World Academy of Science, Engineering and Technology
International Journal of Aerospace and Mechanical Engineering
Vol:12, No:12, 2018

Numerical Analysis of Supersonic Impinging Jets onto Resonance Tube

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Abstract : In recent, investigation of an unsteady flow inside the resonance tube have become a strongly motivated research field for their potential application as high-frequency actuators. By generating a shock wave inside the resonance tube, a high temperature and pressure can be achieved inside the tube, and this high temperature can also be used to ignite a jet engine. In the present research, a computational fluid dynamics (CFD) analysis was carried out to investigate the flow inside the resonance tube. The density-based solver of rhoCentralFoam in OpenFOAM was used to numerically simulate the flow. The supersonic jet that was driven by a cylindrical nozzle with a nominal exit diameter of φd = 20.3 mm impinged onto the resonance tube. The jet pressure ratio was varied between 2.6 and 7.8. The gap s between the nozzle exit and tube entrance was changed between 1.5d and 3.0d. The diameter and length of the tube were taken as D = 1.25d and L=3.0D, respectively. As a result, when a supersonic jet has impinged onto the resonance tube, a compression wave was found generating inside the tube and propagating towards the tube end wall. This wave train resulted in a rise in the end wall gas temperature and pressure. While, in an outflow phase, the gas near tube enwall was found cooling back isentropically to its initial temperature. Thus, the compression waves repeated a reciprocating motion in the tube like a piston, and a fluctuation in the end wall pressures and temperatures were observed. A significant change was found in the end wall pressures and temperatures with a change of jet flow conditions. In this study, the highest temperature was confirmed at a jet pressure ratio of 4.2 and a gap of s=2.0d

Keywords : compressible flow, OpenFOAM, oscillations, a resonance tube, shockwave
Conference Title : ICAEFLVA 2018 : International Conference on Aerospace Engineering, Flying Vehicles and Aerodynamics
Conference Location : Bangkok, Thailand
Conference Dates : December 13-14, 2018

Open Science Index, Aerospace and Mechanical Engineering Vol:12, No:12, 2018 publications.waset.org/abstracts/98109.pdf