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Science Results from Ground Based Research (4)

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MULTI-PHASE COMBUSTION IN WEIGHTLESSNESS

Abstract

It is an acute problem to ensure the safety of space flights and the reliable operation of the space infrastructure on the space station. The course of many processes in weightlessness differs significantly from the course of processes on Earth in the presence of gravity. In conditions of "weightlessness" when spacecraft move in near-earth orbits, these spacecraft carry multidirectional microaccelerations, which form a special environment called "microgravity". The mechanisms of development of many hydrogasdynamic and physicochemical processes under microgravity conditions require a separate special study. One of the most dangerous scenarios on the space station is the development of a fire in microgravity. At the same time, the main factors affecting the spread of the flame are air flows in the atmosphere of the station, as well as heat flows in the materials of internal coatings. Therefore, the safety criteria in terms of flame propagation for the International Space Station (ISS) are particularly important. The processes taking place in zero gravity have their own characteristics. For example, the absence of gravity leads to the fact that combustible products formed as a result of a chemical reaction are not carried away from the surface, but remain close to it, i.e. cessation of combustion (absence of visible flame) cannot serve as a guarantee that combustion will not occur again at the slightest movement of air flows in the station's atmosphere. In addition, contrary to expectations, some materials turned out to be more flammable in zero gravity than on Earth. Thus, the results of experimental and theoretical studies will improve safety on board the spacecraft and develop protocols for actions in the event of a fire for astronauts, as well as contribute to the creation of new materials and fire extinguishing systems on the ISS. In addition, the fundamental results obtained with full or partial disabling of the effects of gravity will allow a better understanding of the combustion process, which in turn can lead to more efficient combustion of fuels on Earth, as well as reduce the formation of soot and other negative effects. Investigating the behavior of individual droplets in a heated airflow allowed distinguishing two scenarios for droplet heating and evaporation. Small droplets undergo successively heating, then cooling due to heat losses for evaporation, and then rapid heating until the end of their lifetime. Larger droplets could directly be heated up to a critical temperature and then evaporate rapidly. Atomization of droplets interferes heating and evaporation scenario. (The research was partially supported by Russian Science foundation (20-03-00297)