

# **TITLE OF INVENTION: A SEAWATER DESALINATION DEVICE AND AN APPLICATION THEREOF**

## **TECHNICAL FIELD**

5   **[0001]**   The present invention relates to the technical field of seawater desalination equipment, and in particular to a seawater desalination device.

## **BACKGROUND**

10   **[0002]**   Seawater desalination is to produce fresh water through seawater desalting, and is an open source incremental technology that realizes the utilization of water resources. It can increase the total amount of the fresh water; is not affected by time, space, and climate; and can guarantee stable water supply for drinking water of coastal residents and water replenishing of industrial boilers. The process of obtaining fresh water from seawater is called seawater desalination. The  
15   methods of seawater desalination currently used include seawater freezing method, electrodialysis method, distillation method, reverse osmosis method, and profitable ammonium carbonate ion exchange method. However, these methods have either large energy consumption or high cost or need seawater pretreatment.

20   **[0003]**   A patent with a publication number of CN109956509A discloses a "Seawater Desalination System Driven by Windmill and Based on Open Stirling Cycle", which obtains fresh water by cyclically compressing and condensing water vapor using a Stirling two-stroke piston structure. Although the system can desalt seawater directly without the need of external energy, it also relies heavily on the movement of a Stirling two-stroke piston cylinder, and the movement of the system  
25   is periodic. As a result, the desalination process of seawater cannot be continuous, and the operation rate of the whole system is severely restricted. As two-stroke operation must be maintained within a certain rate to ensure evaporation and condensation of seawater, the seawater desalination rate of the system cannot be adjusted as required. Therefore, the efficiency of seawater desalination of the  
30   system has certain limitations.

## **SUMMARY**

**[0004]** The objective of the present invention is to provide a seawater desalination device which can desalinate seawater efficiently and does not need additional energy supply.

**[0005]** The embodiments of the present invention are achieved by the following technical solutions: A seawater desalination device, comprising: a windmill, a crank connected to a rotating shaft of the windmill, a connecting rod connected to the crank, an air-liquid compression mechanism connected to the connecting rod, a mixing tank connected to the air-liquid compression mechanism, a desalination chamber connected to the mixing tank, a heating device arranged in the desalination chamber, a condensing device arranged above the heating device, a collecting tank connected to the condensing device, and an air energy heat pump, wherein the mixing tank is connected to the desalination chamber through a connecting pipe, and the connecting pipe is conductively connected to lower end of the desalination chamber; the air energy heat pump comprises a hot pipe in communication with an outlet end, and a cold pipe in communication with an inlet end, wherein the hot pipe is arranged in the heating device, the cold pipe is arranged in the condensing device; and the cold pipe is connected to the hot pipe through a throttle valve.

**[0006]** Further, the air-liquid compression mechanism comprises an air compression mechanism and a liquid compression mechanism, wherein the air compression mechanism comprises an air cylinder, and a first piston arranged in the air cylinder, the outlet end of the air cylinder arranged in communication with the mixing tank through an air pipe, the first piston being connected to the connecting rod; the liquid compression mechanism comprises a hydraulic cylinder, and a second piston arranged in the hydraulic cylinder, the outlet end of the hydraulic cylinder being in communication with the mixing tank through a water pipe, the second piston being connected to the connecting rod.

**[0007]** Further, there is a plurality of mixing tanks, and the plurality of mixing tanks are conductively connected in sequence; and the connecting pipe is conductively connected to the plurality of mixing tank located at the end.

**[0008]** Further, the air pipe is conductively connected to the plurality of mixing tanks simultaneously; and the water pipe is conductively connected to the plurality of mixing tanks simultaneously.

**[0009]** Further, two adjacent mixing tanks are connected through a constant pressure valve; and the constant pressure valve is arranged at a joint between the connecting pipe and each mixing tank.

**[0010]** Further, the air energy heat pump further comprises a liquid pump, wherein the liquid is configured to drive the air energy heat pump, and the liquid pump is conductively connected to the connecting pipe.

**[0011]** Further, the rotating shaft of the windmill is connected to a generator, and the generator is electrically connected to the air energy heat pump.

**[0012]** Further, multiple atomizing nozzles are provided at one end of the connecting pipe arranged in the desalination chamber.

**[0013]** The present invention also provides an application of the above-mentioned seawater desalination devices in agricultural irrigation.

**[0014]** The present invention also provides an application of the above-mentioned seawater desalination devices in air humidification.

**[0015]** The technical solutions of embodiments of the present invention have at least the following advantages and beneficial effects: in a seawater desalination device of the present invention, a windmill is driven to rotate by wind power, a connecting rod is driven by a rotating shaft of the windmill through a crank to move up and down, thus, to drive an air-liquid compression mechanism. External air and water are periodically sucked by the air-liquid compression mechanism and periodically pumped into mixing tanks. At this time, a certain amount of high-pressure air and water are stored in the mixing tanks, and then the water is turned into the form of droplets suspended in the air under the action of the high-pressure air through a connecting pipe and brought into a desalination device. The droplets are heated by a heating device in the desalination device, further gasified, raised to a condensing device, and cooled down. Finally, the water passing through a cooling device is collected by a collecting tank, and the water collected is desalinated water. An air energy heat pump can be directly powered by the electricity generated by the windmill; and a heat transfer medium can be compressed and heated by the air energy heat pump to enter a hot pipe, and then enter the heating device through the hot pipe to heat water vapor. The medium is discharged from the heating device and enters a cold pipe through a throttle valve. The throttle valve causes the heat transfer medium to expand by changing the diameter of the pipe, thereby absorbing a large amount of heat from the surrounding areas. The high-temperature water

vapor is rapidly liquefied through a condensing device and flows into a collecting tank, while the cooled heat transfer medium flows back to the air energy heat pump for a new cycle. In this way, the whole device uses only one energy source, i.e. the windmill, and can operate automatically without additional power supply, which can not only significantly save energy, but also efficiently desalinate seawater.

[0016] To spray the desalinated seawater in this device, or fresh water in the first place, into air in the form of water droplets through the air-liquid compression mechanism, can not only efficiently implement irrigation, but also effectively improve the humidity of the air and reduce the degree of soil salinization in some areas.

## BRIEF DESCRIPTION OF DRAWINGS

[0017] To illustrate the technical solutions of the embodiments of the present invention more clearly, the following is a brief description of the drawings referenced in the embodiments. It should be understood that the following drawings merely show certain embodiments of the present invention, and therefore they should not be regarded as a limitation of the scope. For those of ordinary skill in the art, other related drawings can be obtained based on these drawings without undertaking any creative work.

[0018] Fig. 1 is a structural schematic diagram of a seawater desalination device provided by an embodiment of the present invention.

[0019] Legends: 10-windmill, 11-generator, 12-connecting rod, 21-air compression mechanism, 22-liquid compression mechanism, 23-air pipe, 24-water pipe, 25-mixing tank, 26-constant pressure valve, 27-connecting pipe, 30-desalination chamber, 31-heating device, 32-condensing device, 33-collecting tank, 34-hot pipe, 35-cold pipe, 36-throttle valve, 37-atomizing nozzle, 40- air energy heat pump, 41-liquid pump.

## DESCRIPTION OF THE EMBODIMENTS

[0020] To further clarify the objective, technical solutions, and advantages of the embodiments of the present invention, the technical solutions of the embodiments of the present invention will be clearly and completely described below in combination with drawings in the embodiments. Apparently, the embodiments described herein are just some rather than all of the embodiments of the present invention. The components of the embodiments of the present invention generally described and

showed in the drawings herein can be arranged and designed in various configurations.

**[0021]** Therefore, the following detailed description of the embodiments of the present invention provided in the drawings are not intended to limit the scope of the claimed invention, but merely represent selected embodiments of the present invention. Based on the embodiments of the present invention, all other embodiments obtained by those of ordinary skill in the art without making any creative work shall fall within the scope of protection of the present invention.

**[0022]** It should be noted that similar reference numerals and letters indicate similar items in the following drawings. Therefore, once a certain item is defined in one drawing, it is not required to be further defined and explained in the subsequent drawings.

**[0023]** In the description of the present invention, it should be noted that the orientational or positional relationship indicated by the terms "center", "upper", "lower", "left", "right", "vertical", "horizontal", "inner", "outer", etc. is based on the orientational or positional relationship shown in the drawings or the orientational or positional relationship usually placed when the product of the application is being used; and it is only for the convenience of describing the present invention and simplifying the description, rather than indicating or implying that the indicated device or component must have a particular orientation and must be constructed and operated in a particular orientation. Therefore, it cannot be understood to limit the present invention.

**[0024]** In the description of the present invention, it should also be noted that, unless otherwise clearly defined and limited, terms "set", "install", "link" and "connect" should be interpreted broadly. For example, it can be a fixed connection, or can also be a detachable connection or integral connection; it can be a mechanical connection, or can also be an electrical connection; it can be a direct connection, or can also be an indirect connection via an intermediary, or can be an internal communication between two components. For those of ordinary skill in the art, the specific meaning of the above-mentioned terms in the present invention can be understood in specific situations.

## **EMBODIMENT 1**

**[0025]** THE present invention is further described below in combination with specific embodiments. As shown in Fig. 1, a seawater desalination device of the present invention, comprising a windmill 10, a crank connected to a rotating shaft of the windmill 10, a connecting rod 12 connected to the crank, an air-liquid compression mechanism connected to the connecting rod 12, mixing tank 25 connected to the air-liquid compression mechanism, a desalination chamber 30 connected to the mixing tank 25, a heating device 31 arranged in the desalination chamber 30, a condensing device 32 arranged above the heating device 31, a collecting tank 33 connected to the condensing device 32, and an air energy heat pump 40. The mixing tank 25 is connected to the desalination chamber 30 through a connecting pipe 27, and the connecting pipe 27 is conductively connected to the lower end of the desalination chamber 30. The air energy heat pump 40 comprises a hot pipe 34 in communication with the outlet end, and a cold pipe 35 in communication with the inlet end. The hot pipe 34 is arranged in the heating device 31, and the cold pipe 35 is arranged in the condensing device 32; and the cold pipe 35 is connected to the hot pipe 34 through a throttle valve 36. The rotating shaft of the windmill 10 is connected to a generator 11, and the generator 11 is electrically connected to the air energy heat pump 40. Specifically, the windmill 10 is driven to rotate by wind power, the connecting rod 12 is driven by the rotating shaft of the windmill 10 through the crank to move up and down, thus to drive the air-liquid compression mechanism; external air and water are periodically sucked by the air-liquid compression mechanism and periodically pumped into the mixing tank 25; at this time, a certain amount of high-pressure air and water are stored in the mixing tank 25, and then the water is turned into the form of droplets suspended in the air under the action of the high-pressure air through the connecting pipe 27 and brought into the desalination device; the droplets are heated by the heating device 31 in the desalination device, further gasified, raised to the condensing device, and cooled down; finally, the water passing through the cooling device is collected by the collecting tank 33, and the water collected is desalinated water. The air energy heat pump 40 can be directly powered by the generator 11 driven by the windmill 10; and a heat transfer medium can be compressed and heated by the air energy heat pump, enter the hot pipe 34, and then enter the heating device 31 through the hot pipe 34 to heat water vapor. The medium is discharged from the heating device 31 and enters the cold pipe 35 through the throttle valve 36, the throttle valve 36 causes

the heat transfer medium to expand by changing the diameter of the pipe, thereby absorbing a large amount of heat from the surroundings, the high-temperature water vapor is rapidly liquefied through the condensing device 32 and flows into the collecting tank 33, while the cooled heat transfer medium flows back to the air energy heat pump 40 for a new cycle. In this way, the whole device can use only one energy source, i.e. the windmill 10, and can operate automatically without additional power supply, which can not only significantly save energy, but also efficiently desalinate seawater. By means of desalinated seawater in this device, or fresh water in fact, spraying the water in air in the form of water droplets through the air-liquid compression mechanism can not only efficiently implement irrigation, but also effectively improve the humidity of the air and reduce the degree of soil salinization in some areas.

**[0026]** The air-liquid compression mechanism in this embodiment comprises an air compression mechanism 21 and a liquid compression mechanism 22, wherein the air compression mechanism 21 comprises an air cylinder, and a first piston arranged in the air cylinder, the outlet end of the air cylinder being in communication with the mixing tank 25 through an air pipe 23, the first piston being connected to the connecting rod 12; the liquid compression mechanism 22 comprises a hydraulic cylinder, and a second piston arranged in the hydraulic cylinder, the outlet end of the hydraulic cylinder being in communication with the mixing tank 25 through a water pipe 24, the second piston being connected to the connecting rod 12. Specifically, the liquid cylinder is placed in seawater so that seawater enters the liquid cylinder and then is pumped into the mixing tank 25 by the second piston in the liquid cylinder; and the air cylinder is placed in air, so that the air entering the air cylinder is compressed by the first piston and then is pumped into the mixing tank 25, in the mixing tank 25, the seawater is rapidly mixed with high-pressure air, and the seawater is gradually atomized uniformly under the action of the high-pressure air, so as to improve the subsequent heating rate and evaporation rate of the liquid.

**[0027]** Multiple mixing tanks 25 are provided in this embodiment, and the multiple mixing tanks 25 are conductively connected in sequence; and the connecting pipe 27 is conductively connected to the mixing tank 25 located at the end. The air pipe 23 is conductively connected to the multiple mixing tanks 25 simultaneously; the water pipe 24 is conductively connected to the multiple mixing tanks 25 simultaneously. Two adjacent mixing tanks 25 are connected through a constant

pressure valve 26; and the constant pressure valve 26 is arranged at a joint between the connecting pipe 27 and each mixing tank 25. Specifically, because the windmill 10 drives the air-liquid compression mechanism through the crank to operate periodically, air-liquid mixture entering the mixing tanks 25 may fluctuate periodically, and may lead to uneven pressure of the air, so that the air-liquid mixture entering the desalting chamber 30 is not continuous. Thereby, by providing multiple mixing tanks 25 and arranging constant pressure valves 26 between every two adjacent mixing tanks 25, the pressure of the air-liquid mixture gradually stabilizes after passing through the multiple mixing tanks 25, at this time, even though each mixing tank 25 still has a separate air pipe 23 and water pipe 24, the air-liquid mixture can finally enter the desalination chamber 30 uniformly and stably from the connecting pipe 27 at this time under the action of the constant pressure valves 26.

**[0028]** Multiple atomizing nozzles 37 are provided at one end of the connecting pipe 27 arranged in the desalination chamber 30 in this embodiment. Specifically, by densely distributing multiple atomizing nozzles 37 at the bottom of the desalination chamber 30, the air-liquid mixture can be uniformly sprayed out and came to contact with the heating device 31 uniformly, and then be fully heated and gasified.

## **EMBODIMENT 2**

**[0029]** This embodiment is identical to embodiment 1 in basic structure and is different from embodiment 1 in that: the rotating shaft of the windmill 10 in embodiment 1 is connected to a generator 11, and the generator 11 is electrically connected to the air energy heat pump 40. However, the generator 11 not applicable in this embodiment, and the air energy heat pump 40 in this embodiment further comprises a liquid pump 41, wherein the liquid pump 41 is configured to drive the air energy heat pump 40; and the liquid pump 41 is conductively connected to the connecting pipe 27. Specifically, the liquid pump 41 is driven to rotate using high-pressure air or liquid, while a large amount of stable high-pressure air-liquid mixture are stored in the connecting pipe 27 in this embodiment. Thus, the connecting pipe 27 can be branched, so some of the high-pressure air-liquid mixtures are introduced into the liquid pump 41 to drive the liquid pump 41 to rotate, and the liquid pump 41 drives the rotating shaft of the air energy heat pump 40 to rotate and then drives the air energy heat pump 40 to normally operate. As the high-pressure air-liquid mixture in the connecting pipe 27 passes through the constant pressure valves 26 and

multiple mixing tanks 25, it can be guaranteed that the pressure and flow rate of the high-pressure air-liquid mixture in connecting pipe 27 are relatively stable. In this way, the liquid pump 41 can drive the air energy heat pump 40 to normally operate without providing additional energy for the air energy heat pump 40, so that the whole device can operate independently of external equipment.

**[0030]** The above is merely the preferred embodiments of the present invention, and not intended to be used to limit the present invention. For those skilled in the art, the present invention can have various modifications and changes. Any modifications, equivalent substitutions, improvements, etc. made within the spirit and principle of the present invention shall all fall within the scope of protection of the present invention.

## CLAIMS

[Claim 1] A seawater desalination device, comprising:

5           a windmill,  
          a crank connected to a rotating shaft of the windmill,  
          a connecting rod connected to the crank,  
          an air-liquid compression mechanism connected to the connecting rod,  
          a mixing tank connected to the air-liquid compression mechanism,  
          a desalination chamber connected to the mixing tank,  
10          a heating device arranged in the desalination chamber,  
          a condensing device arranged above the heating device,  
          a collecting tank connected to the condensing device, and  
          an air energy heat pump,  
          wherein the mixing tank is connected to the desalination chamber  
15          through a connecting pipe, and the connecting pipe is conductively connected  
          to lower end of the desalination chamber; the air energy heat pump comprises  
          a hot pipe in communication with an outlet end, and a cold pipe in  
          communication with an inlet end, wherein the hot pipe is arranged in the  
          heating device, the cold pipe is arranged in the condensing device; and the  
20          cold pipe is connected to the hot pipe through a throttle valve.

[Claim 2] The seawater desalination device according to [Claim 1], characterized in  
that: the air-liquid compression mechanism comprises an air compression  
mechanism and a liquid compression mechanism, wherein the air compression  
25          mechanism comprises an air cylinder, and a first piston arranged in the air cylinder,  
          the outlet end of the air cylinder arranged in communication with the mixing tank  
          through an air pipe, the first piston being connected to the connecting rod;  
          the liquid compression mechanism comprises a hydraulic cylinder, and a second  
          piston arranged in the hydraulic cylinder, the outlet end of the hydraulic cylinder  
30          being in communication with the mixing tank through a water pipe, the second piston  
          being connected to the connecting rod.

[Claim 3] The seawater desalination device according to [Claim 2], characterized in that: there is a plurality of mixing tanks, and the plurality of mixing tanks are conductively connected in sequence; and the connecting pipe is conductively connected to the plurality of mixing tank located at the end.

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[Claim 4] The seawater desalination device according to [Claim 3], characterized in that: the air pipe is conductively connected to the plurality of mixing tanks simultaneously; and the water pipe is conductively connected to the plurality of mixing tanks simultaneously.

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[Claim 5] The seawater desalination device according to [Claim 4], characterized in that: two adjacent mixing tanks are connected through a constant pressure valve; and the constant pressure valve is arranged at a joint between the connecting pipe and each mixing tank.

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[Claim 6] The seawater desalination device according to [Claim 1], characterized in that: the air energy heat pump further comprises a liquid pump, wherein the liquid is configured to drive the air energy heat pump, and the liquid pump is conductively connected to the connecting pipe.

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[Claim 7] The seawater desalination device according to [Claim 1], characterized in that: the rotating shaft of the windmill is connected to a generator, and the generator is electrically connected to the air energy heat pump.

25 [Claim 8] The seawater desalination device according to [Claim 1], characterized in that: multiple atomizing nozzles are provided at one end of the connecting pipe arranged in the desalination chamber.

[Claim 9] An application of the seawater desalination devices of any one of [Claims 1-  
30 8] in agricultural irrigation.

[Claim 10] An application of the seawater desalination devices of any one of [Claims 1-8] in air humidification.