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Variable-voltage-variable-frequency inverter drive of 20 kW class the High-Temperature Superconducting Induction/Synchronous Motor

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We have conducted research and development on a high-temperature superconducting motor, which has been expected as a next generation transportation equipment. Our target motor is so-called high-temperature superconducting induction/synchronous motor (HTS-ISM). The HTS-ISM has the similar structure as a squirrel cage induction motor, but replaces the winding with a HTS wire. Basically, by merely superconducting the secondary winding, the HTS-ISM is promised to have excellent features such as high efficiency and high torque density. Furthermore, all superconducting HTS-ISM currently undergoing research and development are expected to have high efficiency and high torque density. Assuming the actual application of HTS-ISM, it is possible to improve the efficiency of the whole power-train system using the technology of regeneration and inverter loss reduction. In this study, we carry out rotation test of the fabricated 20 kW class HTS-ISM with a variable-voltage-variable-frequency inverter, and investigate transient performance of it. Especially, we concentrate on instantaneous current/voltage waveforms, of which will be affected by the nonlinear current transport properties of the HTS rotor windings. And then, we will give an explanation of such transient phenomenon based upon Magnet-axis vs. Torque-axis coordinate, so that relationship between torque and magnetic flux is clarified. We also study harmonic components of the above-waveforms, by changing the carrier frequency of the inverter. These results would support the realization of the highly efficient power-train system installing the HTS-ISM.
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