MICROGRAVITY SCIENCES AND PROCESSES (A2)
Fluid and Materials Sciences (2)

Author: Prof. Nickolay N. Smirnov
Lomonosov Moscow State University, Russian Federation, ebifsun1@mech.math.msu.su

Prof. Vladimir Betelin
Russian Federation, betelin@niisi.msk.ru
Mr. Dmitriy Gromov
Russian Academy of Sciences, Russian Federation, d_grom@mail.ru
Dr. Anatolii Kushnirenko
Russian Academy of Sciences, Russian Federation, agk_@niisi.msk.ru
Dr. Valeriy Nikitin
Lomonosov Moscow State University, Russian Federation, *(email is not specified)*
Mrs. Valentina Nerchenko
Lomonosov Moscow State University, Russian Federation, ebifsun1@mech.math.msu.su

SUPERCOMPUTER MODELING OF POLY-DISPERSED SPRAYS EVAPORATION AND COMBUSTION IN A HEATED ATMOSPHERE

Abstract

Evaporation and combustion under terrestrial conditions are strongly influenced by gravity induced thermoconvective flows. Those effects mask the influence of non-equilibrium processes in phase transitions making the proper understanding of the phenomenon very difficult in the ground-based experiments. Besides, non-equilibrium effects have a stronger manifestation under low gravity conditions for interfaces of high curvature. The aim of the present study is to develop a mathematical model for the non-equilibrium evaporation, ignition and combustion of sprays being injected into a heated atmosphere. The problems of fuel droplets atomization, evaporation being the key factors for heterogeneous reacting mixtures, the non-equilibrium effects in droplets atomization and phase transitions will be taken into account in describing thermal and mechanical interaction of droplets with streaming flows. As it was shown before, accounting for non-equilibrium effects in evaporation for many types of widely used liquids is crucial for droplet diameters less than 100 microns, while the surface tension effects essentially manifest only for droplets below 0.1 micron. Investigating the behavior of individual droplets in a heated air flow allowed to distinguish two scenarios for droplet heating and evaporation. Small droplets undergo successively heating, then cooling due to heat losses for evaporation, and then rapid heating till the end of their life time. Larger droplets could directly be heated up to a critical temperature and then evaporate rapidly. Droplet atomization interferes the heating, evaporation and combustion scenario and brings to segregation of droplets in spray due to much more rapid deceleration of small droplets. Methods for parallel computing of the problem were developed making it possible to take into account enormous number of droplets in spray.
The support of Russian Foundation for basic research is gratefully acknowledged (projects 10-07-00354 and 09-08-00284).