World Academy of Science, Engineering and Technology
International Journal of Aerospace and Mechanical Engineering
Vol:9, No:06, 2015

Study of a Lean Premixed Combustor: A Thermo Acoustic Analysis

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Abstract : In this study, thermo acoustic oscillations of a lean premixed combustor has been investigated, and a mono-dimensional code was developed in this regard. The linearized equations of motion are solved for perturbations with time dependence e^iwt. Two flame models were considered in this paper and the effect of mean flow and boundary conditions were also investigated. After manipulation of flame heat release equation together with the equations of flow perturbation within the main components of the combustor model (i.e., plenum/ premixed duct/ and combustion chamber) and by considering proper boundary conditions between the components of model, a system of eight homogeneous equations can be obtained. This simplification, for the main components of the combustor model, is convenient since low frequency acoustic waves are not affected by bends. Moreover, some elements in the combustor are smaller than the wavelength of propagated acoustic perturbations. A convection time is also assumed to characterize the required time for the acoustic velocity fluctuations to travel from the point of injection to the location of flame front in the combustion chamber. The influence of an extended flame model on the acoustic frequencies of combustor was also investigated, assuming the effect of flame speed as a function of equivalence ratio perturbation, on the rate of flame heat release. The abovementioned system of equations has a related eigenvalue equation which has complex roots. The sign of imaginary part of these roots determines whether the disturbances grow or decay and the real part of these roots would give the frequency of the modes. The results show a reasonable agreement between the predicted values of dominant frequencies in the present model and those calculated in previous related studies.

Keywords : combustion instability, dominant frequencies, flame speed, premixed combustor
Conference Title : ICFMHTT 2015 : International Conference on Fluid Mechanics, Heat Transfer and Thermodynamics
Conference Location : Copenhagen, Denmark
Conference Dates : June 11-12, 2015