IAF MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Interactive Presentations - IAF MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (IP)

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BURNING OF A SINGLE FUEL DROPLET CONTAINING METALLIC PARTICLES IN WEIGHTLESSNESS

Abstract

Most of liquid fuels are being injected into the combustion chamber in the form of liquid sprays, and then evaporation of liquid fuel brings to formation of the combustible mixture of fuel vapor with gaseous oxidant, which is finally burning in the combustion chamber. Solid metallic fuels being injected in the form of a powder in the gaseous oxidant atmosphere burn, mostly, in heterogeneous reacting regime, under which reaction between gaseous oxidant and condensed metal takes place on the surface of the particle. In both combustion mechanisms: gas phase reaction and heterogeneous reaction, - diffusion plays predominant role, because thermal convection being essential in ground based combustion, is negligible in weightlessness. The mechanisms of and models for combustion of such droplets and/or particles are well developed and are being used successfully in main combustion simulators. Aimed at increasing fuel burning thermal efficiency metallic powder could be mixed with liquid fuel. This mixture being injected into combustion chamber forms two-phase droplets, containing both liquid phase and solid particles. Burning of such a two-phase droplet needs a peculiar model. Metallic particles being surrounded by liquid hydrocarbon cannot burn due to the relatively low temperature of fluid. Gradual evaporation of liquid fuel and formation of a diffusion microflame would bring metallic particles to the surface, where they could be heated and enter into heterogeneous reaction with oxidant. The surface fraction of solid particles would grow on evaporating the liquid. Thus the free surface of liquid contributing to evaporation, drastically decreases. On the other hand, surface energy release due to heterogeneous chemical reactions on the surface of particles would increase the heat flux spent for fluid evaporation. All these processes should be taken into account in developing models for two-phase droplets burning in weightlessness. The present research is aimed at developing model of two-phase droplets burning. The present investigation was supported by Russian Foundation for Basic Research (RFBR project code 18-07-00248)