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IGNITION AND COMBUSTION OF MULTI-PHASE FUEL-OXIDANT MIXTURES IN ROCKET ENGINES

Abstract

Ignition and stable combustion in rocket engines of the third stage is a peculiar problem, because very often mixture formation and ignition should take place in weightlessness under the conditions thermogravitational convection mechanism of mixing being damped. Besides, in the engines using hydrogen as fuel the mixture is of “inverse” type, which means fuel is present in gaseous phase (hydrogen), while oxidant is liquid. The paper presents the results of developing of physical and mathematical model making it possible to take into account the effect of droplets density on ignition conditions for aerosols, the problem of the influence of condensed phase volume fraction on ignition and combustion of sprays was studied, physical and mathematical models for multi-phase flows, mixture formation and combustion of liquid fuels in rocket engines based on solving Navier-Stokes equations for gas phase accounting for thermal and mechanical interaction with polidispersed droplets array. The problems of particulate phase dynamics are regarded accounting for the interaction with gas phase atomization, sedimentation, evaporation and combustion. New models for mechanical interaction of droplets with each other in central collisions were developed, in particular, models for fragmentation and agglomeration taking into account their difference in size. Results of investigations of the effects of droplets volume density on ignition and combustion of sprays showed, that the increase of droplets volume share and droplet radius both create less favorable conditions for shock wave ignition, and increase the induction period. On the contrary, on fuel injection into heated and pressurized atmosphere of combustion chamber under the condition of rich mixture the decrease of droplets radius creates less favorable ignition conditions. Russian Foundation for Basic Research is acknowledged for financial support (Project 11-01-12024)