

Description

Title of Invention: COOLING SYSTEM

Technical Field

5 **[0001]** The present disclosure relates to a natural cooling system cooling air without a freeze cycle by using latent heat from the vaporization of water and heat exchange.

Background Art

10 **[0002]** FIG. 1 discloses a cooling system used in a space requiring adequate cooling with low energy, for example, a chicken farm. As shown in FIG. 1, a cooling system 1 includes a pump 20 connected to a water supply source WS and a gas-liquid contact portion 10 connected to the pump.

15 The gas-liquid contact portion 10 discloses a structure in which water is provided with a material such as cellulose, and air is passed between the materials, so that a temperature of the gas passing therethrough decreases and humidity increases as the water evaporates. Such a cooling

20 system 1 may lower the temperature of air by using the latent heat from the vaporization of water without a refrigerant, but the temperature range that can be lowered is limited, making it difficult to substantially provide cool air.

25 **[0003]** Meanwhile, an evaporative cooling technology is

known as a technology that lowers the temperature of air by using the evaporative cooling effect of water and does not use any refrigerant other than water.

[0004] Such an evaporative cooler is configured to alternately and repeatedly form wet channels and dry channels and cool air passing through the dry channels by evaporation in the wet channels.

[0005]

[0006] (Patent Document 1) KR 10-2020-0073720 A

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Summary of Invention

Technical Problem

[0007] The present disclosure is intended to solve the problems of the prior art, and an aspect of the present disclosure is to provide a cooling system sufficiently cooling air by using latent heat from the vaporization of water and heat exchange without a refrigeration cycle.

Solution to Problem

20 **[0008]** An aspect of the present disclosure is to provide a cooling system as below, in order to address the above-described issues.

[0009] According to an aspect of the present disclosure, a cooling system is provided, the cooling system including:
25 a housing; first and second flow paths formed within the

housing; a first heat exchanger disposed on the first flow path; a main water supplier disposed above the first heat exchanger and supplying water to the first exchanger; a second heat exchanger disposed on the second flow path; and
5 a gas-liquid contact portion disposed on the second flow path so that air having passed through the second heat exchanger passes therethrough, wherein the first heat exchanger and the second heat exchanger are connected to each other so that a cooling fluid circulates therebetween,
10 and a pump for circulating the cooling fluid is disposed between the first heat exchanger and the second heat exchanger.

[0010] In an embodiment, the gas-liquid contact portion may include a water supply unit disposed thereabove, and a
15 contact body connected to the water supply unit and configured so that water supplied from the water supply unit is in contact with air as the water flows down.

[0011] In an embodiment, the cooling system may further include a tank for collecting water having passed through
20 the gas-liquid contact portion and the first heat exchanger; and a pump for supplying water stored in the tank to the main water supplier and the gas-liquid contact portion, the first and second flow paths are formed by a separation wall disposed inside the housing, and a through-hole is formed
25 below the gas-liquid contact portion in the separation wall

partitioning the second flow path, and the tank is disposed below the through-hole, and an end of the gas-liquid contact portion may be disposed in the through-hole.

[0012] In an embodiment, the first heat exchanger may have
5 a structure in which a plurality of layers formed of a first head and a second head, disposed side by side and a plurality of tubes connecting the first head and the second head are stacked.

[0013] In an embodiment, a water storage unit is disposed
10 below the contact body, and the water storage unit may be connected to the main water supplier, so that water stored in the water storage unit may be supplied to the first heat exchanger through the main water supplier.

[0014] In an embodiment, the water storage unit is
15 connected to a water supply source, and a tank in which water having passed through the first heat exchanger is stored is disposed below the first heat exchanger, and the tank may include a drainage unit.

[0015] In an embodiment, the second heat exchanger is a
20 fin-tube heat exchanger, and the gas-liquid contact portion may be disposed in a higher position than the first heat exchanger.

[0016] According to an aspect of the present disclosure, a natural cooling system is provided, the natural cooling
25 system including: a housing; a plurality of flow paths

formed within the housing; an evaporative cooler including a main body in which a plurality of dry channels and a plurality wet channels are alternately and repeatedly disposed and a main water supplier supplying water from an upper portion of the main body to the wet channel, and cooling the supplied air having passed through the dry channel; and a gas-liquid contact portion disposed at a rear end of the dry channel of the evaporative cooler, wherein the flow path includes a first flow path passing through the wet channel and a second flow path sequentially passing through the dry channel and the gas-liquid contact portion.

[0017] In an embodiment, the gas-liquid contact portion may be configured to be connected to a water supply unit, so that water supplied from the water supply unit is in contact with air as the water flows down.

[0018] In an embodiment, the natural cooling system may further include a third flow path passing through the gas-liquid contact portion, wherein the third flow path may be configured to pass through an upper portion of the gas-liquid contact portion, more than the second flow path.

[0019] In an embodiment, the housing includes a separation wall partitioning the second flow path and the third flow path, and including a through groove through which the gas-liquid contact portion passes, and the gas-liquid portion

may extend in a vertical direction, and may be disposed through the through groove.

[0020] In an embodiment, the natural cooling system may further include a first pump disposed between the water
5 collection unit and the main water supplier so that water in the water collection unit provided below the gas-liquid contact portion is supplied to the main water supplier.

[0021] In an embodiment, the first flow path may be formed to pass through a first inlet, a wet channel of the
10 evaporative cooler, and a first outlet, and the second flow path may be formed to pass through a second inlet, a dry channel of the evaporative cooler, a gas-liquid contact portion, and a second outlet.

15 Advantageous Effects of Invention

[0022] As set forth above, according to the present disclosure, a cooling system sufficiently cooling air with a small energy source may be provided by using latent heat from the vaporization of water and heat exchange.

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Brief description of drawings

[0023] FIG. 1 is a schematic diagram of a conventional natural cooling system.

[0024] FIG. 2 is a schematic diagram of a natural cooling
25 system according to a first embodiment of the present

disclosure.

[0025] FIG. 3 is a schematic diagram illustrating a change in temperature in the natural cooling system of FIG. 2.

[0026] FIG. 4 is a schematic diagram of a natural cooling
5 system according to a second embodiment of the present disclosure.

[0027] FIG. 5 is a schematic diagram of a natural cooling system according to a third embodiment of the present disclosure.

10 **[0028]** FIG. 6 is a schematic diagram of a natural cooling system according to a fourth embodiment of the present disclosure.

[0029] * Reference of numerals *

[0030] 1: Natural cooling system 10: Gas-liquid contact
15 portion

[0031] 11: Water supply unit 12: Contact body

[0032] 13: Water storage unit 21, 24: Inlet

[0033] 22, 23, 25: Outlet 31, 32, 33: Fan

[0034] 50: Housing 51, 52: Separation wall

20 **[0035]** 60: Evaporative cooler 61: Main body

[0036] 62: Main water supplier 70, 70a, 70b: Pump

[0037] 80: First heat exchanger 81: Main water supplier

[0038] 85: Second heat exchanger WS: Water supply source

25 Mode for Invention

[0039] Hereinafter, preferred embodiments will be described in detail so that those skilled in the art can easily practice the present invention with reference to the accompanying drawings. However, in describing a preferred
5 embodiment of the present disclosure in detail, if it is determined that a detailed description of a related known function or configuration may unnecessarily obscure the gist of the present disclosure, the detailed description will be omitted. In addition, the same reference numerals
10 are used throughout the drawings for parts having similar functions and actions. In addition, in the present specification, terms such as 'upper,' 'upper portion,' 'upper surface,' 'lower,' 'lower portion,' 'lower surface,' and 'side surface' are based on the drawings, and may
15 actually vary depending on a direction in which elements or components are disposed.

[0040] In addition, throughout the specification, when it is said that a portion is 'connected' to another portion, which includes not only a case in which it is 'directly
20 connected,' but also a case in which it is 'indirectly connected' with another element interposed therebetween. In addition, 'including' a certain component means that other components may be further included, rather than excluding other components unless otherwise stated.

25 **[0041]** FIG. 2 is a schematic diagram of a natural cooling

system according to a first embodiment of the present disclosure.

[0042] As shown in FIG. 2, a natural cooling system 1 according to an embodiment of the present disclosure includes a housing 50, a plurality of flow paths F1, F2, and F3 formed within the housing 50, an evaporative cooler 60 including a main body 61 in which a plurality of dry channels and a plurality of wet channels are alternately and repeatedly disposed and a main water supplier 62 supplying water from an upper portion of the main body 61 to the wet channel, and cooling the supplied air having passed through the dry channel; and a gas-liquid contact portion 10 disposed at a rear end of the dry channel of the evaporative cooler 60.

[0043] Separation walls 51 and 52 may be formed inside the housing 50, to separate an air flow so that each flow path F1, F2, and F3 is not mixed, and a plurality of inlets 21 and 24 and a plurality of outlets 22, 23, and 25 are formed in the housing 50.

[0044] A tank 63 is provided below the wet channel of the evaporative cooler 60, and a water storage unit 13 is provided below the gas-liquid contact portion 10. The tank 63 and the water storage unit 130 are connected to a pump 70, and the pump 70 circulates water collected in the tank 63 and the water storage unit 130 to the water supply unit

11 of the gas-liquid contact portion 10 and the main water supplier 61. A filter may be provided in a circulation path through which water circulates.

[0045] The flow paths F1, F2, and F3 include a first flow
5 path F1 passing through the wet channel of the evaporative cooler 60, a second flow path F2 passing sequentially through the dry channel of the evaporative cooler 60 and the gas-liquid contact portion 10, and a third flow path F3 configured to pass through an upper portion of the
10 contact body 12 of the gas-liquid contact portion 10, more than the second flow path.

[0046] The gas-liquid contact portion 10 includes a water supply unit 11 and a contact body 12 disposed thereabove, and a water storage unit 13 disposed therebelow, and the
15 contact body 12 may be a structure formed of a plastic and/or paper material which allows water to flow through the surface, and may be, for example, Celdek from Munters. The gas-liquid contact portion 10 is configured to cool the air passing through the contact body 12 by being vaporized
20 by the air passing through the contact body 12 when the water supplied to the water supply unit 11 flows down through the contact body 12.

[0047] The water supply unit 11 sprays or flows the supplied water to the contact body 12, an air flow passes through
25 the contact body 12, and as water flows through a surface

of the contact body 12, heat exchange between air and water passing therethrough is performed. The water flowing down through the contact body 12 due to its own weight is collected in the water storage unit 13, and the water
5 collected in the water storage unit 13 is resupplied to the water supply unit 11 by the pump 70. Since evaporation occurs in the gas-liquid contact portion 10, a water supply is required. The water supply may be provided from the water storage unit 13, but in this embodiment, a water supply
10 source WS is connected to a tank 60 in a lower portion of the evaporative cooler 60 to supply water to the natural cooling system 1.

[0048] In this embodiment, two air flows pass through the gas-liquid contact portion 10, and a third flow path F3
15 passes through an upper portion of the gas-liquid contact portion 10, and a second flow path F2 passes through a lower portion of the gas-liquid contact portion 10. As the third flow path F3 passes through the gas-liquid contact portion 10 and water in the gas-liquid contact portion 10
20 evaporates, and the air passing through the third flow path F3 is cooled by the latent heat from the vaporization, and at the same time, the water passing through the corresponding region of the gas-liquid contact portion 10 is also cooled.

25 **[0049]** As air passing through the second flow path F2 is

in contact with water that was primarily cooled by the third flow path F3 and the second flow path F2 causes evaporation again, and the air passing through the second flow path F2 is cooled by latent heat from the vaporization of water.

5 In this case, since water at a lower temperature is supplied through the second flow path F2 rather than through the third flow path F3, the air passing through the second flow path F2 may have a lower temperature.

[0050] Meanwhile, the air passing through the second flow
10 path F2 is primarily cooled while passing through the dry channel of the evaporative cooler 60 before passing through the gas-liquid contact portion 10. Since the configuration of the evaporative cooler 60 is known in Patent Document 1 of the background technology, the description of the
15 configuration itself will be omitted, and the evaporative cooler 60 includes a main body 61 in which dry channels and wet channels are formed to cross each other and a main water supplier 62 spraying or supplying water from an upper portion of the main body 61 to the wet channels.

20 **[0051]** In the evaporative cooler 60, the first flow path F1 passes through the wet channel, and therefore, the water supplied to the wet channel through the main water supplier 62 is evaporated by the air passing through the first flow path F1, thereby lowering the temperature, and the air
25 passing through the second flow path F2 having passed

through the dry channel may be cooled. In the evaporative cooler 60, since the dry channel and wet channel are separated, only the temperature of the air passing through the dry channel is lowered without increasing humidity.

5 **[0052]** In the first flow path F1, external air (OA) is introduced through an inlet 21, external air (OA) passes through the main water supplier 62 and the wet channel of the main body 61 of the evaporative cooler 60, and external air (OA) is exhausted through an outlet 22. The air flow
10 of the first flow path F1 is formed by a fan 31 disposed at the outlet 22, but the location of the fan 31 is not limited to the outlet 22, and may be formed at any location on the first flow path F1.

15 **[0053]** In the second flow path F2, external air (OA) is introduced through an inlet 24, different from the inlet 21, external air (OA) passes through the dry channel of the evaporative cooler 60, and external air (OA) passes through the gas-liquid contact portion, and is then supplied (SA) to the room or a desired space. The air flow of the second
20 flow path F2 is formed by a fan 33 disposed at an outlet 25 for supplying air (SA), but the location of the fan 33 is not limited to the outlet 25, and may be formed at any location on the second flow path F2. For example, the fan 33 may be disposed between the dry channel of the
25 evaporative cooler 60 and the gas-liquid contact portion

10.

[0054] In the third flow path F3, external air (OA) is introduced through the same inlet 21 as the first flow path F1, external air (OA) passes through the gas-liquid contact portion 10, and external air (OA) is then exhausted through an outlet 23. The air flow of the third flow path F3 is formed by a fan 32 disposed at the outlet 23, but the location of the fan 32 may be formed in any location on the third flow path F3 in the same manner as the first and second flow paths F1 and F2.

[0055] In the first embodiment, air passing through the first flow path F1 and the third flow path F3 are introduced into the housing 50 through the same inlet 21, and then branched off by a separation wall 51. The separation wall 51 includes a through groove 51a, and the gas-liquid contact portion 10 passes through the through groove 51a. The gas-liquid contact portion 10 may be disposed to pass through the through groove 51a of the separation wall 51a, thereby being disposed across the third flow path F3 and the second flow path F2, and since the temperature of the water flowing through the gas-liquid contact portion 10 is lowered due to the air passing through the third flow path F3, it can meet the air passing through the second flow path F2, the temperature of the air passing through the second flow path F2 may be sufficiently lowered.

[0056] FIG. 3 is a diagram illustrating a temperature at each point of the second flow path F2 of the embodiment of FIG. 2 on a psychrometric chart.

[0057] When a temperature of external air (A) on a summer day in Korea is approximately 35°C, humidity is approximately 40%, and a wet bulb temperature is approximately 24°C, the temperature when the external air (A) passes through only the gas-liquid contact portion 10, the temperature changes according to the wet bulb temperature, so that the temperature that can be lowered is limited.

[0058] However, in this embodiment, the external air (A) is primarily cooled by the evaporative cooler 60 without changing an amount of moisture contained in the air, so the temperature is lowered while the absolute humidity is maintained, and the external air (A) moves to point B. For example, at point B, the temperature of the external air (A) is approximately 27°C, the humidity is approximately 63.5%, and the wet bulb temperature is approximately 21.8°C. The air having passed through the evaporative cooler 60 passes through the gas-liquid contact portion 10, and the temperature may be lowered once more while the wet bulb temperature is maintained, and at point C, the temperature is approximately 23.5°C, the humidity is approximately 85%, and the wet bulb temperature is approximately 21.7°C, and

air, that has been lowered to a sufficiently low temperature, approximately, 23°C through the natural cooling system 1 may be provided, and the level of temperature may provide a practical cooling effect, making it possible to provide
5 cool air not only to livestock sheds but also to homes or other spaces without consuming a lot of electricity, even on hot summer days.

[0059] In particular, tap water is usually maintained to be approximately 25°C even on a normal summer day, but in
10 this embodiment, since the temperature of the tap water is lowered through the air having passed through the third flow path F3 and is in contact with the second flow path F2 in the gas-liquid contact portion 10, in addition to the temperature drop due to evaporation of water, a temperature
15 lower than the approximate temperature described above may be achieved due to a temperature drop caused by heat exchange with the tap water with lowered temperature.

[0060] Therefore, in this embodiment, cool air may be provided without running a refrigeration cycle when cooling
20 is not required to a low temperature, thereby improving energy efficiency, and it also has the advantage in that the temperature of exhausted air does is not increased, so there is no heat emission.

[0061]

25 **[0062]** FIG. 4 illustrates a schematic diagram of a second

embodiment of the present disclosure.

[0063] As shown in FIG. 4, the natural cooling system 1 according to a second embodiment of the present disclosure includes a housing 50, a plurality of flow paths F1 and F2
5 formed within the housing 50, an evaporative cooler 60 including a main body 61 in which a plurality of dry channels and a plurality of wet channels are alternately and repeatedly disposed and a main water supplier 62 supplying water from an upper portion of the main body 61
10 to the wet channel, and cooling the supplied air having passed through the dry channel, and a gas-liquid contact portion 10 disposed at a rear end of the dry channel of the evaporative cooler 60.

[0064] Separation walls 51 and 52 are formed inside the
15 housing 50, to separate an air flow so that respective flow paths F1 and F2 are not mixed, and a plurality of inlets 21 and 24 and a plurality of outlets 22 and 25 are formed in the housing 50.

[0065] The gas-liquid contact portion 10 includes a water
20 supply unit 11, a contact body 12, disposed thereabove, and a water storage unit 13 disposed therebelow, and the contact body 12 may be a structure formed of plastic and/or paper which allows water to flow through the surface. The water supply unit 11 of the gas-liquid contact portion is
25 connected to a water supply source (WS), and when water

from the water supply source (WS) flows down through the contact body 12 through the water supply unit 11, the gas-liquid contact portion 10 is configured to cool the air passing through the contact body 12 by being vaporized by
5 the air passing through the contact body 12.

[0066] The water supplier sprays or flows the supplied water to the contact body 12, an air flow passes through the contact body 12, and heat exchange between the air and water passing through the surface of the contact body 12
10 occurs as water flows down through the contact body 12. The water flowing down through the contact body 12 due to its own weight is collected in the water storage unit 13.

[0067] A pump 70 is connected to the water storage unit 13, and water collected in the water storage unit 13 is supplied
15 to the main water supplier 61 of the evaporative cooler 60 through the pump 70.

[0068] The evaporative cooler 60 is the same as the evaporative cooler 60 of the first embodiment, and includes a main water supplier 61 and a main body 62. The main body
20 62 includes dry channels and wet channels, alternately disposed, and when water sprayed or supplied from the main water supplier 61 meets the air passing through the wet channel, thereby lowering the temperature, and when the lowered air in the wet channel and the air in the dry
25 channel exchange heat, the temperature of the air in the

dry channel can be lowered without changing the absolute humidity.

[0069] A tank 63 is provided in a lower portion of the wet channel of the evaporative cooler 60, and water collected
5 in the tank 63 may be drained. In the second embodiment, water is not circulated, water supplied to the gas-liquid contact portion 10 exchanges heat with air and evaporates, is then supplied to the main water supplier 61 of the evaporative cooler 60 by the pump 70, and after passing
10 through the evaporative cooler 60, is drained from the tank 63.

[0070] In the second embodiment, since water is not circulated, there is no concern about bacterial growth or contamination by foreign substances, and by supplying new
15 water to each component, i.e., the evaporative cooler 60 and the gas-liquid contact portion 10, it is possible to provide the advantage in terms of hygiene, and the water temperature of tap water can be utilized for cooling.

[0071] The flow paths F1 and F2 include a first flow path
20 F1 passing through the wet channel of the evaporative cooler 60 and a second flow path F2 passing sequentially through the dry channel of the evaporative cooler 60 and the gas-liquid contact portion 10.

[0072] In the evaporative cooler 60, the first flow path
25 F1 passes through the wet channel, and therefore, the water

supplied to the wet channel through the main water supplier
62 is evaporated by the air having passed through the first
flow path F1, thereby lowering the temperature. Therefore,
as the temperature of the wet channel decreases, the air
5 in the second flow path F2 passing through the dry channel
that exchanges heat with the wet channel can be cooled. In
the evaporative cooler 60, since the dry channel and the
wet channel are separated, the temperature of the air
passing through the dry channel decreases without
10 increasing the humidity.

[0073] In the first flow path F1, external air (OA) is
introduced through an inlet 21, external air (OA) passes
through the main water supplier 62 and the wet channel of
the main body 61 of the evaporative cooler 60, and external
15 air (OA) is exhausted (EA) through the outlet 22. The air
flow of the first flow path F1 is formed by a fan 31 disposed
at the outlet 22, but the location of the fan 31 is not
limited to the outlet 22, and may be formed at any location
on the first flow path F1.

20 **[0074]** In the second flow path F2, external air (OA) is
introduced through an inlet 24, different from the inlet
21, external air (OA) passes through the dry channel of the
evaporative cooler 60, and external air (OA) passes through
the gas-liquid contact portion 10, and external air (OA)
25 is then supplied (SA) to the room or a desired space. The

air flow of the second flow path F2 is formed by a fan 33 disposed at an outlet 25 for supplying air, but the location of the fan 33 is not limited to the outlet 25, and may be formed at any location on the second flow path F2.

5 **[0075]** In the second embodiment, water of which a temperature is lowered due to latent heat from the vaporization of water in the gas-liquid contact portion 10 is supplied to the main water supplier 61 of the evaporative cooler 60, and accordingly, the temperature of the wet
10 channel of the evaporative cooler 60 may be further lowered, as compared to the first embodiment due to the latent heat from the vaporization as well as heat exchange between water and air in the wet channel of the evaporative cooler 60, and thus the temperature of the air passing through the dry
15 channel may be provided lower than that of the first embodiment. Therefore, a difference in temperatures between points A and B on the second flow path F2 may be increased.

[0076] In addition, the air passing through the evaporative cooler 60 in the second flow path F2 can have the
20 temperature dropped again as the air passes through the gas-liquid contact portion 10, and accordingly, the air supplied (SA) through the outlet 25 may be provided at a sufficiently lowered temperature.

[0077] In the case of the second embodiment, water
25 consumption may increase somewhat because water is not

recycled, but by recycling the water lowered in the gas-liquid contact portion 10 in the evaporative cooler 60), not only it consume less water than when operated separately, but it can also provide a low supply air temperature, and
5 in terms of management, since water is discharged rather than stored, the risk of bacterial growth is lowered, making management easier.

[0078] In the case of the second embodiment, compared to the first embodiment, the temperature difference between
10 point A and point B is greater than in the first embodiment, and the temperature difference between point B and point C is smaller than in the first embodiment, but overall, the same level of cooling may be provided.

[0079] Therefore, like the first embodiment, the natural
15 cooling system of the second embodiment may also provide cold air without running a refrigeration cycle when cooling to a low temperature is not required, thereby improving energy efficiency, and also has the advantage of no heat emission because the temperature of the exhausted air is
20 not increased.

[0080]

[0081] FIG. 5 illustrates a third embodiment of the present disclosure.

[0082] As shown in FIG. 5, the natural cooling system 1
25 according to an embodiment of the present disclosure

includes a housing 50, a plurality of flow paths F1 and F2 formed within the housing 50; first and second heat exchangers 80 and 85 disposed in the plurality of flow paths F1 and F2, a pump 70a circulating a refrigerant to the first and second heat exchangers 80 and 85; a main water supply module 81 supplying water to the first heat exchanger 80; and a gas-liquid contact portion 10 disposed at a rear end of the second heat exchanger 85.

[0083] Separation walls 51 and 52 are formed inside the housing 50 to separate an air flow so that respective paths F1 and F2 do not meet, and a plurality of inlets 21 and 24 and a plurality of outlets 22 and 25 are formed in the housing 50.

[0084] The gas-liquid contact portion 10 includes a water supply unit 11 and a contact body 12 located in the upper portion, and the contact body 12 may be a structure formed of a plastic and/or paper material which allows water to flow through the surface. The water having passed through the contact body 12 flows down to the tank 83 through the through-hole 52a of the separation wall 52 and is collected.

[0085] The water supply unit 11 of the gas-liquid contact portion 10 is connected to a pump 70b, and the pump 70b supplies water from the tank 83 in a lower portion of the housing 50 to the gas-liquid contact portion 10. When the water flows down through the contact body 12 through the

water supply unit 11, the water is vaporized by the air passing through the contact body 12 and cool the air passing therethrough.

[0086] In the third embodiment, a first heat exchanger 80, a second heat exchanger 85, and a pump for moving a cooling fluid circulating the first heat exchanger 80 and the second heat exchanger 85 are included. In the case of the first exchanger 80, a main water supplier 81 is disposed in an upper portion of the first heat exchanger 80, so that a temperature of the cooling fluid passing through the first heat exchanger 80 may be lowered by being in contact with water sprayed/supplied from the main water supplier 81.

[0087] The first heat exchanger 80 cools by using latent heat of the vaporization of water due to evaporation of water supplied from the main water supplier 81, and cooling may be performed to a temperature lower than the temperature of the water supplied from the main water supplier 81. The water sprayed from the main water supplier 81 to the first heat exchanger 80 cools the cooling fluid of the first heat exchanger 80 as the water evaporates, or the remaining water is collected in a tank 83 disposed below the first heat exchanger 80.

[0088] The first heat exchanger 80 is formed to have a structure in which a plurality of layers formed of a pair of heads 80a and 80c disposed on both sides thereof and a

plurality of tubes 80b connecting the heads 80a and 80c between the pair of heads 80a and 80c are stacked, and fins are connected between the tubes 80b to increase a contact area.

5 **[0089]** The stacked heads 80a are connected to each other, and a cooling fluid supplied to the head 80a at one side of the uppermost layer, goes to the head 80c at the other side thereof through the tube 80b, then goes down to the head 80c at the other side of a lower layer, and then goes
10 back to the head 80a at one side of the lower layer, so that the cooling fluid may have a structure in which it can exchange heat with the air and water passing therethrough while changing a direction while passing through the multiple layers within the first heat exchanger 80, but the
15 present disclosure is not limited thereto. Other structures may also be applied as long as they can sufficiently contact the air of the first flow path F1 and the water sprayed from the main water supplier 81.

[0090] The water collected in the tank 83 may be supplied
20 again to the main water supplier 81 by a pump 70b, and a filter (not shown) may be disposed in a portion of the tank 83 connected to the pump 70b to remove foreign substances in the circulating water. The tank 83 collects water which is sprayed from the main water supplier 81 and does not
25 evaporate in the first heat exchanger 80 and water which

does not evaporate while passing through the gas-liquid contact portion 10. Even in the case of water which does not evaporate, a temperature of water is lowered by latent heat from the vaporization of the evaporating water, so the temperature of the water in the tank 83 may be maintained lower than, but not higher than, the temperature of the water supplied from a water supply source WS.

[0091] Meanwhile, the tank 83 is connected to the water supply source WS, and may continuously replenish an amount of water that decreases due to evaporation.

[0092] The second heat exchanger 85 is a heat exchanger performing heat exchange between air and cooling fluid, and may be, for example, a fin-tube heat exchanger.

[0093] The cooling fluid having passed through the first heat exchanger 80 has a temperature thereof lowered by water supplied from the main water supplier 81, and is supplied to the second heat exchanger 85 through the pump 70a. In the second heat exchanger 85, heat is adsorbed from air while exchanging heat between low-temperature water and relatively high-temperature external air, that is, the temperature of the air passing through the second flow path F2 is lowered without changing an amount of moisture contained in the air.

[0094] The cooling fluid circulating through the first and second heat exchangers 80 and 85 may be water, but the

cooling fluid is not limited to water, and other cooling fluids may also be used. In a circulation structure consisting of the first and second heat exchangers 80 and 85, and the pump 70a, a phase change of the cooling fluid is not used, and the pump 70a is to circulate the cooling fluid.

[0095] In the first flow path F1, external air (OA) is introduced through an inlet 21, external air (OA) passes through the first heat exchanger 80, and external air (OA) is exhausted (EA) through an outlet 22. An air flow of the first flow path F1 is formed by a fan 31 disposed at the outlet 22, but a location of the fan 31 is not limited to the outlet 22, and may be formed at any location on the first flow path F1.

[0096] In the second flow path F2, external air (OA) is introduced through an inlet 24, different from the inlet 21 described above, passes through the second heat exchanger 85, passes through the gas-liquid contact portion 10, and external air (OA) is then supplied (SA) to the room or to a desired space. The air flow of the first flow path F2 is formed by a fan 33 disposed at the outlet 25 for supplying air (SA), but a location of the fan 33 is not limited to the outlet 25, and may be formed at any location on the second flow path F2.

[0097] Even in the third embodiment, similarly to the first

and second embodiments, the temperature of the air supplied from the outside along the second path F2 is primarily lowered without changing absolute humidity, and then the temperature is lowered once more while maintaining a wet
5 bulb temperature.

[0098] Therefore, even in the case of the natural cooling system 1 of the third embodiment, sufficiently low air, for example, approximately 23°C, with low energy consumption may be provided as supplied air (SA). Therefore, it is
10 possible to apply the natural cooling system 1 of the third embodiment when a low temperature is not required but a large amount of air is required.

[0099]

[00100] FIG. 6 is a schematic diagram of a natural cooling
15 system 1 of a fourth embodiment of the present disclosure.

[00101] In the case of the fourth embodiment, the first heat exchanger 80, the second heat exchanger 85, and the pump 70a are the same as in the third embodiment, the configuration through which the first and second flow paths
20 F1 and F2 pass and the configurations of the inlets 21 and 24 and the outlets 22 and 25 of the housing 50 are the same, so the description will focus on the configurations that are different.

[00102] In the fourth embodiment, the gas-liquid contact
25 portion 10 includes a water supply unit 11 disposed

thereabove and a water storage unit 13 disposed therebelow,
and the gas-liquid contact portion 10 is configured to cool
the air passing through the contact body 12 by being
vaporized by the air passing through the contact body 12
5 when the water supplied to the water supply unit 11 flows
down through the contact body 12.

[00103] The water supplier is connected to a water supply
source WS, and the water storage unit 13 is connected to a
pump 70b. The pump 70b supplies water from the water storage
10 unit 13 to a main water supplier 81.

[00104] The main water supplier 81 receives water from the
water storage unit 13 and sprays the water into the first
heat exchanger 80. Since the water supplied to the main
water supplier 81 is water having passed through the contact
15 body 12, and may have a lower temperature than that of the
water supply source WS, in the fourth embodiment, cooling
fluid may be cooled to a lower temperature in the first
heat exchanger 80 under the same conditions than in the
third embodiment.

20 **[00105]** Among the water from the main water supplier 83 to
the first heat exchanger 80, water which is not evaporated
in the first heat exchanger 80 is collected in a tank 83,
and the water collected in this manner is drained.

[00106] In the case of the fourth embodiment, since water
25 is not circulated, it does not require any components

required for water circulation and is easy to be managed.
In particular, there is no concern about contamination by
bacteria or foreign substances that may occur in stored
water, and the capacity of the pump 70b may be smaller than
5 that of the third embodiment, so that the energy entering
the pump 70b may be saved. However, an amount of water used
may increase as compared to the third embodiment.

[00107]

[00108] While example embodiments have been illustrated and
10 described above, it will be apparent to those skilled in
the art that modifications and variations could be made
without departing from the scope of the present disclosure
as defined by the appended claims.

CLAIMS

1. A cooling system, comprising:
a housing;
5 first and second flow paths formed within the housing;
a first heat exchanger disposed on the first flow
path;
a main water supplier disposed above the first heat
exchanger and supplying water to the first exchanger;
10 a second heat exchanger disposed on the second flow
path; and
a gas-liquid contact portion disposed on the second
flow path so that air having passed through the second heat
exchanger passes therethrough,
15 wherein the first heat exchanger and the second heat
exchanger are connected to each other so that a cooling
fluid circulates therebetween, and a pump for circulating
the cooling fluid is disposed between the first heat
exchanger and the second heat exchanger.
20
2. The cooling system of claim 1, wherein the gas-
liquid contact portion includes a water supply unit
disposed thereabove, and a contact body connected to the
water supply unit and configured so that water supplied
25 from the water supply unit is in contact with air as the

water flows down.

3. The cooling system of claim 1, further comprising:

5 a tank for collecting water having passed through the gas-liquid contact portion and the first heat exchanger; and

a pump for supplying the water stored in the tank to the main water supplier and the gas-liquid contact portion.

10

4. The cooling system of claim 3, wherein the first and second flow paths are formed by a separation wall disposed inside the housing,

a through-hole is formed below the gas-liquid contact
15 portion in the separation wall partitioning the second flow path, the tank is disposed below the through-hole, and an end of the gas-liquid contact portion is disposed in the through-hole.

20 5. The cooling system of claim 1, wherein the first heat exchanger has a structure in which a plurality of layers formed of a first head and a second head, disposed side by side, and a plurality of tubes connecting the first head and the second head are stacked.

25

6. The cooling system of claim 2, wherein a water storage unit is disposed below the contact body, and

the water storage unit is connected to the main water supplier, so that water stored in the water storage unit
5 is supplied to the first heat exchanger through the main water supplier.

7. The cooling system of claim 6, wherein the water supply unit is connected to a water supply source, and

10 a tank in which water having passed through the first heat exchanger is stored is disposed below the first heat exchanger, and the tank includes a drainage unit.

8. The cooling system of claim 6, wherein the
15 second heat exchanger is a fin-tube heat exchanger, and

the gas-liquid contact portion is disposed in a higher position than the first heat exchanger.

9. A cooling system, comprising:

20 a housing;

a plurality of flow paths formed within the housing;

an evaporative cooler including a main body in which
a plurality of dry channels and a plurality of wet channels
are alternately and repeatedly disposed and a main water
25 supplier supplying water from an upper portion of the main

body to the wet channel and cooling the supplied air having passed through the dry channel; and

a gas-liquid contact portion disposed at a rear end of the dry channel of the evaporative cooler,

5 wherein the flow path includes a first flow path passing through the wet channel, and a second flow path sequentially passing through the dry channel and the gas-liquid contact portion.

10 10. The cooling system of claim 9, wherein the gas-liquid contact portion is connected to a water supply unit thereabove, and is configured so that water supplied from the water supply unit is in contact with air as the water flows down.

15

11. The cooling system of claim 10, further comprising:

a third flow path passing through the gas-liquid contact portion,

20 wherein the third flow path is configured to pass through an upper portion of the gas-liquid contact portion, more than the second flow path.

25 12. The cooling system of claim 11, wherein external air is introduced into the first to third flow paths.

13. The cooling system of claim 12, wherein the housing includes a separation wall partitioning the second flow path and the third flow path, and including a through groove through which the gas-liquid contact portion passes, and

the gas-liquid contact portion extends in a vertical direction, and is disposed to pass through the through groove.

14. The cooling system of claim 11, further comprising:

a tank provided below the wet channel; and

a pump supplying water from the tank to the main water supplier and the gas-liquid contact portion between the tank and the main water supplier and the gas-liquid contact portion.

15. The cooling system of claim 10, further comprising:

a first pump disposed between the water collection unit and the main water supplier so that water from the water collection unit provided below the gas-liquid contact portion is supplied to the main water supplier.

16. The cooling system of claim 15, further comprising:

a tank provided below the wet channel; and

a second pump supplying water from the tank to the
5 main water supplier and the gas-liquid contact portion
between the tank and the gas-liquid contact portion.

17. The cooling system of claim 16, wherein external
air is introduced into the first and second flow paths.

10

18. The cooling system of claim 17, wherein the
first flow path is formed to pass through a first inlet, a
wet channel of the evaporative cooler, and a first outlet,
and

15 the second flow path is formed to pass through a
second inlet, a dry channel of the evaporative cooler, the
gas-liquid contact portion, and a second outlet.