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Research on the linear tubular motor with multilayer flux-concentrating permanent magnets for direct-drive ocean wave conversion

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With the rapid develop of energy crisis and environmental problems, the utilization of renewable energy is attracting an increasing attention in the world. Compared with the wind and solar power, ocean wave energy has many advantages, such as high energy density, large amount and being easy to forecast, etc. Therefore, a various ocean wave energy extraction systems have been proposed and established in recent years. Direct-drive ocean energy conversion system(WEC) has a simple structure and higher efficiency, which merely comprised of linear generator and buoys without any medium-devices. However, the traditional linear generator in WEC usually has disadvantages of large weight and low power density due to the average low speed of ocean waves. In order to solve this problem, the linear tubular motor with multilayer flux-concentrating permanent magnet is proposed. The permanent magnets are arranged evenly and alternately in the axial direction, and the produced flux-concentrating effect can improve the air gap magnetic flux and power density obviously. The multilayers of permanent magnets could make the magnetic flux more sinusoidal distribution. When the WEC operates in the sea, it encounters extreme weather sometimes. The huge force generated by the incident ocean waves may destroy the magnets. But the proposed machine is to embed permanent magnets into silicon steel, this structure would enhance the mechanical strength to withstand the storm to some extent. Using the FEA, the performances comparison between the traditional and proposed machine has identified that the last one has the advantages of high torque capability and power density. The experimental tests on the prototype machine in a wave tank have been conducted to verify the validity of FEA results.

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