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SUPERCOMPUTER MODELING OF PULSE DETONATION ENGINES FED BY ACETYLENE –HYDROGEN

Abstract

Computer aided design of new effective engines needs mathematical tools for supercomputer modeling of components mixing and combustion in rocket engines. Pulse detonation engines is a new trend in increasing rocket engines effectiveness. The paper presents the results of developing verification and validation of mathematical model making it possible to simulate unsteady processes of ignition and deflagration to detonation transition in novel type of pulse detonation engines. One of peculiarities of hydrogen-oxygen rocket engine is the following. On injecting liquid components fuel (hydrogen) having must lower critical temperature comes pre-evaporated and pre-heated in combustion chamber, while oxygen could be liquid then evaporating inside the chamber. Thus contrary to most types of engines hydrogen engine has an inverse mixture entering combustion chamber, in which fuel is gaseous and oxidant is liquid. Combustion in terrestrial conditions is strongly affected by thermogravitational instability, which provides additional very effective mixing of the components and formation of combustible mixture in the vicinity of each droplet. On the contrary, this mechanism does not work under low gravity conditions. Only diffusion contributes to mixing, which makes ignition and combustion conditions less favorable. It should be mentioned, that thermo-convective effect on droplet evaporation manifest as long as Mar number (ratio of evaporation and convection times) is larger then unity. Under microgravity conditions Mar number tends to zero and thermo-convective mixing is not essential for all sizes of droplets. Thus ignition and combustion under microgravity needs special investigation.