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MODERN MATERIALS AND TECHNOLOGIES IMPLEMENTATION INTO THE LRE DESIGN

Abstract

Liquid rocket engines are one of the most energy-intensive and high technology devices. High energy intensity and requirements for weight characteristics requires to use in the engine of all design, materials and manufacturing achievements. All the promising of design and manufacturing, including mathematical modeling, CNC machining, additive technologies and composite materials using, requires a transition to model-based development at all stages of the life cycle. The NPO Energomash transition to design in high-level CAD system controlled by a PLM system make it possible to the realization of all the advantages of this method. The report presents approaches and results of mathematical modeling, additive technologies, composite materials, processing on CNC machine's introduction to NPO Energomash practice. The development of additive technologies is shown on the example of a pressurization unit. One of tasks usually solved by liquid rocket engine, in addition to performing the main functions - creating thrust and specific impulse, is to provide specified parameters in pressurization system of oxidizer and fuel tanks. Traditionally tank pressurization units are made in form of rather complex brazed-welded structures. NPO Energomash together with VIAM have worked out design and manufacture, full cycle of tests has been carried out, which made it possible to ensure introduction of pressurization unit manufactured by additive technologies into engine design. In the process of implementation into engine design, the following main tasks were solved: selection of material taking into account its availability, availability of certificates for use; development of design taking into account the limitations imposed by use of additive technologies; development of manufacturing technology on model samples; development of method for heat transfer calculating taking into account increased roughness values having a regular microrelief; development of technological parameters and characteristics of material, taking into account peculiarities of manufacturing technology and operation: strength, weldability, resistance to fire, etc.; development of manufacturing of full-scale samples with control of geometric characteristics; conducting model "cold" tests: strength, tightness, vibration tests; conducting model fire tests with simulated working conditions; tests as part of experimental engine. As a result of work carried out by NPO Energomash, approach to introduction of parts and units manufactured using additive technologies into design of engines has been worked out. The article also presents approaches in other areas: mathematical modeling, composite materials using, CNC machining.