High power density permanent magnet generator for wind and tidal turbines

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Context:

Converteam is a worldwide specialist in power conversion and in offshore solutions. Wind and tidal energy need power converters for conversion and transport. Direct drive generators in order to increase the efficiency and to reduce the maintenance operations are studied.

For a direct drive application, synchronous generator with a high number of poles is required. Moreover, permanent magnets permit to increase power density in comparison with wound rotors. Thus, the study deals with surface mounted permanent magnet machines with a power range between 400kW and 6MW.

Extended abstract:

A first comparison between brushless AC (BLAC) and brushless DC (BLDC) generators showed that power density of a BLDC machine is better than a BLAC machine (approximately 15 % higher [1]).

Then, the use of a 180-degree converter instead of a 120-degree (see Figure 1), could lead to a decrease of the slots size and an increase of the power density. Indeed, in a 180-degree converter all phases are connected to the source, whereas in 120 degree converter (machine with 3 phases) each phase is open-circuited for a fraction of revolution.

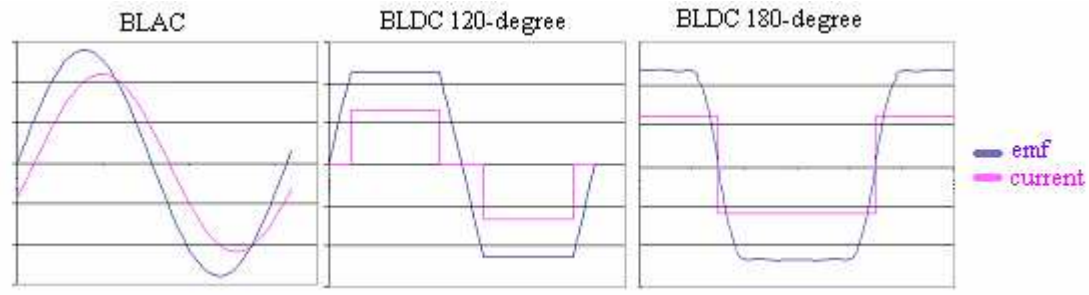

Figure 1: Waveforms of emfs and currents in the different cases.

Concerning machines fed by a 180-degree converter, an investigation on the number of phases has been made in order to improve the machine's dynamics. The result is that greater the number of phases is, better the machine's dynamics is. Nevertheless, limits appear concerning the size of teeth.

Proposal:

A poster will present 2 cases which seem to be the best for a high power density permanent magnet generator for wind and marine turbine. The first is a 3 phases BLDC fed by a 120-degree converter, the second is a 7 phases BLDC fed by a 180-degree converter. The methodology of design will be described and the results of FEM analyses of the electromagnetic behavior and simulations of the converter will be presented.

[1] H-W. Lee, T-H. Kim and M. Ehsani : Power Density Maximization of the Brushless DC Generator, Industrial Electronics Society, 2003. IECON'03. The 29th Annual Conference of the IEEE.