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OPTIMIZATION OF TWO-STAGE CENTRIFUGAL PUMP OF ROCKET ENGINE

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Abstract: The article presents a method for improving the characteristics of fuel pump of rocket engine by the joint usage of mathematical optimization software IOSO, meshing complex NUMECA and CFD programm ANSYS CFX. The optimization software was used for automatic change of the geometry of low-pressure impeller, transition duct and high-pressure impeller to find the optimal design. the original variant of the remaining parts of the pump was keeped. For this reason, only geometrical parameters of the blades were varied without changing the contours of the pump meridional flow part. The investigated pump consists of five parts: inlet duct, low-pressure screw centrifugal stage, transition duct, high-pressure screw centrifugal stage and volute outlet duct. The pump main parameters with water as the working fluid (based on experiment data) were the following: high-pressure stage rotor speed was 13300 rpm; low-pressure rotor speed was 3617 rpm by gearbox; inlet total pressure was 0.4 MPa; outlet mass flow was 132.6 kg/s at the nominal mode. Creation of vane unit mesh (rotors and stator transition duct) was performed using NUMECA AutoGrid5. Sector models were used for the calculation simplification. The flow around only one blade or screw was considered. Setting up and solution of the task were carried out in the ANSYS CFX solver. Comparison of calculated characteristics of the basic pump with the experimental data was performed before the optimization. The analysis of characteristics for the obtained optimized pump geometry was carried out. It was found that pump with optimized geometry has greater efficiency in comparison with the original pump variant. The obtained reserve can be used to boost the rocket engine, and/or to reduce the loading of the main turbine, which operates in aggressive oxidizing environment.