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Research on MgB2 armature windings in fully superconducting AC machine

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Fully superconducting machine is the one that can take the most advantages of superconducting materials with dramatically improving the magnetic loading and electrical loading at the same time. However, intense R&D effort is giving priority to partially superconducting machines not only for their lower manufacture difficulty but also higher feasibility compared to fully superconducting machines. Fully superconducting machines are in trouble with high ac losses during the operation for too much power is consumed to take away all these heat losses and make an unacceptable low efficiency for the entire system. What is more, air-core structures are preferred to use in fully superconducting machines, which caused strong Lorenz force on the superconducting windings. Such stress field will cause a threat to superconducting coils by significant performance degradation. Although with many difficulties, the researches of fully superconducting machines never stop especially when relatively low ac loss superconducting materials such as fine filament NbTi, YBCO, and MgB2 were developed. Much work was done in trying new superconducting materials, proposing novel topologies, designing new cryostat structure and supporting structure to decrease the ac loss or heat leakage. Yet, the research on the superconducting magnets especially the superconducting armature windings in fully superconducting ac machine are lacked. MgB2 is believed to be one of the most promising superconducting materials with acceptable expense, low ac losses, high customizability. In this paper, a 10 MW fully superconducting machines employing MgB2 on both field windings and armature windings for offshore wind turbine is designed. The full paper will focus on the influence of the magnetic field and Lorentz force on the MgB2 armature windings in this machine. Some solutions are tried to lower the ac losses and the affection of magnetic force on the armature windings at various operation conditions.

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