

THRUST VECTOR CONTROL BY DETONATION PRODUCT INJECTION INTO THE SUPERSONIC NOZZLE AREA

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To solve the problem of satellite control and stabilization in emergencies, it is proposed to use a detonation rocket engine, which enables active maneuvering to avoid a collision with space debris. The goal of this work is to study a new way of rocket engine thrust vector control by acting with a detonation shock wave on the gas flow in the nozzle.

A detonation wave in a supersonic flow in a nozzle was numerically simulated. The simulation was conducted in a non-stationary plane formulation at different angles of inclination of the detonation gas generator that initiates a detonation shock wave to the combustion chamber axis with the use of SolidWorks application software for the 11D25 engine of the Cyclone-3 third stage. The simulation results were used to pre-optimize the location of the detonation gas generator on the nozzle wall. It was found that the effect of the detonation wave on the main gas flow in the nozzle is caused by two force factors: the first is due to the reactive force produced by the detonation product injection into the nozzle and a high-pressure zone on the wall where the detonation gas generator is mounted, and the second is due to a change in pressure distribution over the nozzle surface. In order to increase the effect of the shock wave, the detonation products must be injected parallel to the main gas flow in the nozzle or at some angle. The simulation showed the drawbacks and advantages of detonation product injection at different angles. The detonation wave effect on a supersonic nozzle flow was studied experimentally. A system was developed to record the shock detonation wave propagation using a heat meter. A special nozzle model and a gas generator were developed to initiate a detonation wave interacting with a supersonic air flow. It was found out how the detonation wave separates the main flow from the nozzle walls in the overexpanded mode. The results may be used in the space-rocket industry to provide upper stage maneuvering to avoid a collision with space debris.

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

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