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EFFECT OF A DETONATION WAVE ON AN OVEREXPANDED GAS FLOW IN A NOZZLE

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This paper proposes to use the detonation process to solve the problem of controlling highly maneuverable flying vehicles. The goal of the work is to study a new way of the thrust vector control of a rocket engine using the effect of a detonation shock wave on the gas flow in the nozzle.

It is known that the method of thrust vector control by gas injection into the supersonic nozzle area of a rocket engine features one of the lowest losses of specific momentum and a high response speed and produces a significant lateral force. However, for the current level of rocket technology, there is a need to improve these characteristics. Detonation is considered as a method to intensify processes that affect the main gas flow and produce a lateral force. Its features make it possible to develop a system for pulse trajectory correction. In order to study the features of such a system, experimental studies of the detonation wave effect on a supersonic nozzle flow were conducted. A nozzle model and a gas generator for initiating a detonation wave interacting with the main supersonic air flow were developed and made. In the course of experiments, the effect of separation of the main flow from the nozzle wall by the detonation wave during the nozzle operation in the overexpansion mode was revealed. The duration of this effect was much longer than that of the detonation product effect on the main air flow in the nozzle, thus allowing it to be used in the development of a new thrust vector control method.

To better understand the experimental results, a numerical simulation of the detonation wave propagation in a supersonic flow was carried out for the test conditions. The simulation was carried out in a non-stationary 2D formulation using the Solid Works software package. The goal of the simulation was to estimate the flow structure and the value of the relative lateral force produced by the change of this structure during detonation product injection into the supersonic nozzle area. The time evolution of the pressure field was obtained. The relative lateral force produced by detonation product injection into the supersonic air flow in the nozzle was determined.

The presented features and method of jet engine thrust vector control may be used in unmanned systems operating in a wide range of speeds.

Keywords: *injection, detonation engine, overcritical section, thrust vector control, nozzle.*

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