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Thu-Mo-Po4.08-09 [61]: Investigation of multi-phase armature windings in HTS wind turbine generators

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A high torque density enables high temperature superconducting (HTS) generators to be a strong candidate for lightweight, efficient and cost-effective large direct-drive (DD) wind turbines, especially for the next-generation floating wind turbines where a less top head mass is appreciated.
It is very common that 3-phase armature windings are used in HTS generators. One consequence is that AC losses induced in field windings must be well handled, by adding more cooling power or by employing an electromagnetic shield or by increasing the air gap to reduce the influence of armature windings on field windings. One feasible solution to reduce AC losses induced in field windings is to use multi-phase armature windings, which on one hand have fewer harmonics and less influence on field windings and on the other hand help to reduce the probability of sudden short circuits at generator terminals.
This paper comparatively studies effects of 3-phase, 6-phase, and 12-phase armature windings in an HTS wind turbine generator. For a fair comparison, AC losses in the HTS field winding are set to the same value. The results show that the 6-phase and 12-phase armature windings reduce the air gap by 7% and 16%, respectively. The reduction of the air gap corresponds to a torque density improvement of 11 % and 19%. The findings of the paper expand the border of designing of high-torque-density HTS wind turbine generators.

Authors: Dr LIU, Dong (Hohai University); Dr SONG, Xiaowei

Presenter: Dr LIU, Dong (Hohai University)

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