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Zero-Dimensional Modelling of Pulsed Jet Combustion in a Constant Volume Chamber

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ABSTRACT

The zero-dimensional thermo-chemical model for the two-step combustion in the Pulsed Jet Combustion (PJC) in a constant volume chamber is proposed in the paper. In the first step, a rich air-fuel mixture is burned in the prechamber. The combustion products have equilibrium composition and thermo-chemical parameters calculated with the STANJAN code. Then a high-speed turbulent plume of combustion products is isentropically injected into the main chamber. The plume is composed of multiple vortices of different sizes which provide multiple ignition sites. Composition and temperature are assumed as uniform in each vortex while pressure is assumed as uniform in the whole chamber. Combustion is sustained in the vortices due to mixing of the high-temperature combustion products with the cold fresh air-fuel mixture. Vortices grow in size due to engulfing new portions of fresh mixture and due to thermal expansion caused by chemical reaction of one-step Arrhenius type. The combustion terminates when the entire mixture is burned or when rate of entrainment of cold mixture by the vortices is so high that combustion can not be sustained. As an example, a combustion of stoichiometric methane-air mixture is considered in the paper. The effects of velocity associated with mass flow rate of entrainment of the fresh mixture, number of vortices and mass and velocity distribution on pressure history in the chamber are presented in diagrams.