UDC 532.528:621.671

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VERIFICATION OF A HYDRODYNAMIC MODEL OF A LIQUID-PROPELLANT ROCKET ENGINE'S CAVITATING PUMPS USING EXPERIMENTAL AND THEORETICAL PUMP TRANSFER MATRICES

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Cavities at the pump inlet may lead to inadmissible cavitation self-oscillations in the feed system of liquid-propellant rocket engines (LPREs) and to POGO instability if the oscillation frequency of the liquid is close to that of the rocket structure. Because of this, it is important to prevent both cavitation and POGO oscillations as early as at the engine and rocket design stage. This calls for a reliable mathematical model of the dynamics of LPRE cavitating pumps. In this paper, a hydrodynamic model of LPRE cavitating pumps is verified using theoretical and experimental transfer matrices of cavitating pumps. The experimental transfer matrix was borrowed from Brennen, Meissner, Lo, and Hoffman's work because it features the least spread of values among the matrices reported in the literature. The theoretical matrix was borrowed from Pilpenko and Kvasha's work where is was constructed for a cavitating pump as a distributed-parameter system. Four versions of the hydrodynamic model of LPRE cavitating pumps are verified, and six possible model coefficients are considered. Only one coefficient, namely, the liquid inertance at the cavity location, takes a physically meaningless negative value, which makes its use impossible. The verification results show that a four-coefficient model of cavitating pipe dynamics adequately describes cavitation effects in LPRE pumps over the frequency range up to 200 Hz. The four coefficients are the cavitation elasticity, the cavitation resistance, the cavity-caused disturbance transfer delay time, and the cavity time constant or the cavitation resistance distribution coefficient.

Keywords: *liquid-propellant rocket engine, inducer-equipped centrifugal pump, cavitation, transfer matrix, hydrodynamic model, delay element, verification.*

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Received on September 7, 2020,
in final form on September 21, 2020