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## Investigation into a multi-stage rotor rotating magnetic field generator powered by ocean current

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### Abstract

In this work, a prototype of ocean current induced rotating magnetic field multi-stage rotor generator was developed. The power can be improved significantly by using multi-stage rotor structure. In order to improve the power of the prototype of the multi-stage rotor generator, theoretical and experimental investigation has been carried on. Simulation on the performance in different parameters of the rotating magnetic field electric generator was conducted, such as effects of the number of permanent magnets and the windings in axial, the turns number of windings, and the distribution of the permanent magnets, etc. The power of optimized electric generator can be raised from 1.2 to 5.7 mW. A test bed was set up to evaluate the performance of the multi-stage rotor generator under water. The simulation results fit the experimental results well. The power of the electric generator increased obviously with the increase of the flow velocity.

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*Keywords:* Multi-stage rotor generator; ocean current energy; rotating magnetic field

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### 1. Introduction

Deep-sea buoy system plays an important role in the ocean environment investigation. In the past, deep-sea buoys are mainly supplied power by battery, and it is need to replace the battery when the electricity is shortage. The deep

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sea buoys usually need to be far away from the coast or in hundreds of meters underwater. It is expensive to replace the battery by using ships or diving equipments [1]. In order to improve the continuous working ability of the deep-sea buoy, it is need to find a new way which is long-lasting, environmentally friendly and low-cost to replace the traditional supplement.

Therefore, some kinds of clean energy are used as the supplement for the deep-sea buoys, such as solar energy, wind energy, wave energy, ocean current energy, ocean thermal energy, etc. Shashank Priya studied a prototype piezoelectric windmill, which can generate 7.5mW power at the wind speed of 10mph [2]. This kind of windmill is a simple and low cost, but it is easy to be destroyed in the sea. National Data Buoy Center use the energy collected by solar panels to charge the battery of the deep-sea buoy [3]. The cost of the solar panels is high, and it is easy to be corrosion in the seawater. Since the 1960 s, Japan has developed a wave power self-generating electric generator system, which is supply power to the buoy light [4]. However, the energy of ocean waves is not stable, has a strong destructive, so the wave energy is not stable to be as Marine equipment's electricity system.

The ocean current energy have more advantages than the above forms of energy, because of its high energy density, long-time predictability and potentially large resource [5]. Ocean current energy is the only available energy that can be used in the deep sea [6]. Some exploratory research about the ocean current generator which is applied into the buoy power supplement has been carried out in Britain and Russia. There are also some researches in China, such as the Northeast Normal University has developed a low velocity current generator. The research work was concerning about the hydrodynamic characteristic of the ocean current generator. Batten studied the power, thrust and cavitation, and compare Cavitation tunnel experiments with simulations for different blade pitch settings [7]. Bahaj Contrasted and verified the two code based on blade element momentum theory through experiment [8].

The objective of the study is to develop a mechanism for generating electric energy from ocean current energy at small scale. A prototype of the rotating magnetic field powered by ocean current has been proposed, and part of the preliminary work has been carried out [9]. This paper proposed a multi-stage rotor generator. Theoretical and experimental research had been carried on in order to study the structure parameters of it. The power of the prototype can be improved by using multi-stage rotor structure.

## 2. Experimental procedure

### 2.1. Models

Fig. 1(a)-(c) shows the schematic and photographs of the fabricated rotating magnetic field generator. The material of the prototype can be seen from the Table1. The diameter of the generator is 120 mm. The prototype consists of stator parts and rotating parts. The stator shell is made using 4 mm thick plexiglass, and the winding coils are installed at the inter surface of the stator shell. The bottom of the stator is cross. Propeller blade is adopted in the rotating part, and it is fixed on the bottom by the shaft. Magnets are fixed on the outer surface of the impeller shell. Fig. 1(c) is the prototype of the multi-stage rotor magnetic field generator, the two rows of winding coils are staggered, and the magnets are also staggered.

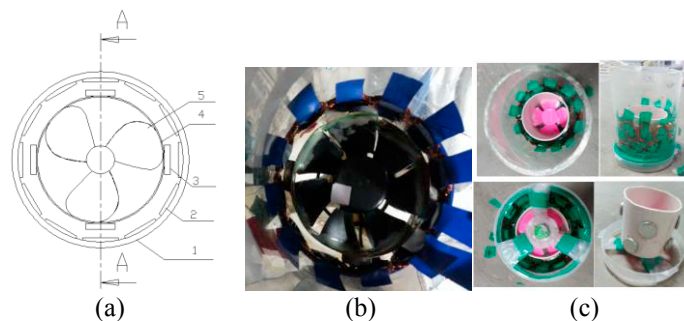


Fig. 1. Schematic and pictures of the ocean current induced rotating magnetic field generator (a) Schematic of the rotating magnetic field generator; (b) Photograph of the fabricated prototype; (c) Photograph of the fabricated prototype with multi-stage rotor.

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