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(71) Applicant: **Jin, Kum-Soo**
Seoul 134-060 (KR)

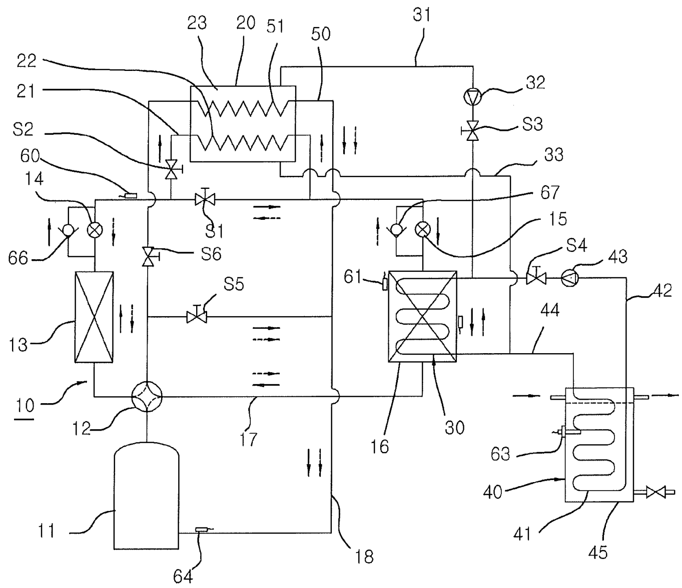
(72) Inventor: **Jin, Kum-Soo**
Seoul 134-060 (KR)

(74) Representative: **Winter, Brandl, Fürniss, Hübner, Röss, Kaiser, Polte - Partnerschaft**
Alois-Steinecker-Straße 22
85354 Freising (DE)

(54) HEAT PUMP SYSTEM

(57) A heat pump system includes a base refrigeration circuit, a heat accumulator, an auxiliary heat exchanger and an outdoor heat exchanger defrosting and cooling means. In the base refrigeration circuit, a compressor, a four-way valve, an indoor heat exchanger, a cooling expansion valve, a heating expansion valve, an outdoor heat exchanger and the four-way valve are connected in a sequence by a refrigerant conduit. The four-way valve and the compressor are connected by a refrigerant suction conduit. The heat accumulator includes a bypass refrigerant conduit connected to the refrigerant conduit between the cooling and heating expansion valves. The heat accumulator has a heating heat exchanger and is injected with a heat medium. The auxiliary heat exchanger is installed in the outdoor heat exchanger and connected to the heat accumulator by a heat medium supply conduit and a heat medium return conduit. The defrosting and cooling means includes a heat exchanger and a costless heat reservoir.

[Fig. 1]



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Description

Technical Field

[0001] The present invention relates generally to heat pump systems and, more particularly, to a defrosting and cooling promotion structure of an outdoor heat exchanger of a heat pump system.

Background Art

[0002] As is well known to those skilled in the art, a heat pump operates a vapor-compression refrigeration cycle in the reverse manner to that of cooling operation, that is, when a heating operation is carried out, an indoor heat exchanger is used as a condenser, and an outdoor heat exchanger is used as an evaporator, whereas when a cooling operation is carried out, the outdoor heat exchanger is used as the condenser, and the indoor heat exchanger is used as the evaporator. Therefore, the evaporation or condensation of refrigerant in an outdoor heat exchanger must be satisfactory in order for the coefficient of performance to be enhanced.

[0003] However, in the case of an air-source heat pump, an outdoor heat exchanger is exposed to the atmosphere so that refrigerant is evaporated or condensed by the outside air. Thus, in particular, when the heating operation is carried out, if the temperature of the atmosphere decreases to at or below the dew point, frost forms on the surface of the outside heat exchanger which is being used as an evaporator, thus deteriorating the evaporation rate of refrigerant gas or rendering evaporation impossible. Due to this, the coefficient of performance is markedly reduced, or the heat pump may malfunction. Furthermore, when the cooling operation is carried out, if the temperature of the atmosphere is comparatively high, the condensation of refrigerant liquid may be unsatisfactory in the outdoor heat exchanger which is being used as a condenser, thus resulting in a deterioration in the coefficient of performance. Solving these problems is most important when developing heat pump technology.

[0004] Meanwhile, in an effort to overcome the problem of the coefficient of performance deteriorating or the heat pump malfunctioning that may result when the heating operation is carried out, a method was proposed, in which the heat pump cycle is converted into the refrigeration cycle so that the outdoor heat exchanger which has been used as the evaporator is used as a condenser to defrost the surface thereof, or in which an electric heater is provided on the outdoor heat exchanger, thus preventing the coefficient of performance from deteriorating. However, the former method requires that the heating operation be interrupted. In the case of the latter method, the improvement effect of the coefficient of performance is not satisfactory, and separate energy is required.

[0005] The inventor and applicant of the present invention developed a heat pump system which can solve the above-mentioned most important factor of the heat pump, and this heat pump system was disclosed in Patent document 1. The heat pump system includes a base refrigeration circuit, a heat accumulator, a heating heat exchanger, a heat exchanger and first and second 2 endothermic heat exchangers. In the base refrigeration circuit, a compressor, a four-way valve, an indoor heat exchanger, a cooling expansion valve, a heating expansion valve, an outdoor heat exchanger and the four-way valve are connected in sequence by a conduit. In addition, the four-way valve is connected to the compressor by a suction conduit. The heat accumulator is provided on the conduit between the cooling expansion valve and the heating expansion valve. The heat accumulator is charged with a heat medium and contains a latent heat storage material. The heating heat exchanger is provided on the portion of the conduit that passes through the heat accumulator. The heat exchanger is connected to the heat accumulator by a return conduit to which a supply conduit and a circulation pump are coupled. The heat exchanger is located adjacent to an inlet side of the outdoor heat exchanger. The first and second endothermic heat xchangers are provided in parallel on the suction conduit and are installed in the heat accumulator so that they are selectively operated depending on the temperature of refrigerant vapor sucked into the compressor. The heating heat exchanger functions as a supercooling condenser so that the heat of condensation is stored in the heat medium contained in the heat accumulator that is maintained at a predetermined temperature, and when the temperature of the atmosphere decreases to at or below the dew point or increases to a preset temperature or more, the heat medium circulates through the outdoor heat exchanger to heat or cool the outside air sucked into the outdoor heat exchanger. Thus, when the heating operation is carried out under low temperature atmospheric conditions, the outdoor heat exchanger can be defrosted or prevented from having frost form on it. When the cooling operation is carried out under high temperature atmospheric conditions, the condensation of refrigerant vapor becomes satisfactory. Therefore, even when the temperature of the atmosphere is comparatively low or high, the coefficient of performance can be enhanced. Furthermore, because dry-saturated or superheated vapor is sucked into the compressor, the coefficient of performance can be further enhanced.

Patent document 1; JP 3,662,557 (B2)

Disclosure

Technical Problem

[0006] In the heat pump system of Patent document 1, refrigerant liquid is supercooled, and the outside air sucked into the outdoor heat exchanger is heated or cooled, so that even when the temperature of the atmosphere is comparatively high or low, the coefficient of performance can be enhanced without interrupting the operation of the system. However, if the high or low temperature conditions of the atmosphere persist for a long period of time, the refrigerant liquid may be excessively supercooled. As such, when the supercooled state of the refrigerant liquid exceeds the optimum level, although the coefficient of performance is increased, the specific volume of the refrigerant liquid is reduced. Thus, when the atmosphere is comparatively low, evaporation of refrigerant supplied into the outdoor heat exchanger further deteriorates, resulting in suction of wet-saturated vapor into the compressor.

[0007] As such, if wet-saturated vapor is sucked into the compressor, the coefficient of performance is reduced because it is difficult to increase the temperature of a refrigerant gas when the compressor compresses the refrigerant gas.

[0008] Furthermore, in the case where low temperature atmospheric conditions persist for a long period of time, the electric heater provided on the heat accumulator must be operated. This requires use of an additional heat source, thus increasing cost of the operation.

[0009] Accordingly, the present invention has been made keeping in mind the above problems occurring in the prior art, and an object of the present invention is to provide a heat pump system which heats or cools the outdoor heat exchanger by using a costless heat source and the supercooled condensation heat of refrigerant liquid to maintain the refrigerant liquid at an appropriate degree of supercooling, and increase the coefficient of performance without using a fee-charging heat source.

Technical Solution

[0010] In order to accomplish the above object, the present invention provides a heat pump system, including: a base refrigeration circuit in which a compressor, a four-way valve, an indoor heat exchanger, a cooling expansion valve, a heating expansion valve, an outdoor heat exchanger and the four-way valve are connected in a sequence by a refrigerant conduit, and the four-way valve and the compressor are connected to each other by a refrigerant suction conduit; a heat accumulator comprising a bypass refrigerant conduit having both ends connected to the refrigerant conduit between the cooling expansion valve and the heating expansion valve, the heat accumulator having therein a heating heat exchanger provided on the bypass refrigerant conduit, with a heat medium injected into the heat accumulator; an auxiliary heat exchanger connected to the heat accumulator by a heat medium supply conduit provided with a heat medium circulation pump and by a heat medium return conduit, the auxiliary heat exchanger being installed in the outdoor heat exchanger; and an outdoor heat exchanger defrosting and cooling means having a heat exchanger connected to the heat medium supply conduit and to the heat medium return conduit by a brine supply conduit provided with a brine circulation pump and by a brine return conduit, and a costless heat reservoir provided around the heat exchanger.

Advantageous Effects

[0011] In the present invention, when the temperature of the atmosphere is at or below a predetermined temperature (for example, 5°C) or is at or above a predetermined temperature (for example, 30°C), the heat exchanger is maintained at a predetermined temperature by a costless heat source flowing through a heat accumulator, and brine which is maintained at a predetermined temperature circulates through a heat exchanger installed in the outdoor heat exchanger. Thus, when the atmospheric temperature is low when the heating operation is being carried out, the outdoor heat exchanger is defrosted or is prevented from having frost form on it. In addition, when the atmospheric temperature is high during the cooling operation, for example, in the hot season, condensation of refrigerant liquid in the outdoor heat exchanger may be satisfactory enough that the coefficient of performance can be kept satisfactory by using the costless heat source. Meanwhile, in the heat accumulator, when the heating operation is carried out, refrigerant liquid which has been unsatisfactorily condensed for some reason, such as a reduction of a load of the indoor heat exchanger, etc., is supercooled. Thus, the coefficient of performance can be enhanced. Moreover, when the heating operation is carried out, even though there is an insufficient amount of the costless heat source, for example, because there is a small amount of rainfall or insufficient waste water, the heat medium that has been heated and stored in the heat accumulator circulates through the auxiliary heat exchanger installed in the outdoor heat exchanger, so that the coefficient of performance can still be satisfactory.

Description of Drawings

[0012] Fig. 1 is a diagram showing the construction of an embodiment of the present invention.

Best Mode

[0013] Fig. 1 is a diagram showing the construction of an embodiment of the present invention. Reference numeral 10 denotes a base refrigeration circuit. In the base refrigeration circuit 10, a compressor 11, a four-way valve 12, an indoor heat exchanger 13, a cooling expansion valve 14, a heating expansion valve 15, an outdoor heat exchanger 16 and the four-way valve 12 are connected in a sequence by a refrigerant conduit 17. In addition, the four-way valve 12 is connected to the compressor 11 by a refrigerant suction conduit 18.

[0014] Reference numeral 20 denotes a heat accumulator. The heat accumulator 20 includes a bypass refrigerant conduit 21, both ends of which are connected to the refrigerant conduit 17 at positions spaced apart from each other by a predetermined distance between the cooling expansion valve 14 and the heating expansion valve 15. The heat accumulator 20 contains therein a heating heat exchanger 22 which is provided on the bypass refrigerant conduit 21. The heat accumulator 20 is injected with a heat medium 23.

[0015] Reference numeral 30 denotes an auxiliary heat exchanger. The auxiliary heat exchanger 30 is connected to the heat accumulator 20 by a heat medium supply conduit 31 provided with a heat medium circulation pump 32 and by a heat medium return conduit 33 in such a way that heat pipes of the auxiliary heat exchanger 30 are located between the heat pipes of the outdoor heat exchanger 16 at positions spaced apart from each other at regular intervals or are integrally or separately installed on a side surface of the outdoor heat exchanger 16. It is desirable that the heat pipes of the auxiliary heat exchanger 30 be located between the heat pipes of the outdoor heat exchanger 16 at regular intervals, because heat transfer efficiency can be more enhanced.

[0016] Reference numeral 40 denotes an outdoor heat exchanger defrosting and cooling means. The outdoor heat exchanger defrosting and cooling means 40 includes a heat exchanger 41 which is connected to the heat medium supply conduit 31 and the heat medium return conduit 33 by a brine supply conduit 42 provided with a brine circulation pump 43 and by a brine return conduit 44. Furthermore, a costless heat reservoir 45 is located around the heat exchanger 41. A costless heat source circulates through the costless heat reservoir 45 so that there is continuous heat exchange between the costless heat source and the heat exchanger 41 in order to maintain brine circulating through the auxiliary heat exchanger 30 at an appropriate temperature (for example, about 20°C).

[0017] Regenerative energy, such as river water, seawater, collected underground water, fluid (e.g., air or hot water) heated by a solar collector, rainwater, waste water, etc., is used as the costless heat source to prevent environmental disruption. In addition, such regenerative energy can be easily obtained from around a place where the present invention is installed. During the heating operation, it is desirable that the temperature of the costless heat source be as high as possible, in particular, in the cold season. During the cooling operation, it is desirable that the temperature of the costless heat source not be over 25°C.

[0018] A refrigerant suction bypass conduit 50 passes through the heat accumulator 20 and is connected to the refrigerant suction conduit 18. An endothermic heat exchanger 51 is provided on the portion of the refrigerant suction bypass conduit 50 that passes through the heat accumulator 20. The endothermic heat exchanger 51 heats refrigerant gas to be sucked into the compressor 11 so that the refrigerant gas is dry-saturated and superheated to prevent liquid back phenomenon and liquid hammer phenomenon of the compressor 11.

[0019] Meanwhile, a solenoid valve S1 is provided on the refrigerant conduit 17 at a predetermined position between both ends of the bypass refrigerant conduit 21, and a solenoid valve S2 is provided on the bypass refrigerant conduit 21 in proximity to the junction between the bypass refrigerant conduit 21 and the refrigerant conduit 17. Thus, when a detecting signal generated from a temperature sensor 60 which is provided on the refrigerant conduit 17 between the indoor heat exchanger 13 and the outdoor heat exchanger 16 registers a predetermined temperature range (for example, when it is 35°C or more), the solenoid valve S1 closes and the solenoid valve S2 opens to supercool the refrigerant liquid.

[0020] Furthermore, a solenoid valve S3 and a solenoid valve S4 are respectively provided on the heat medium supply conduit 31 and the brine supply conduit 42 at positions adjacent to outlet ports of the circulation pumps 32 and 43. Thus, when a detecting signal generated from a temperature sensor 61 provided on the outdoor heat exchanger 16 is within a predetermined temperature range (for example, during the heating operation, it is 10°C or less, and during the cooling operation, it is 30°C or more), the solenoid valve S3 is closed and the solenoid valve S4 is open so that the brine that was heated in the heat exchanger 41 by the costless heat source circulates through the auxiliary heat exchanger 30.

[0021] In addition, a temperature sensor 63 is provided on the costless heat reservoir 45 so that when the temperature of the costless heat source decreases to a predetermined temperature, the solenoid valve S3 is open and the solenoid valve S4 is closed in the reverse manner to the above so as to circulate the heat medium, heated and stored in the heat accumulator 20, through the auxiliary heat exchanger 30, thus defrosting the outdoor heat exchanger 16.

[0022] Also, solenoid valves S5 and S6 are respectively provided on the refrigerant suction conduit 18 at a position adjacent to a connection inlet of the refrigerant suction bypass conduit 50 and at the connection inlet of the refrigerant suction bypass conduit 50. Thus, when a detecting signal generated from a temperature sensor 64 provided on the refrigerant suction conduit 18 indicates a preset temperature range (for example, 5°C or less), the solenoid valve S5 is closed and the solenoid valve S6 is open so that the refrigerant gas to be sucked into the compressor 11 is superheated by heating it in the heat accumulator 20.

[0023] In the drawing, reference numerals 66 and 67 denote check valves.

[0024] In the present invention having the above-mentioned construction, the four-way valve 12 is controlled such that when the heating operation is carried out, the refrigerant flows in the direction of the solid arrow, and when the cooling operation is carried out, the refrigerant flows in the direction of the dotted arrow. Then, when the heating operation is carried out, the indoor heat exchanger 13 functions as a condenser, and when the cooling operation is carried out, the indoor heat exchanger 13 functions as an evaporator. Thus, the present invention can carry out the heating function or the cooling function in the same manner as that of the conventional technique.

[0025] Moreover, in the present invention, when the heating operation or the cooling operation is carried out, the brine, which is kept at a constant temperature by the costless heat source, circulates through the auxiliary heat exchanger 30 provided on the outdoor heat exchanger 16. Thereby, when the temperature of the atmosphere is comparatively low during the heating operation, the outdoor heat exchanger 16 can be defrosted. When the temperature of the atmosphere is comparatively high during the cooling operation, the outdoor heat exchanger 16 is cooled to promote evaporation of the refrigerant gas. Thereby, the coefficient of performance of the heat pump system can remain satisfactory.

[0026] Furthermore, when the refrigerant liquid incompletely condenses in the indoor heat exchanger 13 or the outdoor heat exchanger 16, the solenoid valve S2 is open by a detecting signal of the temperature sensor 60 so that the refrigerant liquid is supercooled in the heat accumulator 20, thus enhancing the coefficient of performance. In addition, the heat medium is heated by the heat of condensation and then stored in the heat accumulator 20. When there is an insufficient amount of the costless heat source supplied into the costless heat reservoir 45, for example, because of a small amount of rainfall or insufficient waste water, the heat medium that has been heated and stored is circulated through the auxiliary heat exchanger 30 so that the coefficient of performance can be maintained satisfactory during the heating operation.

Claims

1. A heat pump system, comprising:

a base refrigeration circuit in which a compressor, a four-way valve, an indoor heat exchanger, a cooling expansion valve, a heating expansion valve, an outdoor heat exchanger and the four-way valve are connected in a sequence by a refrigerant conduit, and the four-way valve and the compressor are connected to each other by a refrigerant suction conduit;

a heat accumulator comprising a bypass refrigerant conduit having both ends connected to the refrigerant conduit between the cooling expansion valve and the heating expansion valve, the heat accumulator having therein a heating heat exchanger provided on the bypass refrigerant conduit, with a heat medium injected into the heat accumulator;

an auxiliary heat exchanger connected to the heat accumulator by a heat medium supply conduit provided with a heat medium circulation pump and by a heat medium return conduit, the auxiliary heat exchanger being installed in the outdoor heat exchanger; and

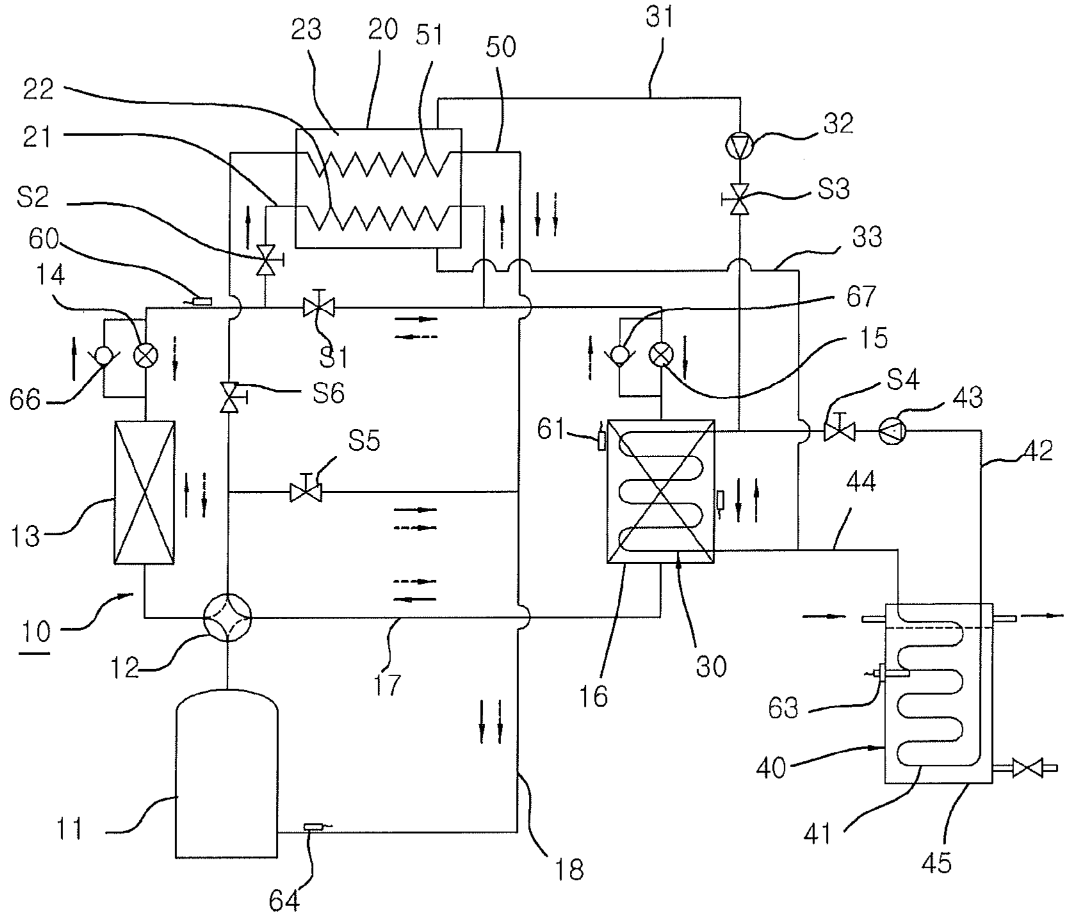
outdoor heat exchanger defrosting and cooling means comprising: a heat exchanger connected to the heat medium supply conduit and to the heat medium return conduit by a brine supply conduit provided with a brine circulation pump and by a brine return conduit; and a costless heat reservoir provided around the heat exchanger.

2. The heat pump system as set forth in claim 1, wherein a costless heat source comprises any one selected from the group consisting of river water, seawater, collected underground water, fluid heated by a solar collector, rainwater and waste water.

3. The heat pump system as set forth in claim 1, wherein a refrigerant suction bypass conduit passes through the heat accumulator, the refrigerant suction bypass conduit being connected to the refrigerant suction conduit, with an endothermic heat exchanger provided on the portion of the refrigerant suction bypass conduit that is placed through the heat accumulator, the endothermic heat exchanger heating refrigerant gas to be sucked into the compressor.

4. The heat pump system as set forth in claim 1, wherein heat pipes of the auxiliary heat exchanger are located between heat pipes of the outdoor heat exchanger at positions spaced apart from each other at regular intervals.

[Fig. 1]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REFERENCES CITED IN THE DESCRIPTION

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