Research on the Application of Wave Energy Converter

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Abstract. The current energy shortage problem is becoming more and more serious, so the development and utilization of renewable energy have become a good solution. Wave energy, as an important part of renewable energy, has the advantages of environmental friendliness and high energy density. Although there are more and more researches on wave energy, research on wave energy applications is still relatively rare. In this paper, the current wave energy technology was fully investigated, and the application fields of wave energy technology were classified and summarized. In view of the relatively lack of wave energy resources in China, this paper also proposes wave energy technology development recommendations suitable for the actual situation of China.

1. Introduction

With the development of the economy and technology, energy demand continues to increase. The reserve of fossil-fuel which serves as a main source of energy supply is decreasing, and environmental pollution caused by fossil-fuel consumption has caused serious concern. As an important supplement to the current energy supply and a research focus for the future energy, renewable energy has received more and more attention and investment [1]. The ocean, which accounts for 71% of the surface of the earth, is rich in renewable marine energies, such as tidal energy, tidal energy, and wave energy. Among them, wave energy is a kind of marine energy with wide distribution and high energy density. Development of marine energy can alleviate the current energy supply crisis and environmental pollution problems.

Compared to Europe and the United States, the wave energy density of China is lower. The wave energy density in coast of Western European and the west coast of the United States which is in the westerly zone can reach 40-100kW/m [2]. The region with relatively abundant wave energy resources in China is the southeast coast, and its wave energy density is only approximately 2-7 kW/m. Compared with other renewable energy sources, the wave energy density in the sea area of China is still at a high level, which helps to accelerate the commercialization of wave energy in the field of marine resources development.

2. Research on the application of wave energy technology

Wave energy converters can be classified based on the type of technology used or technical generation. According to the specific technology types used, wave energy converters can be divided into shrink channel technology, oscillating water column technology, oscillating body technology, and so on.
According to the technical generation difference of wave energy converters, it consists of first generation, second generation, and third generation technologies. The first generation technology refers to a wave energy converter fixed on the shore. This is beneficial to observe the wave energy conversion efficiency and optimize the structure in the early stage of research, but its structure is too complex and depends on the specific terrain, which is not conducive to promotion. The second generation technology refers to a wave energy converter that is offshore but has low conversion efficiency. Offshore wave energy capture technology makes it easier to build and get rid of terrain dependence, but the lower conversion efficiency still restricts its further development. The third generation technology refers to a wave energy converter that is offshore and has high conversion efficiency. This kind of converter is mainly represented by the oscillating body technology with the wave-eliminating function. By increasing the capture efficiency of wave energy, the wave energy conversion efficiency of the whole device is greatly increased.

2.1. Grid power generation
After the wave energy is converted into electrical energy by using wave energy converters, the energy is sold to the power company. Grid-connected power generation is the focus of research in countries with abundant wave energy resources. Such as the Wave Dragon wave energy device in Denmark, the PowerBuoy wave energy device from OPT company in the USA, the LIMPT power station and the Pelamis wave energy device in the UK.[3-6]

2.2. Equipment power supply
Due to the needs of marine development and national defense construction, there are too many equipment in the ocean that require power supply, such as various buoy equipment, underwater robots, and offshore platforms. These devices often require a long-lasting power supply. Currently, batteries or diesel generators are generally used for power supply, which is difficult and costly. Powering with wave energy can effectively reduce power supply costs and improve equipment reliability.

2.3. Used directly as production.
As mentioned above, the current development of wave energy technology is mainly used for power generation, and the energy conversion process can be expressed as wave energy → mechanical energy → electric energy. And then the electric energy can be used as other energy sources. The mechanical energy and electric energy exist in the form of intermediate conversion energy. When the ultimate purpose of the equipment is clear, the wave energy can be converted and used directly for production. For example, the wave energy hydrogen production technology has changed the previous three-stage conversion. The wave energy is directly used for the equipment operation, and good results are obtained. This application is also used in desalination currently.
3. Suggestions for the application of wave energy technology suitable for the resource status of China

Considering the application of the wave energy technology and the actual situation of China, the following suggestions are made:

3.1. The wave energy technology development program in Europe and the United States is not suitable for China.
Countries such as Europe and the United States have relatively abundant wave energy resources, and their main research works are concentrated on grid-connected power generation. Its power generation cost is low with good social and economic benefits. In the seas of China, the cost of wave energy generation is relatively high. Compared with mature grid-connected power generation forms such as thermal power and nuclear power generation, the wave energy technology has no advantage in cost. In addition, the wave energy converters required for grid-connected power generation are often large-sized devices or a large number of device arrays. The East China Sea and the South China Sea where the wave energy resources are relatively abundant in China belong to the typhoon high-incidence area. The reliability and evasiveness of such large-scale devices or device arrays need to be very high.

3.2. Power supply for dedicated devices
China has a wide sea area and a long coastline. Due to the needs of marine resource development and national defense, there are often a large number of marine dedicated devices. Such equipment is far from the coast, so the power supply is difficult and costly. Using wave energy to power the device directly is an ideal solution. This will provide a good energy supply solution for marine buoy equipment, underwater robots, offshore platforms and other marine dedicated devices. In addition, as the ocean strategy of China extends to the open sea, this wave energy converters that supply power to dedicated devices will inevitably have better prospects for development.

3.3. Desalination and power supply in remote islands.
Many of the distant islands in the South China Sea are far from the mainland and are difficult to resupply. The application of wave energy power generation technology can effectively solve the daily electricity consumption and seawater desalination of the island residents. As a kind of renewable ocean energy with wide distribution and high energy density, wave energy can effectively improve the energy self-sufficiency and improve the ability to monitor and control the surrounding seas of remote islands.

4. Conclusion
This paper analyzed and summarizes the application fields of wave energy technology by investigating the current application of wave energy research. In view of the relatively lack of wave energy resources in China, a development plan for prioritizing the development of power supply for dedicated devices and remote islands was proposed.

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