

HEAT EXCHANGE SYSTEM

TECHNICAL FIELD

[0001] The present application relates to the field of air conditioning technology, and in particular, to a heat exchange system.

BACKGROUND

[0002] A heat exchange system can be used in an air conditioner, releasing heat in an area to be air conditioned to raise the temperature of the area for heating purpose, or absorbing heat in the area to lower the temperature of the area for cooling purpose.

SUMMARY

[0003] The application provides an improved heat exchange system.

[0004] An aspect of the present application provides a heat exchange system comprising: a cooling heat exchange unit configured to receive intake air and to cool and dehumidify the intake air; a heating heat exchange unit located downstream of the cooling heat exchange unit and configured to heat the air output from the cooling heat exchange unit; and a water-to-water heat exchange unit, connected with the cooling heat exchange unit and the heating heat exchange unit and configured to receive aqueous solutions output from the cooling heat exchange unit and the heating heat exchange unit, cool the aqueous solution output from the cooling heat exchange unit and supply the aqueous solution having been cooled to the cooling heat exchange unit, and heat the aqueous solution output from the heating heat exchange unit and supply the aqueous solution having been heated to the heating heat exchange unit.

[0005] The heat exchange system in some embodiments of the present application uses the heating heat exchange unit to heat air, which has low energy consumption with less waste, and uses the water-to-water heat exchange unit to produce cold water to be supplied to the cooling heat exchange unit, and produce hot water to be supplied to the heating heat exchange unit, so that the cooling heat exchange unit and the heating heat exchange unit can conduct heat exchange with an aqueous solution as a heat exchange medium, avoiding a danger arose when a refrigerant leaks into the area to be air conditioned in a case where the cooling heat exchange unit and the heating heat exchange unit conduct heat exchange using the refrigerant such as Freon.

BRIEF DESCRIPTION OF DRAWINGS

[0006] FIG. 1 is a schematic diagram of a heat exchange system;

[0007] FIG. 2 is a schematic diagram of another heat exchange system;

[0008] FIG. 3 is a schematic diagram showing an embodiment of a heat exchange system of the present application; and

[0009] FIG. 4 is a schematic diagram showing another embodiment of a heat exchange system of the present application.

DETAILED DESCRIPTION

[0010] Exemplary embodiments will be described in detail herein, examples of which are illustrated in the accompanying drawings. In the following description, when reference is made to the drawings, unless otherwise indicated, the same reference numerals in different figures refer to the same or similar elements. The embodiments described in the following exemplary embodiments do not represent all embodiments consistent with the present application. Instead, they are merely examples of devices and methods consistent with some aspects of the present application as expounded in the appended claims.

[0011] The terminology used in the present application is merely for the purpose of describing particular embodiments, and is not intended to be limiting. Unless otherwise defined, technical terms or scientific terms used in the application shall have ordinary meanings as understood by those of ordinary skill in the art. The words "first", "second" and similar terms used in the specification and claims of the present application do not denote any order, quantity, or importance, but are merely used to distinguish different components. Similarly, the word "a" or "an" and the like do not denote a quantity limitation, but mean that there is at least one. Unless otherwise indicated, the word "comprise" or "include" and the like mean that an element or item ahead of these words covers elements or items listed after these words and their equivalents, but not excluding other elements or items. The word "connect" or "couple" and the like are not limited to physical or mechanical connections, and may cover electrical connections, whether direct or indirect.

[0012] The singular forms "a" or "an", "said" and "the" may refer to a singular form or a plural form, unless otherwise indicated clearly. It should also be understood that the term "and/or" as used herein refers to and encompasses any and all possible combinations of one or more of the associated listed items.

[0013] The heat exchange system of some embodiments of the present application comprises a cooling heat exchange unit, a heating heat exchange unit, and a water-to-water heat exchange unit. The cooling heat exchange unit is configured to receive intake air and to cool and dehumidify the intake air. The heating heat exchange unit is located downstream of the cooling heat exchange unit and is configured to heat the air output from the cooling heat exchange unit. The water-to-water heat exchange unit is connected with the cooling heat exchange unit and the heating heat exchange unit, and is configured to receive aqueous solutions output from the cooling heat exchange unit and

the heating heat exchange unit, cool the aqueous solution output from the cooling heat exchange unit and supply the aqueous solution having been cooled to the cooling heat exchange unit, and heat the aqueous solution output from the heating heat exchange unit and supply the aqueous solution having been heated to the heating heat exchange unit.

[0014] The heating heat exchange unit is used to heat the air, which has low energy consumption and less waste, and the water-to-water heat exchange unit is used to produce cold water to be supplied to the cooling heat exchange unit, and produce hot water to be supplied to the heating heat exchange unit, so that the cooling heat exchange unit and the heating heat exchange unit can conduct heat exchange with an aqueous solution as a heat exchange medium, avoiding a danger arose when a refrigerant, such as Freon, leaks into the area to be air conditioned in a case where the cooling heat exchange unit and the heating heat exchange unit conduct heat exchange using the refrigerant.

[0015] FIG. 1 is a schematic diagram of a heat exchange system 100. The heat exchange system 100 can be used to control the temperature and the relative humidity of an space 10. The space 10 to be air conditioned may comprise a hospital surgical room. In some applications, the heat exchange system 100 can control the temperature and the relative humidity of the hospital surgical room to obtain a dry bulb temperature of 18°C and a relative humidity of 40% to 60%, or a dry bulb temperature of 25°C and a relative humidity of 40% to 60%, but these are not limiting. In other embodiments, the space 10 may not be limited to the hospital surgical room, but may be other spaces such as a laboratory, a factory, a museum, an greenhouse etc., generally any space that requires good temperature and humidity control.

[0016] The heat exchange system 100 includes a cooling heat exchanger 101 and an electric heater 102 located downstream of the cooling heat exchanger 101. The cooling heat exchanger 101 is used to receive intake air and cool the intake air. The cooling heat exchanger 101 may be connected with a chilled water production system 20. The chilled water production system 20 may include a water chiller unit 21 and a cooling tower 22. The cooling heat exchanger 101 is connected to an evaporator of the water chiller unit 21, and a chilled water pump 23 is disposed between the cooling heat exchanger 101 and the evaporator of the water chiller unit 21 to form a chilled water circuit. A condenser of the water chiller unit 21 is connected with the cooling tower 22, and a cooling water pump 24 is disposed between the condenser of the water chiller unit 21 and the cooling tower 22 to form a cooling water circuit. The chilled water production system 20 cools an aqueous solution output from the cooling heat exchanger 101, and outputs chilled water to the cooling heat exchanger 101. The chilled water exchanges heat with the intake air in the cooling heat exchanger 101 to cool the intake air, and also dehumidify the intake air. The chilled water supply to the cooling heat exchanger 101 controlled by a chilled water flow valve 150, and is used to cool the air to a desirable

dewpoint temperature, removing moisture from it in a process known as condensation. A control loop is established on the chilled water flow valve 150 by sensing RH (Relative Humidity) of the space 10. The cooling heat exchanger 101 may be a cooling coil, in some embodiments.

[0017] The cool and saturated air output from the cooling heat exchanger 101 is subcooled, and the electric heater 102 is used to heat the air output from the cooling heat exchanger 101 to a desirable supply air temperature and decrease relative humidity in order to meet the room sensible cooling load (at full load or partial load). The result is a well-controlled dry bulb temperature and RH in the space 10. The electric heater 102 consumes a large amount of electric power with a low COP (Coefficient Of Performance) of 1.0. Its primary function is to artificially introduce heat load to the space 10- wasting electrical energy at the electric heater 102 as well as additional energy needed at the chilled water production system 20 as a result.

[0018] FIG. 2 is a schematic diagram of another heat exchange system 200. The heat exchange system 200 includes a cooling heat exchanger 201, which is connected to a chilled water production system 20, similar to the cooling heat exchanger 101 shown in FIG. 1. The heat exchange system 200 further includes a re-cooling heat exchanger 203 and a heating heat exchanger 202. The heat exchange system 200 is a Direct-Expansion (DX) refrigeration system, the re-cooling heat exchanger 203 is a DX evaporative coil, and the heating heat exchanger 202 is a DX condensing coil. The re-cooling heat exchanger 203 is located downstream of the cooling heat exchanger 201, and the heating heat exchanger 202 is located downstream of the re-cooling heat exchanger 203. The re-cooling heat exchanger 203 is connected with the heating heat exchanger 202, and a compressor 204 is connected between the re-cooling heat exchanger 203 and the heating heat exchanger 202. The refrigerant is circulated in the re-cooling heat exchanger 203 and the heating heat exchanger 202 by the compressor 204. In some embodiments, the compressor 204 may be a fixed speed compressor or a variable speed compressor. The heat exchange system 200 includes a condenser 253 connected between the compressor 204 and the re-cooling heat exchanger 203 with a valve 251 and a diverting valve 252. The diverting valve 252 is connected to the heating heat exchanger 202. The condenser 253 is configured to adjust heat between the re-cooling heat exchanger 203 and the heating heat exchanger 202. In some embodiments, the condenser 253 may be an air-cooled condenser.

[0019] The cooling heat exchanger 201 cools and dehumidifies intake air, and the re-cooling heat exchanger 203 further cools and dehumidifies the air output from the cooling heat exchanger 201. The heating heat exchanger 202 heats the leaving saturated air from the re-cooling heat exchanger 203 to meet the required dry bulb temperature of the air-conditioning space 10. The relative humidity of the space 10 is better controlled in the process above since the heating heat exchanger 202, having lower evaporative temperature, is able to cool the air to a low dewpoint.

[0020] The compressor 204 of the heat exchange system 200 shown in FIG. 2 requires electric power to transfer the heat from the re-cooling heat exchanger 203 to the heating heat exchanger 202 along with the compression work done by the compressor 204. As most of the heat energy at the DX condensing coil is transferred from the DX evaporative coil, the electrical power consumed by the compressor 204 is only a fraction to the electrical power consumed by an electrical heater 102 shown in FIG. 1. In the same process, the system 200 provides incidental cooling at the re-cooling heat exchanger 203, thus saving additional energy which otherwise be needed at the chilled water production system 20 as in the case of FIG 1. Under the same conditions (intake air having the same temperature and humidity, outputting air of the same temperature and humidity to the space 10), in one example, the amount of electric power required by the compressor 204 is 6 kW, and the amount of electric power required by the electric heater 102 is 31 kW, significantly saving electric power. Considering different technologies and products used, the heating COP of such system 200 could well be in a range of 2 - 5 COP provided that 100% of the heat generated is used in the process. This system 200 uses cooling priority mode as its primary control logic; any unused excess heat generated and not used at the heating heat exchanger 202 is usually diverted to an air-cooled finned condenser (a part of the system 200) and eventually be rejected into the atmosphere.

[0021] Further, under the same conditions, compared with the cooling heat exchanger 101 shown in FIG. 1, the air output from the cooling heat exchanger 201 shown in FIG. 2 after cooling has a higher temperature, and is further cooled by the re-cooling heat exchanger 203. Therefore, compared with the chilled water production system 20 shown in FIG. 1, the chilled water production system 20 shown in FIG. 2 requires low energy and releases less heat, thereby saving energy. Under the same conditions, in one example, the chilled water production system 20 shown in FIG. 1 requires 50kW electric power when inputting a cooling capacity of 50RT and outputting heat energy of 62RT, while the chilled water production system 20 shown in FIG. 2 requires only 43kW electric power when inputting a cooling capacity of 43RT and outputting heat energy of 55RT. The chilled water production system 20 in FIG. 2 requires less energy and has less energy waste.

[0022] There are however, inherent occupant risk in the system described in FIG. 2. As refrigerant is the main heating transfer medium circulating between the re-cooling heat exchanger 203 and the heating heat exchanger 202 in the air stream serving the air-conditioned space 10, any leaks at these heat exchangers could send the entire refrigerant charge to the air-conditioned space 10 such as a small confined space like a medical surgical room. The DX refrigeration system 200 usually operates using high pressure refrigerant gas such as Freon which evaporates at room temperature. Gases used in such application are mostly odourless and are heavier than air. When leaked into a room through ducts and diffusers, it could pose asphyxiation risk to occupants in the room

unknowingly.

[0023] FIG. 3 is a schematic diagram of an embodiment of a heat exchange system 300 of the present application. The heat exchange system 300 includes a cooling heat exchange unit 305, a heating heat exchange unit 302, and a water-to-water heat exchange unit 306. The cooling heat exchange unit 305 is configured to receive intake air and to cool and dehumidify the intake air. The heating heat exchange unit 302 is located downstream of the cooling heat exchange unit 305 to heat the air output from the cooling heat exchange unit 305. The water-to-water heat exchange unit 306 is connected with the cooling heat exchange unit 305 and the heating heat exchange unit 302, and is configured to receive aqueous solutions output from the cooling heat exchange unit 305 and the heating heat exchange unit 302, cool the aqueous solution output from the cooling heat exchange unit 305 and supply the aqueous solution having been cooled to the cooling heat exchange unit 305, and heat the aqueous solution output from the heating heat exchange unit 302 and supply the aqueous solution having been heated to the heating heat exchange unit 302. The water-to-water heat exchange unit 306 includes a water-to-water heat exchanger.

[0024] The heating heat exchange unit 302 is configured to heat the air, which has low energy consumption with less waste; and the water-to-water heat exchange unit 306 is used to produce cold water to be supplied to the cooling heat exchange unit 305 and produce hot water to be supplied to the heating heat exchange unit 302, so that the cooling heat exchange unit 305 and the heating heat exchange unit 302 can exchange heat using an aqueous solution as a heat exchange medium, avoiding a danger arose when a refrigerant leaks into the space 10 in a case where the cooling heat exchange unit 305 and the heating heat exchange unit 302 perform heat exchange using the refrigerant such as Freon. In some embodiments, the aqueous solution comprises saline or the like. Even if the aqueous solution leaks, it will not cause any danger to any occupants in the cooling space 10.

[0025] In some embodiments, the cooling heat exchange unit 303 may be connected with a chilled water production system 20. The chilled water production system 20 is similar to the chilled water production system 20 shown in FIGs 1 and 2 and will not be described here again. In some embodiments, the cooling heat exchange unit 305 includes a first cooling heat exchanger 301 and a second cooling heat exchanger 303 disposed downstream of the first cooling heat exchanger 301. The first cooling heat exchanger 301 is configured to be connected with the chilled water production system 20, and the heating heat exchange unit 302 is located downstream of the second cooling heat exchanger 303. The first cooling heat exchanger 301 is similar to the cooling heat exchanger 201 shown in FIG. 2 for cooling and dehumidifying intake air. The first cooling heat exchanger 301 is connected with the chilled water production system 20 to form a heat exchange circuit so that a heat exchange medium (e.g., an aqueous solution) circulates within the first cooling

heat exchanger 301 and the chilled water production system 20. The second cooling heat exchanger 303 further cools and dehumidifies the air output from the first cooling heat exchanger 301. In some embodiments, the first cooling heat exchanger 301 may comprise a finned cooling coil and the second cooling heat exchanger 303 may comprise a finned cooling coil. The heating heat exchange unit 302 may include a finned heating coil. In another embodiment, the second cooling heat exchanger 303 could be placed upstream of the first cooling heat exchanger 301 depending on whether the chilled water from the chilled water production system 20 is cold enough to produce the desired leaving dewpoint temperature to maintain RH required in the occupied space 10.

[0026] In some embodiments, the heating heat exchange unit 302 reheats the cold air output from the second cooling heat exchanger 303 to decrease the relative humidity, so that the temperature and humidity of the air output into the space 10 to be air conditioned meet the requirement. In an embodiment, the heating heat exchange unit 302 may comprise a heating heat exchanger, and the heating heat exchanger may comprise a coil.

[0027] In some embodiments, the water-to-water heat exchange unit 306, the cooling heat exchange unit 305, and the heating heat exchange unit 302 form a heat exchange circuit, and the water-to-water heat exchange unit 306 enables the cooling heat exchange unit 305 and the heating heat exchange unit 302 to exchange heat there between, so that the cooling heat exchange unit 305 can cool the air, and the heating heat exchange unit 302 can heat the air. The water-to-water heat exchange unit 306 receives the hot water output from the cooling heat exchange unit 305, and after cooling the water, supplies cold water to the cooling heat exchange unit 305, and the cold water flows in the cooling heat exchange unit 305 to exchange heat with the air so as to cool the air. The water-to-water heat exchange unit 306 receives the cold water output from the heating heat exchange unit 302, and after heating the water, supplies hot water to the heating heat exchange unit 302, and the hot water flows in the heating heat exchange unit 302 to exchange heat with the air so as to heat the air.

[0028] In some embodiments, the water-to-water heat exchange unit 306 is connected with the second cooling heat exchanger 303 and the heating heat exchange unit 302 to form a heat exchange circuit. The water-to-water heat exchange unit 306 enables the second cooling heat exchanger 303 and the heating heat exchange unit 302 to exchange heat there between. The water-to-water heat exchange unit 306 receives the hot water output from the second cooling heat exchanger 303, and after cooling the aqueous solution, supplies cold water to the second cooling heat exchanger 303, and the cold water flows in the second cooling heat exchanger 303 to exchange heat with the air so as to cool the air.

[0029] In the water-to-water heat exchange unit 306, heat exchange between the hot water received from the cooling heat exchange unit 305 and the cold water received from the heating heat

exchange unit 302 is realized through a heat exchange medium, so that cold water is produced to be supplied to the cooling heat exchange unit 305, and hot water is produced to be supplied to the heating heat exchange unit 302. In some embodiments, the water-to-water heat exchange unit 306 includes a first heat exchanger 310 and a second heat exchanger 311. The first heat exchanger 310 is connected with the cooling heat exchange unit 305 for receiving the aqueous solution output from the cooling heat exchange unit 305, and after cooling the aqueous solution output from the cooling heat exchange unit 305, supplies the aqueous solution to the cooling heat exchange unit 305. In some embodiments, the first heat exchanger 310 is connected with the second cooling heat exchanger 303 to receive the hot water output from the second cooling heat exchanger 303 so as to produce cold water to be supplied to the second cooling heat exchanger 303.

[0030] In some embodiments, a first water pump 312 is connected between the first heat exchanger 310 and the cooling heat exchange unit 305 to cause the aqueous solution to flow within the first heat exchanger 310 and the cooling heat exchange unit 305. In an embodiment, the first water pump 312 is located between the outlet 317 of the second cooling heat exchanger 303 and the inlet 318 of the first heat exchanger 310 to pump the aqueous solution output from the second cooling heat exchanger 303 into the first heat exchanger 310.

[0031] The second heat exchanger 311 is connected with the first heat exchanger 310 and is connected with the heating heat exchange unit 302 for receiving and heating the aqueous solution output from the heating heat exchange unit 302 and supplying the aqueous solution having been heated to the heating heat exchange unit 302. The second heat exchanger 311 receives the cold water output from the heating heat exchange unit 302, and produces hot water to be supplied to the heating heat exchange unit 302.

[0032] In some embodiments, a second water pump 313 is connected between the second heat exchanger 311 and the heating heat exchange unit 302 to cause the aqueous solution to flow within the second heat exchanger 311 and the heating heat exchange unit 302. In an embodiment, the second water pump 313 is located between the outlet 337 of the heating heat exchange unit 302 and the inlet 335 of the second heat exchanger 311 to pump the aqueous solution output from the heating heat exchange unit 302 into the second heat exchanger 311.

[0033] A heat exchange circuit is formed between the second heat exchanger 311 and the first heat exchanger 310. A heat exchange medium such as a refrigerant, for example, Freon, flows between the second heat exchanger 311 and the first heat exchanger 310. The heat exchange medium exchanges heat with the aqueous solution in the first heat exchanger 310 so that the first heat exchanger 310 outputs cold water. The heat exchange medium exchanges heat with the aqueous solution in the second heat exchanger 311 so that the second heat exchanger 311 outputs hot water.

[0034] In some embodiments, a compressor 314 is connected between the first heat exchanger 310

and the second heat exchanger 311. The compressor 314 is used to boost a low pressure gas to a high pressure gas. In the present embodiment, the compressor 314 draws in a low-pressure gaseous heat exchange medium and boost the low-pressure heat exchange medium to a high-pressure gaseous heat exchange medium to be output. The heat exchange medium comprises a gaseous, liquid or gas-liquid mixed state.

[0035] In some embodiments, the first heat exchanger 310 comprises an evaporator and the second heat exchanger 311 comprises a condenser. The second heat exchanger 311 can receive the gaseous heat exchange medium output from the compressor 314, and increase the temperature of the cold water through heat exchange between the heat exchange medium and the cold water having a lower temperature than the heat exchange medium to produce and output hot water. The gaseous heat exchange medium exchanges heat with the cold water in the second heat exchanger 311 and is condensed to form a liquid heat exchange medium to be output from the second heat exchanger 311 to the first heat exchanger 310.

[0036] The first heat exchanger 310 receives a heat exchange medium in a liquid or gas-liquid mixed state, and the heat exchange medium exchanges heat with hot water having a higher temperature than the heat exchange medium to lower the temperature of the hot water so as to produce and output cold water. The heat exchange medium in a liquid or gas-liquid mixed state is vaporized in the first heat exchanger 310 to form a gaseous heat exchange medium, and the gaseous heat exchange medium is output from the first heat exchanger 310 into the compressor 314. In turn, the compressor 314 outputs a gaseous high-pressure heat exchange medium to the second heat exchanger 311, thus a circular heat exchange is performed.

[0037] In some embodiments, a third flow control device 315 is connected between the first heat exchanger 310 and the second heat exchanger 311 and can adjust the flux of the heat exchange medium flowing in the first heat exchanger 310 and the second heat exchanger 311. In some embodiments, the third flow control device 315 may comprise a throttle valve. When the throttle valve performs throttling and depressurizing, the liquid heat exchange medium passes through the throttle valve to output a heat exchange medium in a gas-liquid mixed state. In some embodiments, the liquid heat exchange medium output from the second heat exchanger 311 passes through the throttle valve to produce a heat exchange medium in a gas-liquid mixed state to be output to the first heat exchanger 310.

[0038] In some embodiments, the heat exchange system 300 includes a chamber 320 in which the cooling heat exchange unit 305 and heating heat exchange unit 302 are disposed. The water-to-water heat exchange unit 306 is isolated from the cooling heat exchange unit 305 and the heating heat exchange unit 302, and isolated from the heat-exchanged and dehumidified air, so that the heat exchange medium in the water-to-water heat exchange unit 306 will not enter the chamber 320 in

case of leakage, thus it will not enter the space 10 to cause a danger.

[0039] In some embodiments, the cooling heat exchange unit 305, the heating heat exchange unit 302 and the chamber 320 are assembled into one device, and the water-to-water heat exchange unit 306 can be disposed in another independent device, and the two devices can be connected. In other embodiments, the cooling heat exchange unit 305, the heating heat exchange unit 302, the chamber 320 and the water-to-water heat exchange unit 306 can be assembled into one device, and inside the device, the water-to-water heat exchange unit 306 is located outside the chamber 320 and isolated from the cooling heat exchange unit 305 and the heating heat exchange unit 302.

[0040] In some embodiments, the compressor 314 comprises a fixed-speed compressor of a constant rotational speed such that the heat exchange system 300 does not need to adjust and control the speed of the fixed-speed compressor, and therefore the control of the system is simple. In some embodiments, the heat exchange system 300 comprises a third heat exchanger 304 connected between the second heat exchanger 311 and the heating heat exchange unit 302 and connected with the chilled water production system 20 to receive a portion of aqueous solution output from the second heat exchanger 311, and cool the portion of aqueous solution using the chilled water output from the chilled water production system 20 and return the portion of aqueous solution back to the second heat exchanger 311. In some embodiments, the third heat exchanger 304 can cool a portion of the hot water output from the second heat exchanger 311 and return the cooled water to the second heat exchanger 311, so that the temperature of the hot water output from the second heat exchanger 311 can reach the requirement of the heating heat exchange unit 302.

[0041] The third heat exchanger 304 includes a first inlet 330, a first outlet 331, a second inlet 332, and a second outlet 333. The first inlet 330 of the third heat exchanger 304 is connected with the outlet 334 of the second heat exchanger 311, and the first outlet 331 of the third heat exchanger 304 is connected with the inlet 335 of the second heat exchanger 311. The first inlet 330 of the third heat exchanger 304 is connected between the outlet 334 of the second heat exchanger 311 and the inlet 336 of the heating heat exchange unit 302, and a portion of the aqueous solution output from the second heat exchanger 311 is input into the heating heat exchange unit 302, while the other portion of the aqueous solution output from the second heat exchanger 311 is input into the third heat exchanger 304. The first outlet 331 of the third heat exchanger 304 is connected between the outlet 337 of the heating heat exchange unit 302 and the inlet 335 of the second heat exchanger 311. In some embodiments, the first outlet 331 of the third heat exchanger 304 is connected with the inlet 335 of the second heat exchanger 311 through a second water pump 313, and the second water pump 313 pumps the hot water output from the third heat exchanger 304 into the second heat exchanger 311.

[0042] In some embodiments, the third heat exchanger 304 is connected with a pipe connecting

the first cooling heat exchanger 301 and the chilled water production system 20. The second inlet 332 of the third heat exchanger 304 is connected with a pipe 345 connecting the inlet 344 of the first cooling heat exchanger 301 and the chilled water production system 20. The second outlet 333 of the third heat exchanger 304 is connected with a pipe 339 connecting the outlet 338 of the first cooling heat exchanger 301 and the chilled water production system 20. Chilled water output from the chilled water production system 20 flows into the third heat exchanger 304 and exchanges heat with the aqueous solution flown into the third heat exchanger 304 from the second heat exchanger 311 in the third heat exchanger 304 to cool the aqueous solution in the third heat exchanger 304. The cooled aqueous solution is returned to the second heat exchanger 311. The chilled water output from the chilled water production system 20 flows back to the chilled water production system 20 after being heated in the third heat exchanger 304. In some embodiments, the third heat exchanger 304 includes a water-water heat exchanger, which can avoid a danger of refrigerant leakage and has high safety. In some embodiments, the third heat exchanger 304 includes a plate heat exchanger.

[0043] In some embodiments, a first flow control device 340 is provided on the pipe connecting the third heat exchanger 304 and the second heat exchanger 311. The heat exchange system 300 includes at least one controller. In some embodiments, at least one controller includes a main controller 341. The main controller 341 may be disposed outside the water-to-water heat exchange unit 306. The heat exchange system 300 includes a first temperature sensor 342 disposed in the space 10 for detecting the temperature of the space 10. The main controller 341 is connected with the first temperature sensor 342 and the first flow control device 340 for controlling the first flow control device 340 based on the temperature detected by the first temperature sensor 342 to adjust the flux of the aqueous solution output from the second heat exchanger 311 that flows into the third heat exchanger 304, so that the hot water output from the second heat exchanger 311 into the heating heat exchange unit 302 enables the heating heat exchange unit 302 to heat the air to a desired temperature. The first temperature sensor 342 may detect a dry bulb temperature of the space 10.

[0044] In some embodiments, the first flow control device 340 is connected on a pipe from the output of the third heat exchanger 304 to the second heat exchanger 311 and a pipe from the output of the heating heat exchange unit 302 to the second heat exchanger 311. In some embodiments, the first flow control device 340 may include a three-way valve that connects the first outlet 331 of the third heat exchanger 304, the inlet 335 of the second heat exchanger 311 and the outlet 337 of the heating heat exchange unit 302. In other embodiments, the first flow control device 340 may be connected on a pipe from the output of the second heat exchanger 311 to the third heat exchanger 304 and a pipe from the output of the second heat exchanger 311 to the heating heat exchange unit 302.

[0045] In some embodiments, a second flow control device 343 is connected on a pipe connecting the third heat exchanger 304 and the chilled water production system 2, and the main controller 341 is connected with the second flow control device 343 for controlling the second flow control device 343 to adjust the flux of the chilled water output from the first cooling heat exchanger 301 that flows into the third heat exchanger 304. The main controller 341 can control the second flow control device 343 based on the temperature detected by the first temperature sensor 342. The main controller 341 may control both the first flow control device 340 and the second flow control device 343 based on the temperature detected by the first temperature sensor 342 until the temperature detected by the first temperature sensor 342 reaching a desired temperature. In some embodiments, the second flow control device 343 is connected between the second outlet 333 of the third heat exchanger 304 and the chilled water production systems 20. In other embodiments, the second flow control device 343 is connected between the second inlet 332 of the third heat exchanger 304 and the chilled water production systems 20. In some embodiments, the second flow control device 343 comprises a two-way valve.

[0046] In some embodiments, the heat exchange system 300 includes a RH sensor 355 located in the space 10 to measure RH. The main controller 341 is connected with the RH sensor 355. In some embodiments, the heat exchange system 300 includes a second temperature sensor 356 located downstream of the cooling heat exchange unit 305 to detect the temperature of the air leaving from the cooling heat exchange unit 305. In some embodiments, the second temperature sensor 356 is located downstream of the second cooling heat exchanger 303 to detect the temperature of the air leaving from the second cooling heat exchanger 303. In some embodiments, the second temperature sensor 356 may be an averaging temperature sensor to measure an average temperature of the air leaving from the second cooling heat exchanger 303. A chilled water flow valve 350 similar to the chilled water flow valve 150 in FIG 1 is connecting the cooling heat exchange unit 305 to the chilled water production system 20. In some embodiments, the chilled water flow valve 350 is connecting the first cooling heat exchanger 301 to the chilled water production system 20. The main controller 341 is connected with the second temperature sensor 356 and the chilled water flow valve 350, and is configured to control the chilled water flow valve 350 based on the temperature detected by the second temperature sensor 356 until the temperature detected by the second temperature sensor 356 reaching a desired temperature, so as to control the temperature in the space 10 reaching a desired temperature and the RH in the space 10 reaching a desired RH.

[0047] In some embodiments, at least one controller includes an auxiliary controller 360 inside the water-to-water heat exchange unit 306. The auxiliary controller 360 may be connected with the main controller 341. In some embodiments, the auxiliary controller 360 is connected with and controls the compressor 314, the first water pump 312 and the second water pump 313.

[0048] In some embodiments, the third heat exchanger 304 is disposed in the chamber 320 to fully utilize the space in the chamber 320 and obtain a compact system structure, and the aqueous solution flowing in the third heat exchanger 304 will not leak to cause danger. In other embodiments, the third heat exchanger 304 is disposed outside of the chamber 320 as it does not provide heat exchange to the air stream. In some embodiments, the third heat exchanger 304 may be disposed outside of the chamber 320 and the water-to-water heat exchange unit 306. In other embodiments, the third heat exchanger 304 and the water-to-water heat exchange unit 306 may be disposed in a same device. In some embodiments, the first flow control device 340 and the second flow control device 343 may be disposed inside the chamber 320 or disposed outside of the chamber 320.

[0049] In some embodiments, glycol solution may be required in the evaporator water circuit to prevent the chilled water in the water-to-water heat exchange unit 306 from freezing.

[0050] In some embodiments, the water-to-water heat exchange unit 306 may include a stand-alone water-source DX heat pump described here could be a dedicated one for each air handler, or a combination of a few heat pumps to a single air-handler, or one heat pump to a few air-handlers performing similar humidity control function. The air-handler is the heat exchange system 300. Each heat pump includes one or more first heat exchanger 310 which may be refrigerant-to-water evaporator, one or more second heat exchanger 311 which may be a refrigerant-to-water condenser, one or more fixed or variable speed compressor 314 and the third flow control device 315 which may be a DX expansion valve with refrigerant medium that complete a vapour-compression refrigeration cycle. The advantage of having an isolated refrigerant circuit such as a water-source heat pump as contrast to using a DX heating or cooling coil in the air stream as described in Fig. 2, is that the control of temperature and RH of the control room can be more responsively accurate, other than being safer from asphyxiation risk described earlier.

[0051] FIG. 4 is a schematic diagram of another embodiment of a heat exchange system 400. The heat exchange system 400 shown in FIG. 4 is similar to the heat exchange system 300 shown in FIG. 3. In comparison with the heat exchange system 300 shown in FIG. 3, a compressor 414 of a water-to-water heat exchange unit 406 of the heat exchange system 400 shown in FIG. 4 comprises a variable speed compressor 414 whose rotational speed is adjustable and variable. A first temperature sensor 442 of the heat exchange system 400 is disposed in the space 10 for detecting the temperature of the space 10. At least one controller is connected with the first temperature sensor 442 and the variable speed compressor 414 for controlling the rotational speed of the variable speed compressor based on the temperature detected by the first temperature sensor 442, thereby adjusting the flux of a heat exchange medium flowing in a first heat exchanger 410 and a second heat exchanger 411 so as to control the temperature of an aqueous solution output from the

second heat exchanger 411 to satisfy the heat requirement for the heating heat exchange unit 402 to heat the air. The heat exchange system 400 shown in FIG. 4 may eliminate the third heat exchanger 304, the first flow control device 340 and the second flow control device 343 in the heat exchange system in FIG. 3, and has a simple system structure with fewer components, and is low in cost.

[0052] In some embodiments, at least one controller includes an auxiliary controller 460 inside the water-to-water heat exchange unit 406 connected with the variable speed compressor 414 to control the variable speed compressor 414. In some embodiments, at least one controller comprises a main controller 441 outside the water-to-water heat exchange unit 406 connected with the first temperature sensor 442 and the auxiliary controller 460 to control the auxiliary controller 460 to control the variable speed compressor 414 based on the temperature detected by the first temperature sensor 442. The main controller 441 receives signals of temperature from the first temperature sensor 442, and sends a command generated based on the signals to the auxiliary controller 460, and the auxiliary controller 460 controls the variable speed compressor 414 in response to the command, so that the control can be more accurate. The main controller 441 is similar to the main controller 341 in FIG. 3, and the auxiliary controller 460 is similar to the auxiliary controller 360 in FIG. 3.

[0053] The above are only preferred embodiments of the present application, and are not intended to limit the present application. Any modifications, equivalent substitutions, improvements, etc., which are made within the spirit and principle of the present application, should be comprised in the scope of the present application.

WHAT IS CLAIMED IS:

1. A heat exchange system, comprising:

a cooling heat exchange unit configured to receive intake air and to cool and dehumidify the intake air, and comprising a first cooling heat exchanger and a second cooling heat exchanger;

a heating heat exchange unit located downstream of the cooling heat exchange unit and configured to heat the air output from the cooling heat exchange unit;

a chilled water production system connected with the first cooling heat exchanger;

a water-to-water heat exchange unit comprising a first heat exchanger and a second heat exchanger, wherein the first heat exchanger is connected with the second cooling heat exchanger and configured to receive aqueous solutions output from the second cooling heat exchanger, cool the aqueous solution output from the second cooling heat exchanger and supply the aqueous solution having been cooled to the second cooling heat exchanger, and the second heat exchanger is connected with the first heat exchanger and the heating heat exchange unit and configured to receive the aqueous solution output from the heating heat exchange unit, heat the aqueous solution output from the heating heat exchange unit and supply the aqueous solution having been heated to the heating heat exchange unit; and

a third heat exchanger connected between the second heat exchanger and the heating heat exchange unit and connected with the chilled water production system, and configured to receive a portion of the aqueous solution output from the second heat exchanger, cool the portion of the aqueous solution with chilled water output from the chilled water production system and return the portion of the aqueous solution having been cooled to the second heat exchanger.

2. The heat exchange system according to claim 1, wherein a compressor is connected between the first heat exchanger and the second heat exchanger.

3. The heat exchange system according to claim 2, wherein the compressor comprises a fixed-speed compressor.

4. The heat exchange system according to claim 1, wherein the heat exchange system comprises:

a first flow control device disposed on a pipe connecting the third heat exchanger and the

second heat exchanger;

a first temperature sensor configured to detect a temperature of an air-conditioned space;
and

a main controller connected with the temperature sensor and the first flow control device to control the first flow control device based on the temperature to adjust a flux of the aqueous solution output from the second heat exchanger that flows into the third heat exchanger.

5. The heat exchange system according to claim 4, wherein the first flow control device is connected on a pipe from an output of the third heat exchanger to the second heat exchanger and a pipe from an output of the heating heat exchange unit to the second heat exchanger.

6. The heat exchange system according to claim 4, wherein the heat exchange system comprises a second flow control device disposed on a pipe connecting the third heat exchanger and the chilled water production system, and the main controller is connected with the second flow control device to control the second flow control device based on the temperature detected by the first temperature sensor.

7. The heat exchange system according to claim 1, wherein the third heat exchanger is connected on a pipe connecting the first cooling heat exchanger and the chilled water production system.

8. The heat exchange system according to claim 1, wherein the third heat exchanger comprises a water-water heat exchanger.

9. The heat exchange system according to claim 2, wherein the compressor comprises a variable speed compressor, and the heat exchange system comprises at least one controller and a first temperature sensor, the first temperature sensor is configured to detect a temperature of an conditioned space, and the at least one controller is connected with the first temperature sensor and the variable speed compressor to control a rotational speed of the variable speed compressor based on the temperature.

10. The heat exchange system according to claim 9, wherein the at least one controller comprises an auxiliary controller inside the water-to-water heat exchange unit connected with the variable speed compressor to control the variable speed compressor.

11. The heat exchange system according to claim 10, wherein the at least one controller comprises a main controller outside the water-to-water heat exchange unit connected with the first temperature sensor and the auxiliary controller to control the auxiliary controller to control the variable speed compressor based on the temperature detected by the first temperature sensor.

12. The heat exchange system according to claim 1, wherein the heat exchange system comprises a third flow control device connected between the first heat exchanger and the second heat exchanger.

13. The heat exchange system according to claim 1, wherein the heat exchange system comprises a Relative Humidity sensor configured to detect a Relative Humidity in an air-conditioned space.

14. The heat exchange system according to claim 1, wherein the heat exchange system comprises:

- a second temperature sensor located downstream of the cooling heat exchange unit to detect the temperature of air leaving from the cooling heat exchange unit;

- a chilled water flow valve connecting the cooling heat exchange unit to a chilled water production system; and

- a controller connected with the second temperature sensor and the chilled water flow valve, and configured to control the chilled water flow valve based on the temperature detected by the second temperature sensor.