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# *Influence of Performance Calculation Method Based on Kinetic Energy Theorem on Tidal Power Generation in Offshore Engineering*

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***Keywords:*** Kinetic Energy Theorem, Ocean Engineering, Tidal Power Generation, Theorem Performance

***Abstract:*** Tidal power generation is a new type of energy developed in recent years. It has the advantages of simple structure, reliable and stable operation and renewable energy. In this paper, the tidal effect in ocean engineering is analyzed and studied. After introducing the theoretical knowledge of waves, a complete mathematical model system of waves is proposed based on the kinetic energy theorem. Then use the kinetic energy theorem performance calculation method to solve the formula to obtain the sea water density function expression, and use the simulation result curve to calculate the number of fan revolutions and the corresponding coefficient distribution parameter values under different types. The model test results show that the tidal power generation model based on the performance calculation method of kinetic energy theorem has excellent detection time, compatibility of more than 90%, and high accuracy.

## 1. Introduction

Tidal power generation is a new type of energy developed in recent years. There are two main ways to use it: the first is to pump and exchange heat with sea water on the seabed, and the second is to replenish marine fuel. Tidal power generation is most widely used in coastal areas of China [1-2]. With the continuous progress of economic and social development, the improvement of scientific and technological level and the increasingly strict environmental protection requirements, a new round of climax in the field of marine power research has begun under the trend of large-scale ships. The word " marine energy " has also emerged and has been proposed as a world-wide topic, precisely because it has the characteristics of high energy density, high efficiency and clean and pollution-free [3-4].

Tidal power generation has become an important part of the marine environment. The research

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on tidal power generation started early and has made some progress since the 1980s. Due to the lack of sufficient understanding of tidal characteristics and relevant influencing factors in offshore engineering in China and the lack of a complete and scientific rigorous system in practical application [5-6]. Foreign scholars mainly analyze and calculate the tidal differences of seawater under different types and different time scales. Domestic researchers have done a lot of research on the tidal wave phenomenon in seawater by using numerical models to study the different wave periods of ships along the coast or at sea. Some scholars calculated the relationship between wave coefficient and frequency change when a port in Xiamen enters the ocean on a daily basis by using physical methods [7-8]. Other scholars used hydrodynamics software to simulate and analyze the impact of seawater tide on the daily import and export of motor sets. Therefore, this paper studies tidal power generation in ocean engineering based on the performance calculation method of kinetic energy theorem.

In marine engineering, tidal power generation is a very important way of energy conversion, which has great application potential. Based on the kinetic energy theorem, this paper analyzes and studies the surface area changes of water waves caused by ship dynamics, tidal current and buoyancy in seawater. Taking a certain sea area as an example, this paper introduces the influencing factors and relevant calculation methods of the tidal power station in the structural design of hydraulic structures, and through numerical simulation, the results are consistent with the theoretical values and the conclusion is that the model can be used to realize the conversion between wind waves and sea water in the ocean, so as to achieve the purpose of energy conservation and emission reduction.

## 2. Discussion on Tidal Power Generation in Ocean Engineering Based on Kinetic Energy Theorem and Performance Calculation Method

### 2.1. Energy Characteristics of Tidal Power Generation

The energy of tidal power generation comes from the mechanical energy and electrical energy generated in its working process, of which mechanical vibration is the main one. When moving in the ocean, the action of sea water and current will change the structure of the machine to a certain extent. The water turbine is a generator set that drives the blades to rotate through the rotation of the rotor to compress the water flow to form a vacuum state, which is called a centrifugal generator. It is also called a single wing grid system or a vortex generator such as an axial unit and a turbine. The wind turbine provides power, and the pressure, represented by compressed air, plays a key role in the water vapor flow process in the ocean [9-10]. When the fluid enters the atmosphere, its speed changes due to the pressure change, which leads to the energy consumption of the whole tidal power generation system, which is called the pressure difference effect. When the fluid flows from the seawater to the seawater, the kinetic energy gap between the seawater and the river will become larger. Tidal power generation is to build an island on the sea surface and convert the interaction between sea water and ocean into land energy through the flow of sea water. Because waves and waves are unstable and irreversible, and their waveforms are irregular. Therefore, when the wind speed changes due to wind or waves, it will produce large fluctuations or vibrations, which will affect the whole system and even cause adverse factors to the normal operation of the equipment. At the same time, if the speed of the ship is too fast, the wind can not be converted and utilized in time, resulting in increased energy consumption and further reducing the value of power generation efficiency and power quality indicators [11-12].

## 2.2. Energy Attenuation Coefficient of Tidal Power Generation

Tidal power generation is an ocean current composed of sea water and ocean under natural operating conditions. It has attracted wide attention because of its high energy density, small inertia and good pressure regulation. However, the current development of tidal power generation mainly focuses on two aspects: one is the wave effect caused by natural reasons, and the other is the impact on economic factors. When the wind shear decays to the original state due to the change of sea surface wind speed caused by wind shear, the rate of sea water temperature decline is directly proportional to the increment of ocean pressure, so that its energy is attenuated or reduced. This phenomenon is called typhoon tide effect, which is a physical response mechanism. The attenuation of energy by tidal power generation is mainly carried out in two aspects: one is to generate a large amount of seawater in the ocean, some of which will be consumed in the form of kinetic energy, and the other is called mechanical energy in seawater [13-14]. Second, when natural factors such as waves and wind speed on the sea surface act, huge energy is generated. Tidal power generation has the advantages of high power output, high conversion efficiency, low power consumption and low cost. Tidal power generation is a process of converting the energy of wind turbine into mechanical energy at low wind speed by compressing the density (or volume) of air. At present, the research on it at home and abroad has made some progress. Due to the influence of energy conservation law and generator power characteristics, it is difficult for us to directly obtain accurate and reliable mathematical model expressions about sea water pressure changes, temperature fluctuations, and the degree of connection between unit efficiency and total power generation. Therefore, we must use some means to establish a model that can reflect the flow law of sea water in tidal power generation systems The comprehensive equation of the interrelationship between the output flow characteristics of the generator and the power quality indicators [15-16].

## 2.3. Kinetic Energy Theorem Performance Calculation Method

The dynamic principle of tidal power generation is to change the air density by controlling variables to realize the flow of seawater. In marine engineering, because the sea water has a high pressure, the relative pressure, resultant force and interaction force between the sea water and the atmosphere can be calculated by using the kinetic energy theorem. When equipment such as propeller or fan is installed on the ship, it will also generate a certain degree of internal pressure difference, and cause wave effect to change its motion state [17-18]. Tidal power generation is a kind of power generation with certain periodicity and regularity. It will generate a lot of power during its operation, so it is necessary to calculate the energy. There are two main forms of wave energy: tidal generator and mechanical wave source. It is a complicated and difficult problem to analyze the wave vibration phenomenon caused by wave moment in the ocean by using the kinetic energy theorem. Based on the interaction relationship between the surface of the float and the air established by physical methods, the huge power fluctuation caused by the change of sea water density in the tide is solved by using the law of conservation of momentum, and it is analyzed and calculated. Fig. 1 is a tidal wave model.

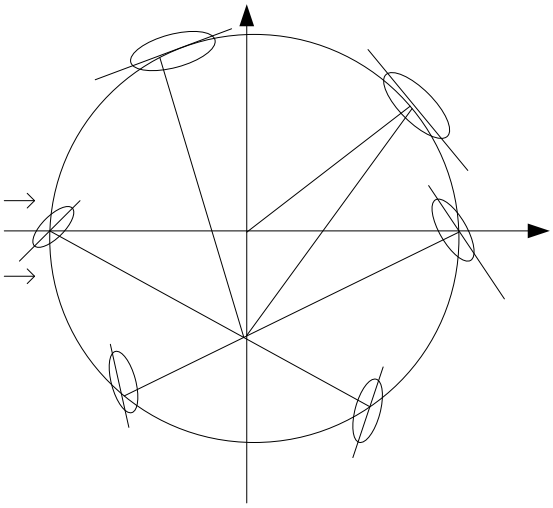

*Figure 1. Tidal fluctuation model*

$$Q = \mu_c A\sqrt{2gz} \tag{1}$$

Ocean engineering mainly calculates the head and velocity of water by analyzing the effect of tidal force. There are two kinds of water flow states under the action of waves and sea water: static pressure wave shear deformation phase type and dynamic pressure wave shear deformation phase type (i.e. kinetic energy > mass transfer mode). Among them, the physical properties in the constant time system in which the power propagation speed is " mechanical " change the most and the most complex is gravity movement.

$$M_P = P \bullet L/3 \tag{2}$$

Compared with the conventional tidal power station, it has a great impact on the environment and resources. Therefore, before energy calculation, it is necessary to first understand the relationship among wave coefficient, kinetic energy and potential energy in the wave energy system, then select appropriate parameters according to the actual situation to establish an effective numerical model, and finally determine their change trend by analyzing the energy characteristic curves provided to the ocean tidal power generation process in different forms, and then draw a conclusion. Fig. 2 is a graph of energy characteristics during tidal power generation.

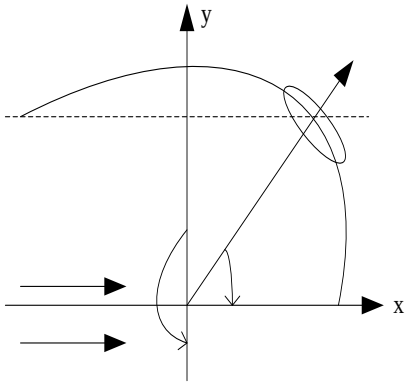


*Figure 2. Energy property diagram*

## 3. Experimental Process of Tidal Power Generation in Ocean Engineering Based on Kinetic Energy Theorem and Performance Calculation Method

### 3.1. Tidal Power Generation Model Based on Performance Calculation Method of Kinetic Energy Theorem

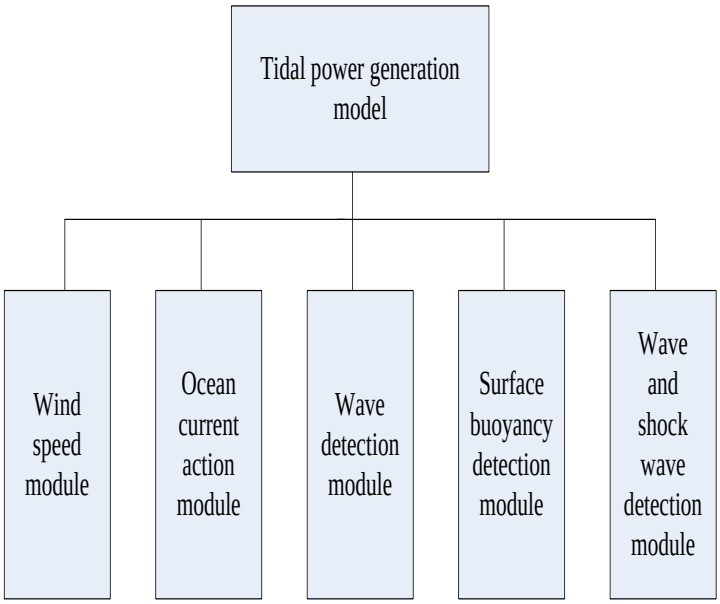


*Figure 3. Tidal power generation functional model*

Tidal power generation model refers to taking a physical quantity with kinetic energy (including conductivity) as the energy source, and establishing the corresponding mathematical relationship through calculation and analysis. It can be divided into two parts: the first part is the electromotive force generated by the interaction between electric potential and electric energy. In the second aspect, the conservation of mechanical energy is used to describe the change law of water vapor interaction caused by the buoyancy of seawater surface and the wave shock wave. The tidal power generation model (as shown in Fig. 3) is a tidal power generation model with simple structure, stable performance and effective utilization by analyzing the interaction of physical fields such as wind speed, ocean current action and wave in the ocean, treating it as a complex system. In the calculation process, the " buoy " method is used, that is, according to the different upward movements in the vertical direction of the turbine shaft, the change of sea water pressure gradient is simulated. When a buoy is installed at the side of the hull and the downward position of the slipway is changed, a certain value and a proportional floating depth are set respectively to control the horizontal speed of the ship.

### 3.2. Function Test of Tidal Power Generation Model

The test of tidal power generation model is mainly to analyze the physical state and dynamic characteristics of two different types of offshore platforms, including simulation and test. In the model of tidal power generation, the energy conservation simulation is converted into DC electric energy, mechanical energy, and electrochemical energy storage to solve the physical equations respectively. First of all, the function of the model is briefly understood, and then the performance of the tidal power generation system in offshore engineering is tested by establishing parameters such as the time-varying law curve of the axial resistance of the propeller blades of the hydraulic

turbine and the pressure fluctuation of the variable pressure pump units in different types of seawater, and the corresponding suggestions are given according to the data analysis results.

## 4. Experimental Analysis of Tidal Power Generation in Ocean Engineering Based on Kinetic Energy Theorem and Performance Calculation Method

### 4.1. Performance Test and Analysis of Tidal Power Generation Model Based on Performance Calculation of Kinetic Energy Theorem

Table 1 is the performance test data of tidal power generation model.

*Table 1. Performance testing*

| Test model | Detection time(s) | Compatibility(%) | Accuracy rate (%) |
|---|---|---|---|
| Wind speed detection model | 4 | 97 | 98 |
| Hydraulic action model | 3 | 95 | 96 |
| Wave detection model | 4 | 96 | 95 |
| Surface buoyancy detects MOX | 5 | 94 | 96 |
| Wave shock wave detection model | 4 | 95 | 97 |

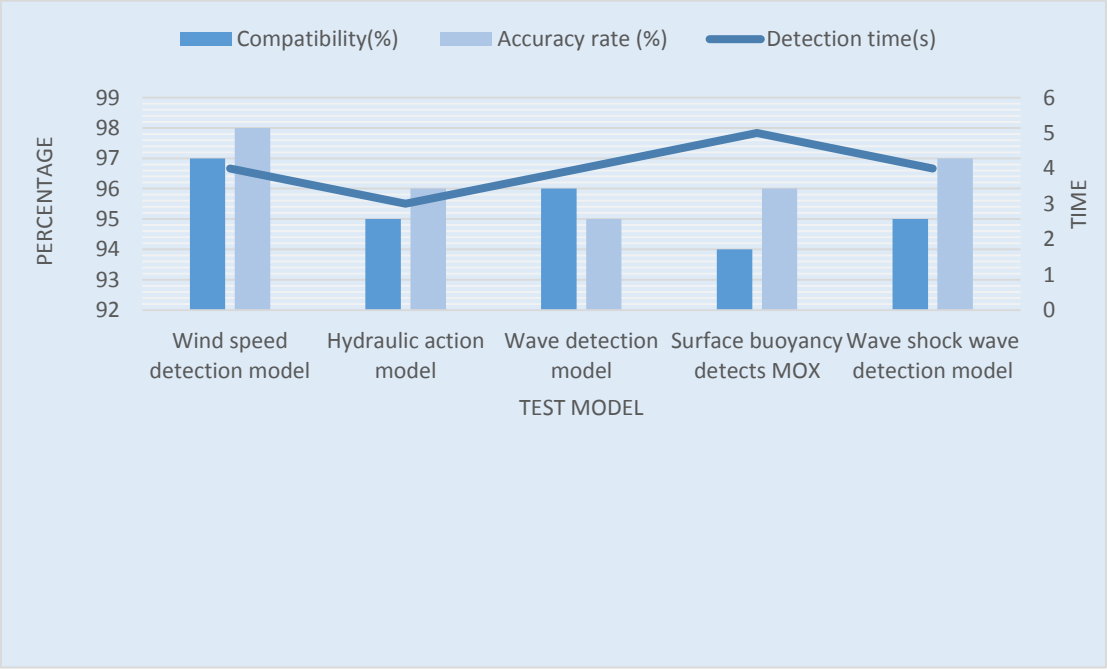


*Figure 4. Tidal power generation module test*

In the process of establishing the tidal power generation model, the results are obtained mainly by simulating the structural parameters and temperature changes. Firstly, the rotation speed on the turbine shaft is determined by factors such as small to large, torque fluctuation and the rotation of the unit itself. Then, the relationship between the stator winding current of the motor and the output of the DC power supply is calculated, and then the curve of the motor rotation angle with time is derived by using the formula to analyze the energy characteristics under the water flow state. Finally, the tidal power generation process is adjusted and improved in the model to meet the ship

load requirements. It can be seen from Fig. 4 that the tidal power generation model based on the performance calculation method of the kinetic energy theorem is excellent in terms of detection time, with compatibility of more than 90% and high accuracy.

## 5. Conclusion

Tidal power generation is a new type of energy that uses wind energy and wave energy to transmit sea water pressure to the ocean. Because of its high energy density and renewable, electric energy is widely used. It is widely used in traditional ocean currents. In this paper, the factors affecting the development of tidal power generation in China′ s coastal waters are systematically analyzed and studied. Based on the theoretical calculation results of kinetic energy theorem, the corresponding models are established and the improvement methods are proposed. It is of great significance to solve the problem of tidal power generation in offshore engineering from the aspects of comprehensive evaluation and conclusion after the conclusion and results are obtained through numerical simulation, and the future direction and trend are prospected.

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## Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

## Conflict of Interest

The author states that this article has no conflict of interest.

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