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NUMERICAL INVESTIGATION ON PERFORMANCE OF FUEL BOOSTER TURBOPUMP FOR STAGED COMBUSTION CYCLE BASED ROCKET ENGINE.

Abstract

ISRO is developing a 2000 kN Semi cryogenic engine which uses propellants, namely, Liquid oxygen (LOX) and Kerosene at high operating pressure of around 200 bar. For high chamber pressure generation in a rocket engine, booster pumps are required in addition to main pumps to provide necessary inlet pressure to the main pumps for its cavitation free operation. The Fuel Booster turbopump used for this engine is an axial flow three bladed inducer with single row partial admission hydraulic turbine of the tip turbine configuration. The volute casing forms a curved diffuser channel downstream of inducer with a conical diffuser at the exit. The required quantity of high pressure kerosene for driving the turbine is drawn from Main Fuel Pump outlet. From the turbine exit, fuel is routed to the pump exit where it mixes with the pumped kerosene. As the entire fuel is admitted into the rotor through two nozzles, high velocity at nozzle exit can cause severe drop in static pressure which may result in cavitation at the rotor blades which affects its performance and efficiency. In view of the above, a steady state three-dimensional CFD analysis of the Semicryo Fuel booster turbopump is carried out including cavitation modelling to determine its flow pattern and pressure distribution along with the performance of partially admitted turbopump for cold flow test condition. The results have been analysed to determine the region of cavitation inception. CFD results are validated with cold flow test carried out with demineralized water and subsequently performance is evaluated for the throttling range varying from 70 to 110 percent of nominal thrust.