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A Field Modulated Linear Permanent Magnet Generator for Direct-Drive Wave Energy Conversion

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In the last two decades, the linear permanent magnet (PM) machines which could directly realize linear movement without any additional transmission mechanisms converting the rotary motion into linear motion, are applied in direct-drive wave energy conversion (WEC) [1-4]. In particular, a conventional linear permanent magnet generator (CLPMG) reciprocates at such low-speed wave motions and makes the generator considerably heavy. If operating in high-speed mode, linear generators would have high power density and low cost. Potentially, the field-modulated linear permanent magnet generator (FMLPMG), which integrates the concept of magnetic-field modulation into the linear PM machine, becomes a good candidate for a direct-drive WEC system. The slow reciprocating wave motion is directly harnessed by the translator of the proposed generator, and then the translator accelerated by magnetic field modulated principle to actuate the generator, hence producing higher output voltage. By finite element method (FEM) and experimental tests, the performances of FMLPMG and CLPMG are analyzed and compared, which confirm that the FMLPMG can offer higher power density, lower cost and higher efficiency than the CLPMG. Therefore, the direct-drive WEC system mainly composed of FMLPMG is feasible and effective and could be used to supply electric power for oceanographic observation instruments in the isolated islands. The structure of FMLPMG is similar in shape to the CLPMG, including the stator and the translator. Particularly, the translator of FMLPMG is of 9 pole-pairs PMs, and winding connection in the stator is of 4 pole-pairs, which must be equal to the pole-pairs number of the largest asynchronous space harmonic in the airgap. Moreover, the stator teeth are the function of magnetic-field modulation, which are equal to the sum of the pole-pairs number of PMs on the translator and the stator winding, viz.13.

Submitters Country

China

Primary author: FENG, Ningjun (Southeast University)

Co-authors: Prof. YU, Haitao (School of Electrical Engineering, Southeast University); Dr GUO, Rong (School of Electrical Engineering, Southeast University); XIA, Tao

Presenter: Dr GUO, Rong (School of Electrical Engineering, Southeast University)

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