Seminar

Institute for Plasma Research

Title : Numerical Simulations of Deflagration to Detonation Transition (DDT) process in Pulse Detonation Engine

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Date : 27th April 2018 (Friday)

Time : 10.30 AM

Venue : Seminar Hall, IPR

Abstract :

The Pulse Detonation Engine (PDE) is a modern rocket engine having thermo-dynamical efficiency better than the present rocket engines and relatively simpler design. The basic idea of a PDE is to get thrust from frequent repetitive detonations in a fuel-air mixture. In the present work, a Fortran code which is based up on the methodology of Conchas-Spray code has been used to study the Deflagration to Detonation Transition (DDT) phenomenon in a long tube. The DDT distance, which decides the size of the PDE, is strongly dependent upon many variables, e.g. size & spatial distribution of fuel droplets, spark energy provided etc. The code performs two dimensional axisymmetric CFD simulations, taking into account phenomena such as liquid droplet dynamics & evaporation and gas-phase chemical reactions. The fuel used in the problem is Iso- Octane. The DDT distance has been studied numerically for different combinations of these variables and the trends are presented. We have also performed studies to determine the effect of ambient temperature as well as the time of fuel injection, which controls the duration of one detonation cycle and also the frequency of operation.

Simulations were carried out to study the effect of gradients in fuel distribution on the onset of DDT. Gaseous octane-air mixtures have been examined by varying the equivalence ratio linearly along the axial direction of the detonation tube and taking different initial variations in the equivalence ratio. Overall stoichiometry was maintained in the whole tube. It is observed that DDT onset is significantly affected by the initial fuel distribution at the time of ignition. Three regimes have been observed. In the first regime, if the fuel density gradient is very small i.e. equivalence ratio is near to 1.0 in whole detonation tube, corresponding to a nearly uniform mixture, DDT occurs at large distances. In the second regime, with moderate gradients, DDT onset occurs at relatively short lengths where equivalence ratio near closed end is close to 1.20. Finally, in mixtures with larger gradients, DDT onset occurs at lengths exceeding 2 meters and the shock pressure does not become constant even up to the end of the tube. If the equivalence ratio near the open end is 1.4 or above, no stable detonation wave is formed even at 4 meters distance.