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Tue-Af-Po2.16-03 [18]: Design and performance analysis of a dynamo-type HTS flux pump for a 10 kW superconducting generator

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In general, superconducting rotating machines have been widely deployed because they have advantages such as smaller volume, lighter weight, and higher efficiency than conventional rotating machines. However, superconducting rotating machines need a cryogenic system to keep field coils in a superconducting state. High temperature superconducting (HTS) flux pumps inject DC current into superconducting field coils without current leads and external power supplies. Therefore, the HTS flux pump removes the need for a current lead, thereby reducing the associated heat load and improving cryogenic efficiency. This paper deals with the design and performance analysis of a dynamo-type HTS flux pump for a 10 kW superconducting generator. The HTS field coil of the 10 kW superconducting generator was designed and fabricated. The induced DC current, output voltage, and dynamic resistance of the flux pump connected to the HTS field coil were estimated using electric circuit equations. They were tested at various rotational speeds and air gaps at 77 K, and the test results were compared with the estimated results. As a result, when the rotational speed of the flux pump increased from 500 rpm to 2500 rpm, the output voltage of the flux pump connected to the HTS field coil increased proportionally. As the air gap of the flux pump increased from 6 mm to 13 mm, the output voltage decreased. The HTS field coil of the designed 10 kW superconducting generator was well excited by the DC current of the flux pump when the rotational speed and air gap were 2500 rpm and 6 mm, respectively. These results will help to apply a flux pump to excite the field coil of a superconducting rotating machine.

Primary authors: Mr NAM, Gi-Dong (Changwon National University); Dr SUNG, Hae-Jin (Changwon National University); Dr BADCOCK, Rodney A (Robinson Research Institute); Dr BUMBY, C. W. (Robinson Research Institute); Prof. YU, In-Keun (Changwon National University)

Co-author: Prof. PARK, Minwon (Changwon National University)

Presenter: Mr NAM, Gi-Dong (Changwon National University)

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