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EFFECT OF THE TIP GEOMETRY OF A TRUNCATED SUPERSONIC NOZZLE ON ITS CHARACTERISTICS

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Truncated nozzles are used for tight packing of the rocket engine. Such nozzles have a profiled tip to maximize the filling of space and reduce the overall weight. This paper is concerned with the study the effect of the tip geometry of a truncated supersonic nozzle on its characteristics. The features of the gas flow at different initial pressures and different environmental conditions in the supersonic area of a nozzle with a bell-shaped tip of different lengths are considered. The flow inside the nozzle followed by the jet outflow into the surrounding space was simulated. The flow simulation for tips at sea level showed a similar structure of the Mach number isolines, and the only difference was in the intensity of the vortex structure near the tip wall. As the pressure at the nozzle inlet increases, the length of the first “barrel” increases proportionally, and the vortex structure near the tip walls decreases. For the upper atmosphere, the flow pattern is different. The supersonic flow in the nozzle does not undergo separation, and therefore there are no vortex structures from the external environment. The flow downstream of the tip exit deflects from the axis through the angle determined by the Prandtl–Meier flow at the corner point of the tip exit, and the shape of the first “barrel” is distorted by a hanging shock. An analysis of the obtained results shows that the ambient pressure downstream the nozzle exit significantly affects the flow pattern in the nozzle. It is established that the thrust coefficient of both circuits at sea level decreases with increasing pressure at the nozzle inlet, which is explained by a decrease in the effect of the ambient pressure on the tip wall. In the upper atmosphere, the flow is adjacent to the tip wall, and the thrust coefficient for nozzles of different lengths has almost the same constant value at different inlet pressures. It is shown that a decrease in the length of the nozzle, all other geometrical dimensions of the nozzle being equal, does not significantly affect the impulse characteristics.

Keywords: *truncated nozzle, supersonic flow, bell-shaped tip, impulse response, vortex flow*.

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