

Development of Advanced Liquid Rocket Engines in Russia

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ABSTRACT

Peculiarities of the design and development of advanced Liquid-Propellant Rocket Engines (LPRE) in Russia are described. Main problems of their development and ways to solve them disclosed and analyzed, such as the selection of propellants, structure of the propulsion system, schemes of injectors, cooling devices, turbo-pump assemblies (TPA) and other principal parts of the engine. It was discovered that staged combustion cycle with afterburning of fuel-rich or oxidizer-rich gas after TPA turbine in the main combustion chamber provide strong increase in LPRE efficiency due to more high expansion ratio. Moreover, the presence of gaseous propellant allows using it for atomization of liquid one in wide range of propellants mass flow rate, which provides increase in combustion efficiency and thrust variability. Increased pressure and elevated temperature define supercritical flow of propellants, when atomization as a process and problems connected with it are absent. Gaseous stages of injectors can be acoustically tuned and used as absorbers of acoustic energy, which eliminated combustion instability without usage of acoustic cavities and in some cases even without baffles. Results of research provided the design of numerous outstanding LPRE, examples of which are described in the Paper. Trends of future design of tri-propellant and dual-stage combustion cycle LPRE are presented.