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Research on Multi -mode Power Generation Devices based on Wave Energy

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Abstract: This paper mainly studies a multi-mode power generation device based on wave energy, which is mainly composed of power generation device, energy storage device, monitoring device, through the use of electromagnetic machinery, piezoelectric ceramics, hydraulic system in a variety of ways to generate electricity, and then the energy storage device stable output, is a kind of power generation system will be converted into electrical energy device, to achieve high efficiency conversion of wave energy. Each part of the project is innovative and practical, which has high application value in ocean power generation. Compared with some traditional power generation devices, this device uses a new type of energy, ocean wave energy, which is a pollution-free, clean and renewable new energy. Wave energy has high flow density, huge reserves and wide distribution, which is the main direction of the development of ocean energy utilization in the future. It will make positive contributions to Marine construction, economic development and infrastructure construction of countries and regions along the Belt and Road.

Keywords: Wave Power Generation; Multi-mode; Piezoelectric Ceramics; Piezoelectric Effect.

1. Introduction

Faced with the problems of maritime information monitoring and defense, the increasing contradiction between conventional energy exhaustion and rapid economic development, and the environmental pollution caused by conventional energy, it is urgent to develop clean and efficient renewable energy. Because of its abundant reserves, wide distribution and all-weather characteristics, wave energy has become one of the new Marine energy sources that scientists focus on exploring and developing. [1] The effective development of wave energy will also be of certain benefit to alleviate the shortage of energy and power in our country [2]. However, current wave power generation devices are beset with technical difficulties such as the low conversion efficiency, extreme wave condition survival and grid-connected electric energy filtering, and wave power technology is not yet mature [3]. To this end, this paper studies a multi-mode power generation device based on wave energy. The device uses clean and pollution-free renewable energy wave energy, uses electromagnetic machinery, piezoelectric ceramics, hydraulic system and other ways to generate electricity, high conversion efficiency and stability, can meet the increasing demand for electricity of various platforms at sea.

1.1. Power Generation Device

The inside of the device (Figure 1) is equipped with permanent magnet (using NdFeb material), coil, cushion rubber, piezoelectric ceramic sheet, hydraulic system, and the outside is equipped with a floating plate (Figure 2). The coil is outside the permanent magnet, and the device moves up and down due to waves. At the same time, the coil follows the device to move up and down relative to the permanent magnet, thus cutting the magnetic inductance line generated by the permanent magnet to generate induced electromotive force and generate electricity. In addition, the coil is equipped with a spring, the inner wall of the device is equipped with piezoelectric ceramic plate, coil moving up and down at the same time to drive the spring extrusion ceramic plate, so that the piezoelectric ceramic internal deviation from the original state of the phenomenon, so that the piezoelectric ceramic charge, electricity generation. A floating plate mounted on the outside of the device rises and falls with the waves, driving the hydraulic device to generate electricity.

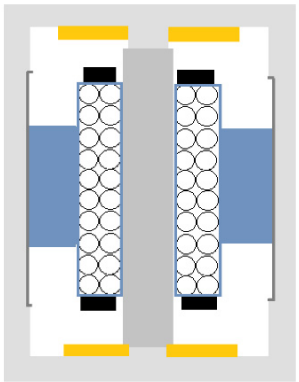


Figure 1. Interior plan

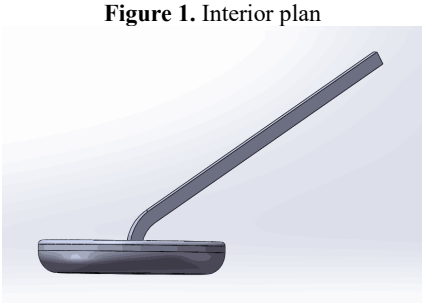


Figure 2. Floating plate

1.2. Energy Storage Device

For the system composed of permanent magnet and coil, because the coil up and down cutting magnetic induction line, the generated electricity for alternating current, the first use of diodes to rectify the alternating current, positive and negative two-way electricity into unidirectional electricity, the use of capacitors to filter the current operation, finally change to a smooth DC voltage stored in the battery. Due to the different amplitudes and wavelengths of each wave, the nonlinear and reciprocating characteristics of the wave make the output power of the wave energy device fluctuate greatly [4], and the coil drives the spring to different pressure on the platen ceramic, so that the alternating current from the piezoelectric ceramic becomes uneven, and the uneven alternating current cannot be charged for small batteries. To solve this problem, we filter the frequency of a specific band of alternating current, convert alternating current into direct current, and use the stored energy of the capacitor to make it output a constant voltage circuit. At the same time, we rectify and filter the electric energy generated by the hydraulic device to make it usable electric energy. The battery can then be recharged, or power supplied to other areas where electricity is needed.

1.3. Monitoring Device

In view of the unmanned characteristics of the device, install the monitoring device.

By the current and voltage meter in the circuit, the working status of different power generation modules is monitored; the motion of the horizontal instrument monitoring device fixed on the device shell is mounted in the wavy; And to process and store the collected data through the single -chip microcomputer system to help the working area of the artificial analysis device suitable for wavy power generation and power generation efficiency. In conjunction with the independent -developed APP, you can remotely monitor the power generation device, master the operation in real time, and remote control. In the later period, you will consider the large -scale layout of the power generation device to develop more software used on the computer.

2. Theoretical Analysis

2.1. Analysis of Theoretical Analysis of Electromagnetic Machinery Power Generation

There is an iron heart inside the coil, and most of the magnetic flux is passed from the iron heart. It does not consider the impact of the magnetic leakage, and the magnetic field is evenly distributed in the iron heart along the axial direction. Including the number of coils turns, there are segment I magnetic chain $\psi_i = \varphi_i$ (where φ_i is the III magnetic flux), the magnetic chain of the entire winding:

$$\Psi = \sum_{i=1}^{n} \psi_i = \sum_{i=1}^{n} \frac{N}{n} \varphi_i \tag{1}$$

And $\varphi_i = B_i S$, B_i is the magnetic induction strength of the winding section i, S is the radial cross-sectional area of the iron heart. According to the definition of the inductive electromotive force:

$$e = -\frac{d\Psi}{d\varphi} = -\frac{d\Psi}{dh} \times \frac{dh}{dt} = -v\frac{d\Psi}{dh} = -\frac{NvS}{n} \times \frac{\sum_{i=1}^{n} dB_i}{dh} \tag{2}$$

In the formula, e is an inductive electromotive force; dh is a variable volume of axial height; v is the instantaneous speed of the coil; when the winding coil is divided into n sections, $dh = \frac{H}{n}$ (h is an axial height of the coil), set the magnetic induction in the winding group in the winding group, and set the magnetic induction in the winding group. The amount of strength variable $\Delta B = \sum_{i=1}^{n} dBi$, then there is a formula for solving the induction electrical momentum when the air load is available

$$e = -\frac{NvS}{H} \Delta B \tag{3}$$

Therefore, the power of the induction current is:

$$P = \frac{U^2}{R} = \left(\frac{NvS}{H} \Delta B\right) 2 \times \frac{1}{R} \tag{4}$$

R is the total resistance of the device

In addition, in the case of empty load, there is no induction current in the coil. The actual output voltage of the generator will be reduced.

2.2. Analysis of the Theory of Power Generation in Hydraulic System

The role of the hydraulic device is to increase the force to strengthen the pressure. A complete hydraulic system consists of five parts, namely power components, execution elements, control components, auxiliary components and hydraulic oil.

The hydraulic transmission system is a set of hydraulic circulation system composed of various hydraulic elements. It first transformed the mechanical energy of the motor into the pressure of the liquid. By regulating and controlling the liquid flow of the hydraulic components to transmit pressure and working signals, the hydraulic energy can be re - transformed by the proper execution agency to drive the working institution. Realize the various actions required.

The power calculation formula of the pump is: P×Q; the volume efficiency of the hydraulic pump refers to the ratio of the actual output flow of the pump to the theoretical output flow; in addition to the volume efficiency, the hydraulic pump also has an efficiency indicator, mechanical efficiency. Mechanical efficiency is equal to the liquid flow difference between the theoretical flow to the pump body, and then divide the input power; the total efficiency is the ratio of the actual output power to the input power, and its size is equal to the volume efficiency and mechanical efficiency.

2.3. Analysis of Theoretical Analysis of Piezoelectric Ceramic Power Generation

There are four types of vibration modes in common piezoelectric vibrations. This device is planned to use a piezoelectric power and power generation device. When using a length vibration mode, the smaller force can produce larger deformation. Below the voltage vibrator of the length telescopic mode is analyzed. Figure 3 shows the voltage vibration of the length telescopic mode. The length, width and height of the voltage vibrations are l, a, and h, and the direction of each axis of the coordinate shaft is shown in the figure. The polarization direction of the piezoelectric ceramics is y, and the electrode surface is parallel to the XOZ plane, and the load is added in the direction of x.

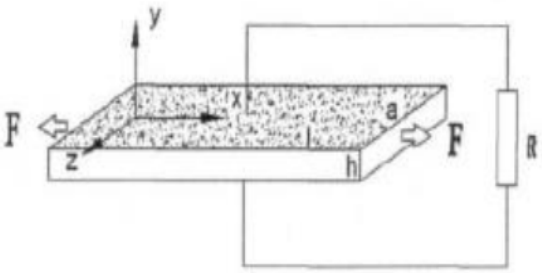


Figure 3. Capital vibration of length telescopic mode

By analyzing the output parameters of a single piezoelectric unit, the size of the output power P is related to the size of the load resistance R. When the load resistance value is the maximum value P when the ideal load R is equal to the equivalent lolance R. The expression of power P is regarded as a function of the load resistance value R. The derivative of the load resistance corresponding to the derivative of the guide is R. Therefore, the expressions of P and R are as follows (d is the piezoelectric strain constant):

$$P = \frac{\mathrm{d}^2 lF\omega}{4\sqrt{2}ah\varepsilon} \tag{5}$$

$$R = \frac{h}{\sqrt{2}aL\omega\varepsilon} \tag{6}$$

3. Summary

This paper mainly introduces a kind of multi-mode power generation device based on wave energy. The device realizes the utilization of wave energy through electromagnetic machinery, piezoelectric ceramics and hydraulic system. It achieves the maximum efficiency collection and conversion of wave energy through a variety of power generation modes. Through our theoretical analysis and calculation, it can be concluded that the maximum conversion efficiency of the device from wave energy to electric energy can reach 36.8%, which is about 5% higher than that of the traditional power generation device. The development of Marine new energy is not only one of the best choices to solve the energy dilemma of the "Maritime Silk Road", but also a good opportunity to promote connectivity and international cooperation. This device uses clean and pollution-free renewable energy wave energy and is equipped with piezoelectric ceramics to generate electricity by the polarization phenomenon of crystals in a novel way. The device can be used in all kinds of offshore platforms, the use range is wider, more practical.

Acknowledgments

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