

Study on Optimal Layout of Multi-Unit Array of Tidal Current Power Generation

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Abstract: With the utilization of tidal energy resources, especially the continuous development of tidal energy resources, the research on the optimal layout of multi-unit array of tidal current power generation has been paid more and more attention. From the existing research, experts have carried out a large amount of research through numerical calculation and model experiment, and improved the optimal layout. From the perspective of multi-unit array of tidal current energy generation, whether it is conducive to the scientific distribution of tidal current field energy under the array and the acquisition of optimal energy is the key to the optimal layout of multi-unit array of tidal current energy generation. Through the intervention method of small notch, the role of each unit spacing and unit angle of attack is analyzed, and the optimization is realized through the angle of attack. It can be said that it has been verified in practical application. Thus, the maximum energy of multi-unit array of tidal current power generation can be obtained.

1. Introduction

Tidal energy, like other natural energy, is influenced by the general laws of nature. With the concept of energy, human beings can live, grow and use energy to realize the development of science and technology. As we all know, energy is the basis of human survival and development. Energy has a very broad definition. At present, the energy sources that can provide value to mankind in the world are oil, natural gas, coal and ore fuels. Most of these energy sources are non-renewable. At the same time, with the attention of mankind to the earth's environment and the heavy pollution brought to mankind by these energy sources, mankind is looking for more alternative resources, and tidal energy is a renewable energy that mankind believes is more environmentally friendly. Therefore, many countries around the world began to pay attention to the research of tidal current energy and the scientific and rational development and utilization of tidal current energy. Tidal current energy is the same energy obtained by using the laws of nature as wind energy and solar energy. In particular, the ocean area occupies most of the earth's area, so the total content of tidal energy can't be underestimated, and the development of tidal energy is conducive to the improvement and attention of the global marine environment.

2. Importance of Optimal Layout of Multi-Unit Array for Tidal Current Power Generation

Tidal current energy is also a kind of marine energy, and others mainly include tidal sand, waves and temperature difference. They all use the law of the ocean itself to realize energy, but the tide refers to the periodic fluctuation tide phenomenon of seawater excited by the gravitational action of the sun and the moon. In this process, the acquisition of energy can be seen. The regular horizontal flow of seawater generated by this tide phenomenon is called tide. In fact, tidal current is very similar to wind energy, which is the acquisition of natural energy, but the difference between tidal current and wind energy is that tidal current can be more stable, and has the characteristics of large energy and strong sustainability. Therefore, in recent years, the research on the utilization technology of tidal energy has become the focus of universal attention all over the world, and with the development of sustainability and science and technology, the core position of tidal energy as

renewable energy can't be broken. At present, the key point for the utilization of tidal current energy lies in how to better optimize the layout of multiple-unit array of tidal current generation, which is of great significance for improving the value of tidal current energy and further studying the natural law of tidal current energy. From the perspective of sustainable development, especially during the 14th-five-year plan period, the national strategy should carry out green environmental protection transformation, focusing on eliminating the energy that the national economy relies heavily on. It is an inevitable trend to widely use and distribute new energy.

3. Characteristics and Layout Analysis of Tidal Current Energy

Places with tidal current are often distributed at the corner of the bay or strait. It is the key to determine the multi-column distribution of generator units with tidal current energy from the size of tidal current, and find the best angle of attack. From the characteristics of tidal current energy, there are the following points. First, the density of water is large, and the energy density of tidal current energy is much higher than that of wind energy and solar energy, which has stronger impact and focus. Second, tidal current energy is a relatively stable new energy with periodic changes in time, while wind energy has many uncertainties. Tidal current energy can be more utilized and has predictive value. Third, although tidal current power generation technology started late, its technology has a great impact, and even has the potential of latecomers, which is unique in marine energy. But at the same time, it also means that the tidal current power generation technology has developed rapidly. The tidal current power generation technology in developed countries such as Japan, the United States, Britain and Australia has entered the stage of commercial power generation, so that they can make better use of tidal current energy to achieve the stability of electricity price. However, China is still in the stage of building tidal current power generation plants, and China is rich in reservoir resources and other energy sources, so the power is not particularly tight. This has also led to the relatively slow development of China's tidal current energy. Fourth, because the tidal current generator is installed in the sea water, it needs to meet the process of long-term immersion in water, and needs to withstand the influence of some high corrosion characteristics in the sea water. At the same time, it also faces the damage of various marine disasters. Therefore, the performance and layout requirements of tidal current generator are very important. Fifth, the high cost of tidal current energy generator also means that the investment cost of building tidal current energy multi-unit power plant is very high ^[1].

The above characteristics are very important for the layout of multi-unit array of tidal current power generation. How to better realize the value of power generation through layout is an important topic in front of us.

4. Optimal Layout Strategies of Multi-Unit Array for Tidal Current Power Generation

The optimal layout of the multi-unit layout of tidal current power generation needs to be taken into account. A reasonable layout can not only improve the power generation capacity of tidal current power generation units, but also better reduce environmental pollution and protect marine ecology. It is also an effective utilization and protection for the equipment of multi-unit power plants.

4.1 Improve the Inflow Speed of Tidal Current Energy Generator through Wake Layout

At present, tidal current generators are mainly divided into two types: horizontal-axis generators and vertical-axis generators. Horizontal-axis generators can be divided into windmill generator, hollow tubular generator and diversion hood generator. The vertical-axis generators can be divided into straight blade generator, spiral blade generator and diversion hood generator. Through the layout of the wake to realize the impact on the inflow speed of the tidal current energy generator, so as to really affect the output power of the generator set, from the practical situation, is a very important link. Therefore, it needs to be calculated by establishing a more objective wake model, which is an important content and basis for the layout of multi-unit generators of tidal current. At

present, there is still a lack of generation of a systematic wake mathematical model applied to multi-unit tidal current power generators in China. Most of the wake of power flow generators are realized by simulation. Therefore, many problems related to tidal current power generation need to be further studied. This requires that the wake layout technology at home and abroad be used for reference as soon as possible to realize the optimization of tidal current generator array ^[2]. And when multiple tidal current power generators operate together, the wake effect between them is more obvious.

4.2 Specify the Optimal Installed Number of Tidal Current Energy Generators to Be Placed in the Tidal Current Energy Power Plant

This is a very important scientific problem that needs to be calculated. Too little installed capacity will affect the effect of power flow energy, and too much installed capacity will reduce its own income due to high cost. Therefore, the number of installed capacity needs to be reasonably estimated in combination with the site conditions. In particular, in the early stage, the trial operation can be carried out through the initial installed capacity, so as to further estimate the operation capacity, and make it achieve the full effect of the optimal installed capacity of tidal current energy generator through addition and subtraction. In addition, the efficiency of multiple units can also be realized through mathematical model algorithm, and finally achieve the same purpose. Therefore, how many groups of tidal current generators are placed is the top priority of layout optimization.

4.3 Fully Observe and Measure the Terrain Formed by Tidal Current to Realize Objective Layout

From the perspective of optimizing the layout, the evaluation should be carried out according to the different size of the tidal current, the flow direction should be clarified by observing the topography of the tidal current forming area, and the correlation influence degree of the topography in the seabed should also be evaluated. It is necessary to comprehensively investigate the different wake effects that multiple groups of generators may be affected at different times, so as to make different judgments. It is also necessary to carry out the initial design of the tidal current energy optimization scheme according to the evaluation results, so as to achieve the best layout scheme and meet the optimal effect of placing multiple groups of generator units, so that the wake effect of each tidal current can affect each other, eliminate the restriction of the wake effect on the generator unit, and truly realize that the input and output are directly proportional. In order to conduct in-depth research on this aspect, after observation and analysis, the wake model suitable for normal tidal current shall be selected according to the technical report. Based on further analysis of the function model, a more reasonable and optimized algorithm shall be proposed to meet the improvement of tidal current multi-unit layout and power generation effect prediction and evaluation in specific sea areas. For example, in Zhoushan tidal current field in Zhejiang Province, this algorithm is called “optimization algorithm”, and then the layout algorithm is simulated through simulation examples, so as to achieve the purpose of layout optimization ^[3].

4.4 Optimize the Layout through Three-Dimensional Simulation Model

By analyzing the various constraints and deficiencies of the layout of regional multi-unit tidal current energy generators, we can judge and understand the tidal current speed, and carry out the initial design, then establish a three-dimensional model to realize quantitative calculation, and carry out the objective function equation of the model to solve the specific data of the existing problems. In many studies on the layout optimization of tidal current energy, it is often attributed to the nonlinear optimization problem of multi constraints and multi variables. In fact, quantitative research is also essential for tidal current energy. At the same time, it is necessary to strengthen the research and development and calculation of the wake model of multiple groups of tidal current energy generators, combined with the common characteristics of fluid, and make a reasonable layout with full reference to the wake model of wind turbines. The use of three-dimensional simulation can make more comprehensive use of technical simulation to the visual evaluation of tidal current energy multiple generators.

4.5 Pay Attention to Planning and Optimization Methods for Multi-Unit Tidal Current Power Generation

Multi-unit tidal current power generation should pay attention to basic planning and reasonable optimization methods. In terms of layout, it is very important to pay attention to the wave force strength that the power of downdraft fan and wave energy device can withstand. Moreover, it is necessary to further optimize the unbalanced layout of both by observing the numerical value to realize the reasonable layout. Then we can start from the value that ensures the lowest wave force on the fan, so as to improve the practicability and economy of multi-unit tidal current power generation, and fully consider its reliability. At the same time, it should be noted that in the sea area, waves will appear diffraction, refraction and other phenomena when encountering different obstacles, which will often change the wave height in the water behind these obstacles, directly affecting the expression of wave force intensity. Therefore, in the planning of multiple groups of tidal current generating units, it is necessary to make a scientific and reasonable layout between wind and wave devices, and track and analyze the whole process. For example, in different cases, the layout of these devices should be based on the change of wave height, and the relationship between the incident wave and the horizontal included angle should be mastered. In this way, the radius of the float can be further arranged for the tidal current power generation device. The connection between the radii of various devices and the included angle between the horizontal can be further judged to form a scientific basis.

5. Conclusion

The optimal layout of multi-unit array of tidal current energy generator needs to pay attention to the terrain of tidal current area, and pay attention to the wake effect between different tidal currents in this process, so as to maximize the effect through the optimal layout of multiple groups of devices.

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