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EXPERIENCE IN DEVELOPMENT OF LONG LIFETIME ELECTRIC PUMP UNITS FOR SPACECRAFT THERMAL CONTROL SYSTEMS

Abstract

Electric pump units are widely used in space technology, and are especially common used in thermal control systems (TCS) of different applications. Space systems development trends require electric pump regulators as part of the active TCS, known as pumped fluid loops (PFL), in automatic interplanetary stations, existing and advanced spacecrafts. In series of manned and robotic spacecrafts, in interplanetary stations and rovers, high temperature stability (up to 0.5 C) and / or deep cooling of some blocks below 100 K are required. During functioning of heavy or high-power-to-weight spacecrafts, it is required to redistribute large amount of thermal power, in some cases reaching 8 kW. Under such conditions PFL with an electric pump unit is an priority type of TCS for most modern space systems. TCS are on-board systems that provide the required reliability and vital signs of the entire spacecraft, thus it serious requirements are placed on it for reliability and long lifetime of up to 15 years. For PFL, the main element that ensures reliability is the electric pump unit. Highlevel reliability and long-lifetime requirements of PFL also become requirements of electric pump unit. Operation at spacecraft requires resistance to the effects of outer space factors. While ensuring the thermal control of highly sensitive measurement and guidance systems, requirements are also imposed on the low vibrational activity of electric pump unit. All of the above requirements form the science and technical objective for design of the modern electric pump unit of existing and advanced spacecrafts' thermal control systems. Taking into account world experience and own developments in the space industry, research team in BSTU "VOENMEH" is working on the design of a new generation electric pump unit. Experience of development, the main aspects of engineering, debugging and testing of design product is presented in this report. High technical requirements are achieved by complex approach to design of an electric pump, with application of a radiation-resistant electronic component base with a microcontroller as a control element, and effective, high resource technical solutions of bearing and pump part. Based on the microcontroller, control system has been built that provides fault-tolerant methods of control the electric motor of pump, including in the sensorless mode. As well, monitoring of technical state has been implemented for diagnosis and life prediction. Diagnostics and prediction of the remaining useful life are carried out by embedded software using machine learning methods.