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Compact energy storage with a high-power pulsed MHD generator

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The standard solid propellant fueled pulsed MHD generators with an electric power of 10–600 MW developed in the 1970-80s provided reliable autonomous power supply of various consumers. The time required for such MHD generators with self-excitation to reach the rated operating conditions is about one second. Recently new scientific, engineering, and technological results have been obtained that allow significant improvements in the size, weight, life, and other characteristics of high-power pulsed MHD generators.
This paper presents the results of a numerical study of the characteristics of a compact electric power system based on a pulsed MHD generator and discusses its potential as a source of high-power current pulses. The system consists of a new-generation solid-propellant-fueled pulsed MHD generator with an electrical power of 50 MW with a superconducting magnet system and a step-up transformer with superconducting windings. The primary and secondary windings of the transformer operate as inductive energy storage with current gain. After accumulating energy, the secondary winding of the transformer can be connected to various pulsed electrophysical devices with operating currents of hundreds of kilo-amperes using switching devices. Configurations of the system with transformer stored energy of
50 and 100 MJ at currents up to 500 kA were designed. The operation of the system, including the supersonic plasma flow in the MHD generator channel and the magnetic field distribution in the transformer, was analyzed. The operation time, consumption, and mass of the plasma-generating propellant and the main characteristics of the MHD generator were determined and the weight and size parameters of the system were evaluated. The results of the study show that the proposed pulsed electrical power system holds promise as a multipurpose source of current pulses up to 1 MA with a duration of a few milliseconds to hundreds of milliseconds.

Authors: Dr AFONIN, Anton; Prof. BUTOV, Vladimir; Dr NOSOV, Gennady; Dr NOSOV, Maria; Dr PANCHENKO, Victor; SHVETSOV, Gennady (RAS); Dr SINYAEV, Sergey; Dr SOLONENKO, Victor; Dr YAKUSHEV, Andrey

Presenter: SHVETSOV, Gennady (RAS)

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