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REVIEW

Automatic Measurement and Control Design of Sea Wave Energy Storage and Seawater Desalination Device

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ABSTRACT

The application of seawater desalination has become more and more popular. The reverse osmosis membrane method is one of its applications, but it consumes more energy resources and produces freshwater with high cost. The four-column floating bed we designed has low investment and is simple and easy to operate. The sea wave energy storage and seawater desalination device produced by this method has greatly reduced the cost of freshwater produced. This paper focuses on the design of the automatic measurement and control loop of the device.

1. Introduction

There are many places where the sea is lacking freshwater, making the seawater desalination become popular. At present, various seawater desalination methods consume a lot of energy, resulting in high crude water costs. Some units have experimented with the use of wind power from the sea and the power generated by solar energy to drive seawater desalination, so that the sea can send freshwater to shore. It seems feasible, but the current investment in wind and solar power is too large, and the cost of converted freshwater is too high, which is difficult to promote.

At present, the most widely used method for seawater desalination is the reverse osmosis membrane method.[1] The factors that hinder its widespread promotion are also too much energy consumption and high freshwater cost.

2. The Implementation Scheme of Sea Wave Energy Storage and Seawater Desalination Device

We invented the "sea wave energy storage and seawater desalination device", which is located in the shallow beach, does not consume additional energy, and can operate by collecting the waves, so that the sea can send fresh water to shore. At the same time, the total investment is very low, the cost of converting fresh water is very low, and it has a good promotion prospect. This invention has been applied for China's utility model technology inven-

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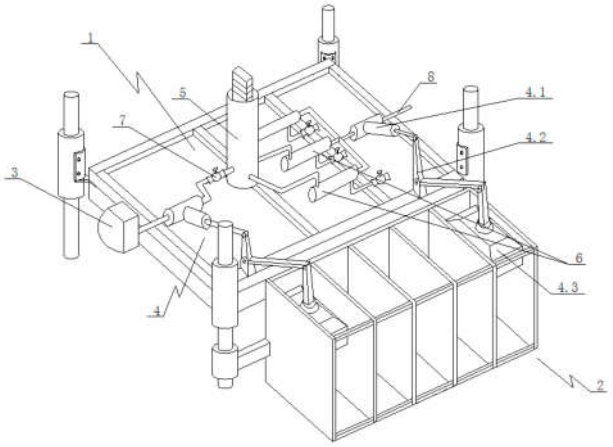
tion patent. Methods as below:

(1) A four-column floating bed is designed: a rectangular bed is made of corrosion-resistant angle steel, and a foam block is bound under the bed body, so that the bed body and the equipment thereon float on the water surface; On the beach, four columns are arranged. The outside of the column is covered with a cylinder about 40 cm long. The cylinder is spaced about 0.5 cm from the cylinder. The cylinder is linked with the four corners of the floating bed. In this way, the floating bed floats with the tide level, but it is not shaken by the impact of the waves. All equipment is installed on a floating bed.

(2) A floating grille is mounted on the side of the floating bed, and the duck head floating body is installed in the grille. The movement of the waves promotes the movement of the duck-headed floating body, and the plunger pump is moved by the lever to pressurize the seawater or fresh water. This is the driving force for the operation of the device. After testing, the wind force is about three levels, and each plunger pump has an output of about o ton of water per hour. The seawater is filtered by the secondary filter before being pressurized by the medium-pressure pump and the drug is detoxified and descaled, and then pressurized by the high-pressure pump. After being pressurized, the seawater is sent to the stabilized water storage tank through the check gate.

(3) After the water storage tank, the seawater is sent to the reverse osmosis membrane filter cartridge through the control valve. The membrane used in the reverse osmosis unit is a composite membrane suitable for seawater.[2] The SWHR-380 seawater membrane produced by American Dow Company has a desalination rate of 99.6% for a single filter cartridge. The desalinated water from the filter cartridge enters the manifold. After the filter cartridge is concentrated, the seawater is discharged through the control valve. The fresh water of the manifold is then pumped to the land via a plunger pump. In this way, only the seawater energy is used to desalinate the seawater and send it to the land, and the equipment cost is low, and the cost of fresh water can also be low.

The schematic diagram of sea wave energy storage and seawater desalination device is as follows (Figure 1).



Notes: 1. Floating bed; 2. Grille; 3. Filter; 4. Plunger pump; 4.1 Freshwater booster pump; 4.2 Transmission rod; 4.3 Duck head float; 5. Regulated water tank; 6. Reverse osmosis cartridge; 7. Check valve; 8. Fresh water outlet pipe

Figure 1. The schematic diagram of sea wave energy storage and seawater desalination device

3. The Design of Device's Measurement and Control System

Compared with conventional terrestrial desalination devices, the difference is that the power is derived from wave energy rather than electricity; the whole set is installed in sea water instead of on land. It is impossible for someone to control it on site. There must be a practical, simple and reliable remote measurement control system.[3] Due to the filtration, dosing, pressurization, desalination and other processes of seawater, it is similar to the conventional reverse osmosis seawater desalination process, and there is no operation of equipment such as motors. The monitoring and control is relatively simple. The output of the whole device, that is, the output of the finished fresh water is determined by the size of the wave energy at that time, that is, "depending on the weather". We have a monitoring room on the land, and there are process simulations of all the equipment on the panel, showing the operating status of all the equipment. Just set up remote control switches for several key devices.

(1) Measurement and control of pretreatment system: We adopted the automated measurement and control system based on PLC and human machine interface (HMI) designed by Tianjin Seawater Desalination Research Institute. Measurement and control of the inlet screen: Due to the convenience of direct access to the beach, the fence area is large. A three-stage filter screen is provided. The first-stage filter fence has a volume of 100 cubic meters, and intercepts objects of more than 3 centimeters. The second-stage filter fence has a volume of 10 cubic meters,

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intercepts objects of more than 1 mm, and adds flocculating agents and descaling agents. The third-stage filter is a 5 micron security filter, which is equipped with a cone filter rod made of polypropylene spray, deep filtration, and large amount of dirt, long life and easy replacement. The third stage is provided with two sets of filter screens. The PLC collects the pressure on the two sides of the filter screen, switches the filter screen according to the pressure difference on both sides, and automatically backwashes.

(2) Since the operation of the plunger pump is unstable and the outlet pressure is unstable, the plunger pump outlet is added with a check valve. The opening and closing monitoring point of the back door can display the running condition of the plunger pump.

(3) The pressure inside the regulated water storage tank is adjusted by the number of top weights. A position monitoring point is installed every 5 cm in the water level in the tank.

(4) There are 5 reverse osmosis membrane cartridges, and each filter cartridge inlet valve is electrically controlled. When the water level in the water storage tank is the highest, the entire filter cartridges are opened, and a filter cartridge is stopped for every 5 cm of the water level. The PIC monitors the transmembrane pressure difference in real time. When the transmembrane pressure difference increases by 10%, it exits the work for cleaning. In order to extend the working cycle of the filter cartridge and reduce the number of cleanings, according to the characteristics of the device, the concentration ratio of seawater is reduced. After the filter cartridge is concentrated, the seawater is discharged through the electric control valve. The desalinated water from the filter cartridge enters the manifold.

(5) The fresh water in the manifold is then sent to the land by a plunger pump.

(6) Solar power panels and small wind turbines and accumulators are installed on the four columns to provide power for the measurement and control device.

(7) There are two safety measures for avoiding wind and waves: first, the predictable wind and waves, untie the link between the floating bed and the cylinder on the column, and drag the floating bed to the safe area; second, suddenly encounter the wind is greater than five levels, start the safety protection device, temporarily loosen some of the foam blocks bound to the floating bed, so that the floating bed sinks to avoid danger.

(8) The monitoring point signals of the device are transmitted to the monitoring room via the optical cable.

4. Conclusion

The four-column floating bed described in this paper provides an ideal platform for the collection and utilization of wave energy. Based on this, sea wave energy storage and seawater desalination device was designed, which realizes the human ideal that the ocean itself sends fresh water to the land and the cost is low, which is worth promoting. This paper focuses on the automatic measurement and control part of the device.

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