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SPACE POWER SYMPOSIUM (C3)
Advanced Space Power Technologies and Concepts (3)

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POWER-SUPPLY SYSTEM OF SPACECRAFT ON THE BASE OF ZIRCONIA FUEL CELLS

Abstract

Fuel cells were used in the US ships for Gemini, and later for Apollo and Shuttle programs. Cosmic fuel cells have reached now a great success. Lockheed Martin, Boeing, Airbus etc. have initiated efforts to commercialize their technologies for various applications. Bloom Energy, grown from the Mars space program, is working with technology at 60% efficiency, safety and durability allow proposing SOFC systems to use them not only for board equipment but for electro-rocket propulsion system. SOFC is a device for transformation of fuel chemical energy into the electric and thermal ones. General power-supply systems including the chemical rocket engines use only the thermal energy of the fuel oxidation reaction. Current fuel cell produces electric power for above 60,000 hours operating time while fuel and oxidant are delivered, moreover it produces energy permanently. The cells may be connected into stacks to get power parameters required. Thermal energy produced as the result of the chemical reactions may be used in the whole system, e.g., for fuel conditioning, or transformation into electricity with different thermo-electric or electro-chemical generators raising whole energy conversion efficiency by 30%. Spacecraft's power system to be based on zirconia fuel cells has main advantages: - Energy conversion efficiency around 90% - There is no moving parts and high safety as result, low deterioration and nearly full soundless (it is not higher than sound of working air-conditioner), low maintenance cost. - Fifty percent less CO₂ emissions in comparison with available thermal power stations and cars. Absence of N₂, SO₂, CO emissions. - Module structure of the generator on the fuel cell stacks gives a possibility to match the power (up to 100 MW). - Easy power control in operating environment, regulation speed is about 1 MW/s. Energy opportunities of the spacecraft with electric propulsion system based on SOFC is much higher compared to the installation based on the liquid rocket engine. This is reached via more efficient use of chemical propellants. The proposed SOFC will create a power-supply system for the spacecraft that could operate for long time. The SOFC based power system is created on Ukrainian RD cooperation and natural resources.