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Hypersonic Air-breathing and Combined Cycle Propulsion, and Hypersonic Vehicle (7)

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SIMULATION OF DIFFERENT MIXTURE FEEDING REGIMES IN A CONTINUOUS WAVE DETONATION ENGINE

Abstract

The Rotating Detonation Engine (RDE) has attracted the attention of an increasing number of researchers in recent decades due to the high efficiency of the thermal detonation cycle. Compared to a pulse detonation engine (PDE), RDEs can provide a steady thrust after ignition, due to their relatively small size, they can be applied in practical propulsion systems. The RDE could be one of the next-generation powerplants. The work considers a numerical model of an engine with a rotating detonation wave. The mathematical model describing the combustion chamber of the device consists of the balance equations for a multicomponent gas mixture with chemical transformations and considering the transport phenomena in the turbulent mode. The combustible gas mixtures under consideration are acetylene-oxygen and hydrogen-oxygen. A combustion chamber with an internal body is a space enclosed between an external cylinder and an internal cylindrical working body located inside it. The case of fuel and oxidizer supply parallel to the axis of the combustion chamber was considered. The supply of fuel and oxidizer was assumed either pre-mixed, or separate. The combustible mixture feed was considered either from a slot, or from separate injectors. The ignition of the mixture was modeled by a short-term source of energy in a given place of the combustion chamber. The influence of fuel composition, the number of injectors, their location and size, and the width of the slot on the traction characteristics was considered. In some variants of fuel mixture supply, a stable detonation mode cannot be obtained, and the detonation wave degenerated into a normal combustion mode. The influence of the combustible components feed configuration on the traction characteristics of the engine was also studied. This work was supported by the subsidy given to the Federal State Institution “Scientific Research Institute for System Analysis of the Russian Academy of Sciences” to implement the state assignment on the topic No. 0580-2021-0021 “Development of algorithms and codes for multiscale processes and combustion simulations”.