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Abstract: In order to protect the environment, save energy and reduce emissions, and promote the utilization of wave energy, this paper reviews the development history of application generation technology, summarizes its development from two aspects of optimization and application of wave energy conversion devices, analyses the application examples of wave energy generation devices on ships. This paper summarizes the application trend of wave power generation devices on ships: wave power generation should be used as auxiliary and domestic electricity for ships and wave energy should be combined with other new energy sources. Wave energy application in marine power generation can effectively reduce emissions from ships, which is conducive to the sustainable development of human society.

1. Introduction

Renewable energy has been established as one of the most prolific development areas in the twenty first century. The difficulties surrounding exploiting renewable energy resources are no longer related to developing novel technologies, but rather related to the transition and implementation of the renewable harvesting systems within the petrol based power grids around the world. Increase in demand for energy has stimulates socio-political pressure to explore sustainable and viable alternatives to fossil fuels. In particular, energy stored in ocean wind-generated waves is considered as an interesting alternative option to reduce the world energy dependence on fossil fuels. The world's energy demand is increasing, traditional fossil energy consumption is rapid, the ecological environment is gradually deteriorating and seriously threatening the sustainable development of human society.

Solar energy, hydropower and wind energy are all being harvested by technologies which are witnessing a high rise in usage, and have been well established and optimized within industry manufacturers. Ocean energy conversion technology on the other hand, while it has a potentially higher efficiency and reduced complexity, is struggling to find its place in the renewable energy market.

1.1. Overview of development of wave energy power generation technology at home and abroad

China has been studying wave energy generation technology for more than 30 years. At present, China has successfully built a number of wave energy demonstration power stations, such as the 105 kW multi-energy complementary power station of Daguan Island, the 500kW island marine energy independent power system demonstration project in the South China Sea, and the 500 kW multi-energy complementary demonstration power station of the Laoshan Island. A 1,000kW class shore wave power station was built in Guangdong, Shandong and Hainan. Since the 1970s, the United Kingdom, Norway, Japan, and the United States have studied the principles and schemes of wave energy conversion, and

proposed some new creative concepts. In the 21st century, successful sea trials of giant wave power generation devices such as "Sea Snake" and "Giant" have marked the maturity of wave power generation technology.

2.Marine power plant power system composition

The power system of ocean energy power generation with wave energy and tidal energy as the research object consists of five parts: ocean energy power generation device, power generation device power collection system, power transmission system, shore-based power distribution system, and grid-connected system. Taking into account the feasibility, reliability and economy, the technical and economic reliability and reliability assessment of the power generation system and transmission system part of the power generation unit, combined with the experience of the offshore wind farm, form a set of research system for the power system of the marine energy field.

The primary system of the marine energy field includes the power generation area, the current collection system, and the power distribution system. The power generation area includes ocean energy power generation devices, converters, airborne transformers, submarine cables, etc; the power collection system includes submarine cables, offshore platforms/conversion stations, etc; shore-based power distribution systems include boost substations, onshore commutation Station, energy storage equipment, etc. The secondary system is mainly a monitoring device and a protection system.

In the collector topology of the generator set, there is a parallel constraint problem in the AC transmission mode of each power generating device. The converter system consists of three parts: an AC/DC converter, a DC/DC converter, and a grid-connected inverter. The electric energy generated by the wave energy and tidal energy power generation device firstly connects several generators to the generator set on the DC side through the rectification link, thereby avoiding the problem of different frequency and phase, and simultaneously increasing the energy output.

The AC/DC converter mainly converts the voltage amplitude and frequency alternating current generated by the marine energy generator set into DC power to ensure the power flow channel at the exit of the tidal current generator set; the DC/DC converter mainly focuses on smooth tidal current and wave The deviation of the power fluctuation and the grid-connected power can be realized, and the system power can be smoothly adjusted; the grid-connected inverter can perform the power adjustment on the inverter side to realize independent control of the active power and the reactive power.

3.One conversion

The primary conversion of wave energy mainly refers to the conversion of kinetic energy and potential energy of waves on the surface of the ocean into other forms of energy.

3.1. Oscillating Water Column

The oscillating water column wave power generation device is currently the most researched and used wave energy device. The basic principle is to use compressed air to drive the steam turbine generator set. According to the installation location, it can be divided into offshore, nearshore and docking. The oscillating water column type wave energy device has good reliability because there are no moving parts under water. The disadvantage is high cost and power generation efficiency of less than 30%.

3.2. Submerged Pressure Differential

The submerged pressure differential pressure wave device works by using the wave crests and troughs of the waves to the pressure difference of the switching device. The Archimedes wave energy conversion device developed in the Netherlands uses the pressure difference to generate relative motion and drive the turbine or linear generator to generate electricity. The United States wave energy company developed a new type of pressure difference wave energy conversion device, using three special shape water floats, respectively, through the gears, racks to drive the generator to generate electricity.

Submerged pressure differential pressure wave device: The overall structure is underwater, which will not affect maritime shipping; it can avoid the damage of wave energy device caused by extreme

weather. The disadvantage is that sealing and rust prevention are not guaranteed.

3.3. Overtopping

The diffuse wave energy device mainly collects the wave potential energy and converts it into electric energy by using a turbine. Denmark has designed two types of conical diffuse reflectors, "SSG," that use the over-wave effect to store and drive the turbine to generate electricity. Denmark's "Wave Dragon" diffuse reflector uses a dedicated waterway to store wave potential energy to a high level and convert it into electricity using a low-head turbine. Sweden has developed a wave energy device for floating wave energy containers, which uses four floats to support the energy storage container with a power of 1.5 MW.

The diffuse power generation device is bulky, inefficient, has moving parts under water, and has low reliability.

3.4. Oscillating Wave Surge Converter

The oscillating wave surge converter works by using the elliptical motion characteristics of water particles. British Green Ocean Energy has designed an oyster wave energy conversion device that uses compressed water as a hydraulic oil to drive generators to generate electricity. Finland has designed an oscillating wave surge converter that uses a plunger pump to absorb the kinetic energy of the oscillating plate and transfer the kinetic energy to a closed hydraulic motor and generator combined hydraulic system. The oscillating rocking wave energy device has a simple structure and high efficiency. But only for shallow seas, hydraulic oil leaks can cause pollution.

4. Wave energy intermediate conversion

Wave energy secondary conversion usually requires intermediate conversion links. The intermediate link processes energy such as mechanical energy to achieve stable, steady speed and accelerated energy transfer.

4.1. Mechanical conversion

Mechanical conversion is mainly composed of gears and other mechanisms. K. Rhinefrank designed a point absorbing wave energy device consisting of two floats and a Spar platform. It used a sealed drive shaft and gear mechanism to transmit wave sway and oscillating energy to the electromagnetic induction generator. Hadano K designed point absorber wave energy balance means by the rotation of the clutch and transmission of energy conversion mechanism growth.

Mechanical conversion is a traditional wave energy conversion method with mature technology; the disadvantage is low efficiency.

4.2. Hydraulic conversion

In 1980, McCabe proposed the hydraulic pump concept. The pump uses a two-wing pontoon to swing the hydraulic pump up and down at sea level, driving the hydraulic motor to drive the motor to obtain electrical energy. In 2005, OPD UK and the University of Edinburgh jointly developed the "Pelamis" conversion unit, which uses a cross-connect structure and a hydraulic cylinder to connect the float. The relative rotational energy of the float can be converted into hydraulic energy. In 2007, Wang Feng of Zhejiang University and other designers designed a new hydraulic power system that uses seawater to drive hydraulic systems with pressure changes in elastic vessels filled with hydraulic oil, achieving an efficiency of 63.8% in the 2,400 m deep sea.

The hydraulic energy can be stored for easy control and is suitable for energy conversion of wave energy transducing devices.

4.3. Pneumatic conversion

Pneumatic conversion typically uses air as a medium to convert air kinetic energy into turbine maneuver energy. Turbines are mainly divided into one-way rectifier turbines and two-way turbines. The one-way

turbines are highly efficient and have a large structure. The two-way turbine is commonly used in Wells turbines, which does not require rectification and has high efficiency. The shortcoming angle of attack is too large and it is prone to stall.

5. Development trend of wave energy power generation technology on board

The New Ship Energy Efficiency Design Index (EEDI) developed by the International Maritime Organization is an indicator used to assess the carbon dioxide efficiency of a ship, is the ratio of social benefits to carbon dioxide emissions generated per unit of the ship. After the implementation of EEDI, new ships must comply with EEDI standards and promote the development of green ship design; and the application of wave energy, such as renewable energy, to ship power generation can effectively reduce ship carbon emissions. Based on the above analysis, the application trends of wave energy generation technology on ships are as follows: In the initial stage of ship design, fully consider the use of wave energy. Wave power generation is used as a ship auxiliary and domestic electricity. Wave energy can be combined with other new energy sources. Wave energy self-propelled power station.

Desalination and comprehensive utilization of seawater are important directions for the development of wave energy. Desalination and wave energy supply are important for solving the energy supply in remote islands and coastal countries. At present, human demand for fresh water is increasing, and desalination can greatly alleviate the pressure on people's demand for fresh water. Especially for remote islands, wave energy plants can provide electricity supply and fresh water supply, which can promote the development and utilization of islands.

The use of ocean wave energy for comprehensive research such as aquaculture and hydrogen production is a new way to utilize ocean energy. Marine aquaculture is an important economic activity of the country. It is of great significance to use wave energy to achieve sea state monitoring, energy supply and improvement of farming conditions. The use of wave energy to produce hydrogen can indirectly achieve the storage of wave energy, and can provide raw materials for power generation devices such as fuel cells.

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