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Computational Fluid Dynamics Model of Various Types of Rocket Engine Nozzles

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Abstract : The nozzle is an element of the rocket engine in which the conversion of the potential energy of gases generated during combustion into the kinetic energy of the gas stream takes place. The design parameters of the nozzle have a decisive influence on the ballistic characteristics of the engine. Designing a nozzle assembly is, therefore, one of the most responsible stages in developing a rocket engine design. The paper presents the results of the simulation of three types of rocket propulsion nozzles. Calculations were made using CFD (Computational Fluid Dynamics) in ANSYS Fluent software. The next types of nozzles differ in shape. The analysis was made of a conical nozzle, a bell type nozzle with a conical supersonic part and a bell type nozzle. Calculation results are presented in the form of pressure, velocity and kinetic energy distributions of turbulence in the longitudinal section. The courses of these values along the nozzles are also presented. The results show that the cone nozzle generates strong turbulence in the critical section. Which negatively affect the flow of the working medium. In the case of a bell nozzle, the transformation of the wall caused the elimination of flow disturbances in the critical section. This reduces the probability of waves forming before or after the trailing edge. The most sophisticated construction is the bell type nozzle. It allows you to maximize performance without adding extra weight. The bell type nozzle can be used as a starter and auxiliary engine nozzle due to its advantages. The project/research was financed in the framework of the project Lublin University of Technology-Regional Excellence Initiative, funded by the Polish Ministry of Science and Higher Education (contract no. 030/RID/2018/19).

Keywords : computational fluid dynamics, nozzle, rocket engine, supersonic flow

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