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Design and Operation Performance Research of Brushless Doubly-Fed Generator with Cage Bar Assisted Reluctance Rotor

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Brushless doubly-fed generator (BDFG) is particularly suitable for using in variable speed constant frequency wind power generation system due to its inherent characteristics. The two sets of stator windings with different numbers of magnetic poles are coupled by magnetic field modulation of a special rotor, so the rotor structure directly affects the performance of BDFG. The commonly used rotor structures of BDFG can be divided into cage rotor, wound rotor and reluctance rotor, however, there are still some deficiencies of these structures even after many years of research and optimization. In this paper, a cage-assisted reluctance rotor structure is presented to enhance the rotor coupling capacity and improve the efficiency of BDFG. The design principle and operation performance of the BDFG with cage-assisted reluctance rotor are researched. Firstly, the structure characteristics and design principle of the proposed rotor are illustrated in detail. The cage-assisted reluctance rotor is obtained by adding some short-circuit cages to the non-magnetic layers of the radial laminated magnetic barrier rotor. Secondly, the magnetic field modulation mechanism of the proposed rotor is analyzed by analytical method to reveal the operation principle of BDFG with the proposed rotor. Then the operation performance of the proposed BDFG especially under sub-synchronous and super-synchronous mode is studied. Finally, a 25kW prototype is designed and manufactured to verify the advantages and feasibility of the proposed rotor structure. The experimental results show that the BDFG with the proposed rotor has some advantages such as strong magnetic field coupling ability, high efficiency, superior performance and so on. This paper has also broadened the idea for the development and application of BDFG.
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