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[Invited] Flux Pump Brushless Exciters for HTS Rotating Machines

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Synchronous generators employing rotor coils wound from high-Tc superconducting (HTS) wire, are attractive for a range of applications requiring very high torque and power densities. However, the injection of large DC currents into rotating HTS coils presents a technical challenge. In this paper we discuss the development of a new type of brushless exciter for HTS rotors, which is based on a dynamo-type HTS flux pump. This device applies a rotating magnetic field across the cryostat wall which leads to the injection of a DC superconducting current into the rotor coil circuit.

Our approach fundamentally reduces the thermal load upon the cryogenic system by removing the need for thermally inefficient normal-conducting current leads. It also obviates the need for high current slip-rings which can be subject to very high wear rates.

We report results from an experimental laboratory device and show that it behaves as a constant DC voltage source with an effective internal resistance. We then discuss the design of a prototype brushless exciter based on our experimental device, and describe its integration with a demonstration 10 kW HTS generator. We estimate the thermal load presented by our prototype exciter, and show that this can be further minimised by utilising duty cycle operation of the device. In this manner, the steady-state heat load is reduced by more than an order of magnitude below that of equivalently-rated metal current leads.

References:

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