

O. V. PYLYPENKO

## SOLVING CURRENT PROBLEMS IN ENGINEERING SYSTEM DYNAMICS

*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: office.itm@nas.gov.ua*

This paper overviews the main results obtained over the past few years at the Department of Hydromechanical Systems Dynamics and Vibration Protection Systems, Institute of Technical Mechanics of the National Academy of Sciences of Ukraine and the State Space Agency of Ukraine, in the solution of current problems in the dynamics of liquid-propellant rocket engines (LPREs), liquid-propellant launch vehicle pogo stability, vibration protection system dynamics, the gas dynamics of aircraft gas turbine engine components, and the dynamics of hydraulic systems with cavitating elements. These results are as follows. A mathematical model of LPRE pump dynamics was developed. The model complements a hydrodynamic model of LPRE cavitating pumps by allowing a mathematical simulation of choking regimes. An approach was developed to the construction of a nonlinear mathematical model of LPRE hydraulic line filling. The approach allows one to automatically change, if necessary, the finite element partitioning scheme of a hydraulic line in the process of its filling during LPRE startup calculations. An investigation was conducted into the startup dynamics of a multiengine liquid-propellant propulsion system that consists of four staged-combustion oxidizer-rich LPRDs with account for the possibility of their nonsimultaneous startup. The maximum values of oxidizer and fuel pressure surges and undershoots at the liquid-propellant jet system (LPJS) inlet at an engine spartup and shutdown were determined and used in determining the LPJS operability at the startup and shutdown of the RD861K sustainer engine. The pogo stability of the Cyclone-4M launch vehicle was analyzed analytically using Nyquist's criterion. A numerical approach was developed to characterizing acoustic oscillations of the combustion products in annular rocket combustion chambers with account for the configuration features of the fire space and the variation of the physical properties of the gaseous medium with the axial length of the chamber. A prototype vibration protection system was developed and made, and its dynamic tests confirmed its high efficiency in damping impact and harmonic disturbances. Approaches were developed to the aerodynamic improvement of aircraft gas turbine engine components. Topical problems in solids grinding in a liquid medium with the use a cavitation pulse technology were solved.

**Keywords:** *liquid-propellant rocket propulsion system, liquid-propellant rocket engine, dynamics, stability, vibration protection system, aerodynamic improvement, gas turbine engine, cavitation pulse technology.*

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