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ID:429 The Effect of Permanent Magnet Faults in PMSG for Offshore WECS

Summary: The increasing reliance on multi-megawatt Direct-Drive Permanent Magnet Synchronous Generators (DD-PMSGs) for offshore wind energy conversion systems (OWECS) places a critical emphasis on their operational reliability. While DD-PMSGs eliminate the failure-prone gearbox, their performance is fundamentally dependent on the health of their permanent magnets (PMs), which are susceptible to demagnetization and mechanical damage. This paper presents a detailed investigation on the electromagnetic signatures of common PM faults using high-fidelity Finite Element Analysis (FEA). A comprehensive 2D model of the 15-MW reference wind turbine generator, defined by the International Energy Agency (IEA), is used as a benchmark. The study systematically analyzes the effects of uniform and localized demagnetization, as well as broken magnet, on key performance indicators. The results demonstrate that each fault type generates distinct and quantifiable changes in the electromagnetic torque, three-phase back-electromotive force (back-EMF), and air-gap flux density distribution. By characterizing these unique fault signatures, this work provides a foundational understanding necessary for the development of advanced condition monitoring and fault diagnosis algorithms, ultimately contributing to the enhanced reliability and reduced operational costs of OWECS.