

Improved Chiller and Method of Use

Field of the Invention

- 5 The invention relates to the chilling of water for a district cooling system, or other such application where the provision of chilled water is required.

Background

- 10 Chiller design involves the balance between energy usage, maximisation of chilled water supply and foot print of the chiller, particularly where space is critical.

Chillers require a substantial amount of energy, for both the application of cold energy to the water passing through, as well as the actual pumping costs for high volumes.

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It would therefore be advantageous to have a chiller system that could be varied to optimise critical parameters, based upon varying end user requirements.

Summary of Invention

- 20 For large flow rates, where the temperature differential is small, the ability to rapidly chill the water requires both residence time within the chiller, as well as significant energy to pump the water through the chiller to effect the heat transfer.

- In a first aspect, the invention provides a system for chilling a supply of water, the system
25 comprising; a chilling chamber with at least two portions in selective fluid communication; an inlet for receiving a water supply and directing said water supply into a first end of a first of said portions; a two way conduit assembly for selectively operating as an inlet, arranged to

receive the water supply and directing said water supply into a first end of a second of said portions, or operating as an outlet arranged to direct flow from the first end of the second of said portions; a selectively operable outlet arranged to direct flow from a second end of the chamber; wherein the two portions are in fluid communication proximate to the second end of the chamber, and the system is arranged to selectively operate in at least two modes; a second mode having the outlet closed and the two way conduit assembly arranged to drain water from the first end of the second portion, such that water flows from the first portion inlet into the first end of first portion to the first end of the second portion, and is drained by the two way conduit assembly, and; a first mode having the outlet open and the two way conduit assembly arranged to direct water into the first end of the second portion, such that water flows from the first portion inlet into first end of the first portion and from the two way conduit assembly into the first end of the second portion, said water drained by the outlet from the second end of the chamber.

15 In a second aspect, the invention provides a method for chilling a supply of water, the method comprising the steps of; providing a chilling chamber with at least two portions in selective fluid communication, said chamber including an inlet and an outlet; a two way conduit assembly for selectively operating as an inlet or operating as an outlet; wherein the two portions are in fluid communication proximate to a second end of the chamber, and the system is arranged to selectively operate in at least two modes; selecting a second mode, including closing the outlet, and so, flowing water from the first inlet into a first end of first portion to a first end of the second portion, and draining the water through the two way conduit assembly, or; selecting a first mode, including opening the outlet, and so, flowing water from the first inlet into the first end of the first portion and flowing water from the two way conduit assembly into the first end of the second portion, so as to drain water from the outlet from the second end of the chamber.

In a third aspect the invention provides a system for chilling water, the system comprising: a chamber for receiving a supply of water, said chamber arranged to chill said water and then release said chilled water; wherein the chamber is selectively convertible from a first mode to a second mode, such that; in the first mode, the chamber is arranged such that the inlet flow

rate is higher than an inlet flow rate in the second mode; the chamber arranged to output said water through a first outlet in the first mode, and through a second outlet in the second mode.

Accordingly, by having a two-way conduit assembly applied to a chilling chamber, and selectively operable inlet and outlet, the ability to switch between a one pass and two pass mode, allows for the system to provide flow rates requirements whilst balancing temperature targets of the chilled water. The chiller system according to the present invention may operate more efficiently in both high and low demand periods as compared to prior art systems.

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Brief Description of Drawings

It will be convenient to further describe the present invention with respect to the accompanying drawings that illustrate possible arrangements of the invention. Other arrangements of the invention are possible and consequently, the particularity of the accompanying drawings is not to be understood as superseding the generality of the preceding description of the invention.

Figure 1A to 1C are schematic views of a chiller system according to one embodiment of the present invention; and

Figure 2A to 2B are isometric views of a chiller system according to a further embodiment of the present invention.

Detailed Description

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Figures 1A to 1C show schematic views of a chiller system according to the present invention. This schematic arrangement excludes the necessary ancillary features that an actual system will have in place, and so only show those features that are required by the system.

An actual system, for instance, may have an evaporator, as the chilling chamber, and a condenser unit. Pipe work connecting the supply flow to the chamber and for draining the chilling chamber have been excluded, as too have the necessary valves to make the components “selectively operable”.

To this end, Figure 1A shows a chilling system 5 in a basic form. The system 5 includes a chilling chamber 10, being internally divided into a first portion 25 and a second portion 30. The two portions 25, 30 are in fluid communication 20, which may be a simple void, or selectively openable orifice. Selectively openable may be through operator control or automatic control. It may also be pressure driven such as being arranged to open when a differential pressure exists across the orifice. As will be explained later, in a one-pass mode flow, pressure will be substantially the same across the orifice, whereas with the outlet 45 closed, the two-pass mode will create a positive pressure in the first portion 25 compared to the second portion 30, causing the orifice to open.

As mentioned, the chamber 10 includes a selectively operable outlet 45 at a second end of the portions 25, 30. At the first end of the first portion 25 is an inlet 35, through which the chamber 10 receives an inflow of fluid. In one embodiment, the inflow may be return chilled water, which requires cooling in order to re-enter a district cooling system.

An important feature of the present invention, is the use of a two-way conduit 40 which is selectively operable to act as either an inlet or an outlet. As mentioned for the orifice for the portions, switching between an outlet and an inlet for the two-way conduit assembly may be through operator control, automatic control or by a pressure driven arrangement.

In one embodiment, the two-way conduit assembly 40 may be a single pipe having a valve set, with the conduit switching directions between inlet and outlet depending upon whether the system is in a one-pass mode or two-pass mode. Alternatively, the conduit assembly 40

may be two separate pipes, with one as a dedicated inlet and the other as a dedicated outlet, with the system changing pipes on switching modes.

Figures 1B and 1C act as illustrative examples of how the system 5 switches from a one-pass mode to a two-pass mode.

As discussed, peak demand for chilled water may vary throughout the day, and throughout the year, subject to the end users requirements. One such requirement may require higher volumes of chilled water for residential use during the evening when the end users are at home. However, on hot days, or during off-peak times, ensuring the outgoing temperature corresponds to the design temperature may be preferable.

To this end, the system according to the present invention is capable of selecting:

- i) One-Pass mode (as shown in Figure 1C): Higher flow capacity is achieved by the inflow passing through both portions in parallel, thus doubling the flow capacity;
- ii) Two-Pass mode (as shown in Figure 1B): A greater temperature differential is achieved by having the water pass through the first portion, then returning through the second portion, and thus doubling the residence time increasing the temperature differential.

With reference to the two-pass mode of Figure 1B, the outlet 45 is closed and the two-way conduit 40 switched to an outlet. The inlet 35 receives an inflow 55 and directs this into the first end of the first portion 25. The water flows through the first portion 25, through the fluid communication device 20 and down the second portion 30 to the first end. The two-way conduit 40, acting as an outlet, directs the water flow 65 out of the second portion 30. Thus, water 60 passing through the chamber 10 effectively travels two lengths of the chamber, doubling the residence time.

With reference to the one-pass mode of Figure 1C, the outlet 45 is opened, and the two-way conduit 40 switched to an inlet. Both the inlet 35 and the two-way conduit 40 direct water 70, 75 into the first end of the first and second portions 25, 30, which flow towards the second

end, and are directed out 85 of the chamber 10 through the outlet 45. Thus, the water 80 passing through the chamber travels one length of the chamber, but the volume of water is twice that of the two-pass mode, doubling the flow rate capacity.

- 5 Figures 2A and 2B show an implemented system adopting the present invention according to a further embodiment of the present invention.

10 A chilled water system 95 is shown having an evaporator 105 and condenser 100. The evaporator 105 is split into a first portion 120 and a second portion 115. At a second end of the evaporator 105 is a manifold into which flows water from the two portions 115, 120, which allows water to flow from one portion into the other. The manifold 130 includes an outlet 135.

15 At the first end is located an inlet 140 which receives return chilled water 170 via a pump 180, directing the return chilled water into the first portion 120 at a first end.

20 A two-way conduit assembly 145 is provided at a first end of the second portion 115, with the direction of flow determined by a first valve 157 isolating the two-way conduit from the outflow and a second valve 147 isolating the two-way conduit 145 from the inlet pump 180.

25 For two-pass mode, Figure 2A shows the outlet isolated, and so effectively closed, by a third valve 153 separating the outflow pipe 155 from the outlet pipe 150. The second valve 147 is closed isolating the second portion from the inflow, and the first valve 157 opened placing the two-way conduit 145 in fluid communication with the chilled water supply 160.

As a result, water passes through the inlet 140 through the first and second portions 115, 120 and out the two-way conduit 145. The chilled water is then placed back into the chilled water supply 160.

A by-pass line 165 acts to re-direct excess flow back to the chilled water return, to be pumped back into the evaporator 105.

5 For one-pass mode, Figure 2B shows the third valve 153 opened, opening the outlet 135. The second valve 147 is also opened, providing fluid communication between the pump 180 and the two-way valve 145. The first valve 157 is then closed shutting off the two-way conduit 145 from the outflow. Consequently, the inflow from the chilled water return is directed into the evaporator 105 through both the inlet 140 and the two-way conduit 145.

10 As a result, water passes into the first and second portions 115, 120 simultaneously, and are extracted through the manifold 130 and outlet 135, to be directed to the chilled water supply 160.

15 Thus, the present invention improves on the prior art in that it provides the flexibility to switch between high flow rate capacity, or high residence time for chilling, subject to demand requirements.

Due to the convertible advantage, the use of the present invention may reduce the necessity for multiple redundant chillers. The present invention may operate in two modes and supply
20 two different designated temperature differentials (Δ) chilled water respectively. That is, if there is a need for two backup chillers in order to supply chilled water at two different temperatures, having two temperature differentials, then the present invention may replace the need for separate chillers with only one, using with the present chiller invention, thereby, reducing capital expenditure and maintenance expenses.

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In particular, the present chiller may be used to provide chilled water to air cooling system which include chilled beams.

The chilled beam typically comprises a fin-and-tube heat exchanger, contained in a housing that is suspended from, or recessed in, a ceiling or mounted in the wall. Chilled water passes through the tubes to remove certain sensible cooling load in the room. Meanwhile, an air-conditioning system may still need conventional ACMV to remove the residual sensible load and latent cooling load in the building.

There may be two different temperatures provided by the chilled water supply in a chilled beam air-conditioning system. By way of a non-limiting example, the chilled water supply temperature in a chilled beam may be higher than 13.4°C (Dew point temperature at room temperature 25°C, Relative humidity 55%) which can avoid condensation happening on the pipes connected to each chilled beam and chilled beam surfaces during operation.

A chilled beam is not applicable to a closed environment such as corridors and lobby, which still need conventional ACMV such as AHU/FCU, in which chilled water supply temperature is below 8°C. Accordingly, the whole chiller plant configuration may have two temperature chillers to supply chilled water and each type shall have their own back up chiller respectively. The installation expenditure and maintenance expense will increase substantially as the installation chiller capacity will also increase substantially.

Accordingly, the present chiller may save installation capex and operation maintenance expense due to the one present chiller can standby for two type of chillers alternatively. One standby function for cold water with larger temperature differential to conventional AHUs/FCUs and another standby function for warm water with smaller temperature differential to chilled beam systems alternatively. In one embodiment, the present chiller may work at two pass mode with lower flow rate when it is to provide cold water with larger temperature differential and work at one pass mode with higher flow rate when it is to provide warm water with smaller temperature differential. For instance, the embodiments of Figures 2B and 2A may be operated so as to operate in a one mode at a higher flow rate with lower ΔT (4.5°C-10°C), and another operation mode at a lower flow rate with higher ΔT (4.5°C -13°C).