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INVESTIGATION ON EXHAUST PLUME RADIATION OF LOX/KEROSENE ROCKET ENGINE

Abstract

The LOX/Kerosene engine, YF-100, designed by Xi'an Aerospace Propulsion Institute, is the first stage engine of Chinese new generation launch vehicle Long-March 6 (CZ-6), which has been successfully launched in Sep. 2015. During the rocket launch or engine trial, launch pad or test bench will be heated intensely by high temperature gas exhausted from the engine nozzle. Because of the low oxygen-fuel equivalence ratio in thrust chamber of the engine, the combustion product is fuel-rich hot gas. Combustion occurs after the fuel-rich hot gas exhausting from engine nozzle and mixing with surrounding air. High temperature flame generates in the gas-air mixing layer. This phenomenon is called afterburning. Radiant heat holds a great quantity and convection holds a less, because the plume do not scour the launch pad directly. In this paper, researches on exhaust plume radiative heat transfer of LOX/Kerosene rocket engine is presented. Firstly, nozzle and plume flow field is obtained via solving Reynolds Averaged Navier-Stokes equations with k-e turbulent model. Finite-rate combustion model is employed to describe the equilibrium flow and afterburning. Secondly, the radiative heat transfer is investigated based on the temperature, pressure and species fraction of the plume flow field calculated previously. Discrete ordinates model (DOM) is used to simulate radiative heat transfer, and narrow band model is used to simulate absorption coefficient of gas. Furthermore, the accuracy and reliability of simulation model are verified through comparison with the radiation measurement in engine trial run. Analysis and simulation results show that afterburning effects lead to a much higher heat flux than expected. Thermal protection method of launch pad is suggested according to the results in the end of this paper.