SPACE PROPULSION SYMPOSIUM (C4)
Hypersonic and Combined Cycle Propulsion (5)

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PROBLEMS OF RAMJET USE ON THE HYPERSONIC SEGMENT OF PROSPECTIVE SPACE VEHICLE INJECTION TRAJECTORY

Abstract

To assure flight of space vehicle with a ramjet at a hypersonic segment of an injection trajectory it is necessary to investigate some engineering problems. The most important among them are: – creation of conditions for hydrocarbonic fuel steady burning in co- current sub- and supersonic stream and guarantee full burning in the combustion chamber of design acceptable length; – optimization of the injection trajectory on the basis of ratio between the fineness and weight, the admissible level of heat fluxes and the pressure head for providing thrust of the ramjet. At the organization of gaseous fuel burning in the combustion chamber of the ramjet the problems occur at the flight speed corresponding to Mach numbers 6-10 and higher. Under these conditions the air temperature at its compression in an inlet can be compared to the temperature at which combustion products dissociation takes place. So the temperature increase that is necessary for making sufficient level of a thrust is problematic. The way out is reached by the reduction of the inlet air compressing in such a manner that the speed of its flow through the combustion chamber is much less than the flight speed, but it is still supersonic one and the static temperature is essentially lower than the temperature of combustion products dissociation. The second circle of problems connected with the ramjet effective using arises at the choice of the injection trajectory at the hypersonic flight at altitudes higher than 30 kilometers at rather small air density. Parameters of this trajectory segment should be chosen to use the fineness maximally, to provide the demanded for the engine operation pressure head, and do not allow the heat fluxes to exceed some limit level. In the report the connected problems are discussed; and proposals on the organization of braking processes in the inlet and burning with the purpose of calorific value fuel maximal use and brake pressure losses reduction are formulated. The research is carried out for the three kinds of fuel: hydrogen, methane and products of aviation kerosene thermochemical conversion. Various combinations of compression rate in the inlet, the character of combustion chamber cross-section area change, fuel discharge intensity are thus considered. The possibility of fuel afterburning in the combustion chamber extending nozzle is considered as well. The analysis of requirements to the fineness value sufficient for the hypersonic flight on the ascending trajectory at restrictions on heat fluxes and achievable thrust levels of the ramjet in the conditions of pressure head along the trajectory is given. On the basis of the carried out analysis the conceptual positions of ramjet use on the hypersonic segment of the space vehicle injection trajectory are formulated.