UDC 532.528:621.671

S. I. Dolgopolov

Mathematical simulation of choking under self-oscillations in hydraulic systems with cavitating pumps of liquid-propellant rocket engines

Institute of Technical Mechanics
of the National Academy of Sciences of Ukraine and the State Space Agency of Ukraine
15 Leshko-Popel St., Dnipro 49005, Ukraine; e-mail: dolmrut@gmail.com

As known from the study of cavity flows in fixed channels (Venturi tube), with decreasing channel outlet pressure there comes a point where the flow rate ceases to increase. To increase the flow rate, the inlet pressure must be increased. This phenomenon of flow rate limitation at a fixed inlet pressure is due to a critical regime of cavity flow at the narrowest cross-section and is termed choking. Impeller pumps also exhibit choking regimes described by the so-called chocking characteristic, which relates the critical pump flow rate to the inlet pressure. This work is aimed at extending a hydrodynamic model of cavitating pumps of liquid-propellant rocket engines (LPREs) by including a mathematical simulation of chocking regimes. A mechanism of realization of the chocking process in pumps is proposed. The mechanism is as follows. When the parameter oscillation amplitudes are high enough, the inlet flow rate and pressure computed at integration step *i* may be in the inadmissible range, i.e., below the chocking regime characteristic. In this case, the flow rate and the pressure must be refined. It is found that the computed decrease in the cavitation self-oscillation frequency in comparison with the eigenfrequency of a hydraulic system with a cavitating pump is close to its experimental value in the case where the inlet flow rate and pressure are assumed to be coordinates of the point of intersection of the choking characteristic and the line that connects the values of the pump inlet flow rate and pressure computed at integration steps *i*-1 and *i*. It is shown that the LPRE pump choking characteristic is a specific nonlinearity associated with the critical cavity flow in the pump and may manifest itself at high parameter oscillation amplitudes. It is found that the choking characteristic of an LPRE pump affects the cavitation oscillation parameters to a greater extent than the cavity volume vs. pump inlet pressure and flow rate relationship does and is the governing nonlinearity in the pump system in choking,

Keywords: *liquid-propellant rocket engine, inducer-equipped centrifugal pump, cavitation, cavitation self-oscillations, hydrodynamic model, choking, choking characteristics.*

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Received on November 16, 2020,
in final form on November 23, 2020