Performance Analysis of a Novel Fall-Back Transverse Flux Permanent Magnet Generator with Outer Rotor Design Suitable for Direct Coupling Wind Turbine

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For direct-drive wind power system, various permanent magnet generators are proposed. Among those, a conventional transverse flux permanent magnet generator (TFPMG) with U-shaped stator core [1] seems to be a suitable generator for wind power application. To overcome the effect of leakage flux, a new concept with a fall-back transverse flux permanent magnet generator (FB-TFPMG) with inner rotor design [2] suited for direct-drive application is proposed to prevent the losses due to inactive magnets.

A fall-back transverse flux permanent magnet generator (FB-TFPMG) with *inner* rotor design, employs half the number of PMs (as against conventional TFPMG), elliptical shaped stator core and toroidal shaped coil. In this paper, a novel concept of FB-TFPMG with *outer* rotor design, suitable for direct coupling of wind turbine, is explored with a possibility to improve the power to volume ratio in comparison with the inner rotor FB-TFPMG. In the proposed configuration, the blades of the wind turbine are directly fastened to the drum to perceive the direct coupling between the wind turbine and the FB-TFPM generator. This leads to immediate benefit of lower weight and better cooling. The dynamic performance of the new topology is analyzed using 3-D finite element analysis tool and the results are compared with the inner rotor FB-TFPMG. The concept with *outer* rotor design of a fall-back transverse flux permanent magnet generator, depicted in fig. 01, is analyzed under no-load condition and with a load of 1kW connected to its terminal.

The results of new FB-TFPMG with outer rotor design are focused on the most important parameters such as electromagnetic field and induced emf under no-load condition and on-load condition. 3-D FEA result of outer rotor FB-TFPMG of induced emfs under no-load condition is shown in fig. 02. The flux linkages, induced emf under no-load and on-load condition are in good agreement with the inner rotor FB-TFPMG. Outer rotor design with 10 percent reduction in volume gives the equivalent output power as compared with the inner rotor design. Overall cost of the generator is reduced due to half of the magnets used and direct coupling of the wind turbine.

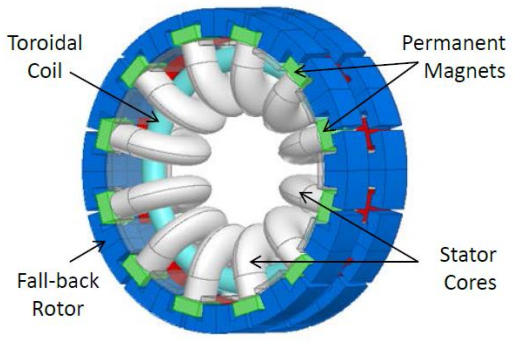

Fig. 01 Outer Rotor FB-TFPMG

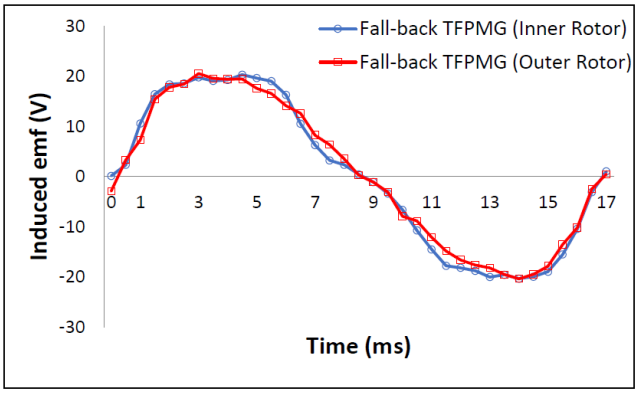

Fig. 02. Induced emf under no-load of inner and outer rotor FB-TFPMG

[1] Jacek F. Gieras, "Transverse Flux Machine," U. S. Patent 7,830,057 B2, Nov. 9, 2010.

[2] M. A. Patel; S. C. Vora, “Analysis of a Fall-Back Transverse Flux Permanent Magnet Generator,” *in IEEE Transactions on Magnetics*, *Vol. PP, Issue 99,* pp. 1 – 1 (Early access)