

Description

This invention relates to evaporative heat and mass exchange apparatus, such as for example cross-flow cooling towers.

Previously in cross-flow cooling towers, where there was a need to balance the two halves of such a tower, or to balance separate units, this was accomplished by placing a butterfly valve in the hot water inlet pipe. However, this system suffered from the disadvantage of adversely affecting the water flow distribution downstream of the valve such that the water flow was non-uniform over the predistribution pan thereby leading to a poor distribution of water to the fill chamber with as a consequence reduced thermal performance. In addition, such a system added significantly to the height of the overall system thus necessitating the separate shipment of the valve parts and field assembly when the oversized unit could not be shipped.

US-A-2961226 discloses an evaporative cooler in which water is fed to a distribution pan by means of a flow control valve. The control valve comprises a cylindrically shaped stationary portion and a concentrically arranged movable portion. The arrangement of this document, however, does not permit uniform distribution of water. US-A-3561487 and DE-C-348029 both disclose valves, for different applications, in which the stationary and movable portions have holes and the flow is controlled by the alignment of these holes. Neither of these arrangements, however, is directed to providing a uniform distribution of water in multiple directions.

Accordingly, the present invention is characterised in that the valve is located within a predistribution pan with said hot water inlet affixed to the top of said predistribution pan, and with a plurality of openings formed in the bottom of said predistribution pan, said stationary portion being fixed to said predistribution pan and both said portions having a height substantially equal to the inside height of the predistribution pan, and in that both said valve portions have holes therethrough, said movable portion being provided with control means for progressive rotation of said movable portion within or about said stationary portion to increase or decrease water flow through those sections of the holes of the stationary and movable portions which are in alignment, to allow water to flow onto the bottom of the predistribution pan through its openings and hence into the gravity distribution system.

An embodiment of the invention will now be described by way of example with reference to the accompanying drawings in which:—

Figure 1 is a cross-sectional view of a typical cross-flow cooling tower.

Figure 2 is an exploded view of a rotary flow control valve in a cooling tower of Fig. 1.

The various flows of the ambient air in, the warmed, humidified air out, the hot water in and the cold water out are shown with bold arrows.

The cooling tower 1 is provided with a fan 2

powered by a motor 28 for causing air movement through the tower system. In this case, the fan and motor are mounted at the top of the unit in a fan housing 3. The fill material 4 provides a large surface area for the water, applied thereto as a spray 10, in order to increase the evaporation rate. Adjacent the fill is a mist-eliminator 5 and louvers 6 to prevent water from splashing outside the tower. The cold water from the fill enters the cold water sump 7 for return to the heat generating system (not shown) and then back to the hot water inlet. At the top of each half of the cooling tower is located the predistribution pan 8 and the water distribution pan 9. In this embodiment the valve is fitted at the outlet of the hot water inlet which feeds the predistribution pan.

Referring now to Figure 2, there is shown an embodiment of the rotary flow control balancing valve, and the predistribution pan and distribution pan with which it is associated. When objects appear in both figures, the same number is used for identification.

In Figure 2, the air flow is shown entering the fill material 4 which provides a large surface area for the maximum evaporation rate. The water is directed to the fill material from the distribution pan 9 which is composed of side member 11 around the perimeter of the pan and a bottom plate 12. The side members and bottom plate are attached together, typically by bolts 23, and usually are provided with sealing means (not shown). To insure the proper distribution of water, the bottom plate 12 is provided with a plurality of openings through which the water is applied to the fill. Generally, the openings are provided with nozzles 24 to generate a spray 10 which helps to assure uniform distribution of the water over the top of the fill 4.

Located close to the distribution pan, usually directly over the distribution pan is the predistribution pan 8. The predistribution pan 8 is provided with a top 15 and a bottom 20, which are attached by bolts 16 or other suitable mounting means. The bottom is provided with a plurality of openings 21 of any desired shape, most typically circular, to evenly distribute the water to the distribution pan 9 below.

Preferably the rotary flow control balancing valve, the predistribution pan and the distribution pan are integrally constructed with the valve integral with and contained within the boundaries of the perimeter of the conventional hot water predistribution pan. In this way the unit can be constructed with minimal addition to the overall height of the unit and the prior necessity of field construction of separately shipped parts can be avoided. By being integral the valve can be constructed without elaborate and expensive seals, because any leakage in the non-sealed valve would merely leak into the predistribution pan where the water is intended to go.

Hot water is provided to the predistribution pan 8 through the hot water inlet 13 which is affixed with a flange 14. The flange/hot water inlet is attached to the top of the predistribution pan 15

with, for example, bolts 25. Generally also, sealing means are provided therebetween to eliminate water escape.

In this embodiment the rotary flow control balancing valve is composed of two cylindrically shaped sections; a stationary section 17 and a concentrically arranged movable internal ring section 18. The valve sections are situated between the top and the bottom of the predistribution pan, taking up substantially the full internal height of the predistribution pan. Usually the stationary section is external to the movable section. The stationary section is mounted to the top and/or bottom of the predistribution pan, but preferably the bottom. Both the stationary and movable sections of the valve have holes or weirs 27 in the sides thereof, through which the full water from the hot water inlet 13 passes. The aggregate area of the holes when the valve is fully opened, is equal to or preferably slightly greater than the cross-sectional area of the hot water inlet 13. The holes may be square, as shown, or they may be of any other desired shape such as circular, oval, triangular and the like. In addition, the holes or weirs in the stationary and movable sections may be congruent and arranged squarely with respect to the surfaces of the predistribution pan as shown, or optionally they may be arranged with a different orientation such as to provide for intersecting square or triangular holes such that the corners of such shapes will intersect to provide for a finer control at flow rate positions of less than fully open valve settings.

The holes or weirs 27 may be arranged uniformly spaced around the perimeter of the valve sections as shown, which will provide for a uniform 360° outward distribution of the hot water over the surface of the bottom of the predistribution pan 20. The pan bottom has affixed thereto a series of baffles 22 which assist in uniformly distributing the water over the bottom surface 20 and into the holes 21.

Alternatively, where the distribution pan 9 or the predistribution pan 8 is of such a shape that exactly 360° uniform water flow is not required, the holes 27 may be arranged about the surfaces of the valve members in a non-uniform manner to direct greater water flow in certain directions and less water flow in other directions. This would be appropriate when the cooling tower distribution basin was of a greatly elongated rectangular shape.

The degree of flow of water through the holes 27 is controlled with the flow control lever 19 which is connected to the movable member 18 of the valve. By moving the flow control lever the movable member 18 is rotated within or about the stationary member 17 so that the holes 27 will be made progressively more or less to match and increase flow or mismatch and block flow. Where the holes, for example initially are fully matched, that is, the valve is fully opened, moving the lever will cause the movable member 18 to progressively cover the holes 27 in the stationary member 17, thus reducing the flow of water

through said holes. The travel of the lever 19 may be restricted to cause it to stop at a predetermined position, either fully closed, that is where the solid portions of the movable member 18 completely cover the holes 27 in the stationary member 17, or the stop may be arranged to allow only flow reduction to a certain specified minimum. An assured minimum flow may be created by stopping the lever 19, before the holes in the stationary member 17 are fully covered, or by having differently shaped holes, or differently arranged holes such that a portion of the holes of both the stationary and movable members always match.

In addition, a locking device 26 is provided such that once the correct balance of the flow rates is obtained, the lever 19 can be secured to prevent any accidental misadjustments. The locking means may be typically thumbscrew or any other convenient means which would secure lever 19.

Thus, there is provided a rotary flow control balancing valve in an associated predistribution box for a gravity feed cross-flow cooling tower. This valve allows the flow at the outlet of a cooling tower hot water pipe to be easily regulated to balance the two halves of a tower with each other or to balance separate towers. The valve allows the circumferentially uniform release of water from the hot water pipe, or may provide for an optional flow arrangement to cause a predicted directionality of water flow.

It is also considered feasible to have a second, separately controlled movable member 18, which may be a separated section of movable member 18, or a multiplicity of concentric movable sections, each separately controlled, with holes suitably arranged so as to provide separate control to a multiplicity of outlets.

It will be appreciated that the rotary flow control valve can also be successfully employed in those evaporative heat and mass exchange apparatus which involve similar water distribution systems such as evaporative condensers, closed circuit fluid coolers, and the like.

Claims

1. An evaporative heat and mass exchange apparatus with a hot water inlet to a gravity water distribution system (9) to a fill material (4) wherein ambient air is forced over the surface of the fill (4) by air distribution means (2) to cause evaporative cooling of the water as it proceeds to the cold water sump, comprising a rotary flow control balancing valve (17, 18) comprising a cylindrically shaped stationary portion (17) and a concentrically arranged movable portion (18), characterised in that said valve (17, 18) is located within a predistribution pan (8) with said hot water inlet affixed to the top of said predistribution pan and with a plurality of openings (21) formed in the bottom of said predistribution pan (8), said stationary portion (17) being fixed to said predistribution pan (8) and both said portions (17, 18) having a height substantially equal to the inside height of the predistribution pan (8), and in



with, for example, bolts 25. Generally also, sealing means are provided therebetween to eliminate water escape.

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It is also considered feasible to have a second, separately controlled movable member 18, which may be a separated section of movable member 18, or a multiplicity of concentric movable sections, each separately controlled, with holes suitably arranged so as to provide separate control to a multiplicity of outlets.

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that both said valve portions (17, 18) have holes (27) therethrough, said movable portion (18) being provided with control means (19, 26) for progressive rotation of said movable portion (18) within or about said stationary portion (17) to increase or decrease water flow through those sections of the holes (27) of the stationary and movable portions (17, 18) which are in alignment, to allow water to flow onto the bottom of the predistribution pan (8), through its openings and thence into the gravity distribution system (9).

2. An evaporative heat and mass exchange apparatus according to claim 1 characterised in that said apparatus is an evaporative condenser with at least one integral valve (17, 18) and predistribution pan (8).

3. An evaporative heat and mass exchange apparatus according to claim 1 characterised in that said apparatus is a closed circuit fluid cooler with at least one integral valve (17, 18) and predistribution pan (8).

4. An evaporative heat and mass exchange apparatus according to claim 1 characterised in that said apparatus is a cross-flow cooling tower with at least one integral valve (17, 18) and predistribution (8).

5. An evaporative heat and mass exchange apparatus according to any of claims 1 to 4 characterised in that said holes (27) are uniformly distributed about the perimeter of said stationary (17) and movable (18) portions.

6. An evaporative heat and mass exchange apparatus according to any of claims 1 to 4 characterised in that said holes (27) are non-uniformly distributed about the perimeter of said stationary (17) and movable (18) portions.

7. An evaporative heat and mass exchange apparatus according to any of claims 1 to 6 characterised in that said holes (27) are the same size and shape on both said stationary (17) and movable (18) portions.

8. An evaporative heat and mass exchange apparatus according to any of claims 1 to 7 characterised in that said holes (27) are rectangular.

9. An evaporative heat and mass exchange apparatus according to any of claims 1 to 6 characterised in that said holes (27) have one shape and size in one portion and another shape and size in the other portion.

10. An evaporative heat and mass exchange apparatus according to any preceding claim characterised in that locking means (26) are provided to secure the position of said movable portion (18).

Patentansprüche

1. Verdampfungswärme- und Massenaustauschgerät mit einem Heißwassereinlauf in ein Schwerkraft-Wasser-Verteilungssystem (9) zu einem Füllstoff (4), worin umgebende Luft mittels eines Luftverteilungsmittels (2) zwecks Verdampfungskühlung des Wassers über die Oberfläche des Füllstoffs (4) geblasen wird, während es zum

Kaltwassersammelbecken fließt, beinhaltend ein Drehdurchflußsteuerventil (17, 18) mit einem zylindrisch ausgebildeten festen Teil (17) und einem konzentrisch angeordneten beweglichen Teil (18), dadurch gekennzeichnet, daß besagtes Ventil (17, 18) sich in einer Vorverteilerschale (8) befindet, daß besagter Heißwassereinlauf oben an dieser Vorverteilerschale (8) befestigt ist und am Boden dieser Vorverteilerschale (8) eine Vielzahl von Öffnungen (21) ausgebildet ist, der feste Teil (17) an dieser Vorverteilerschale befestigt ist und beide Teile (17, 18) im wesentlichen die gleiche Höhe besitzen wie die Vorverteilerschale (8) innen und daß beide Ventiltteile (17, 18) Löcher (27) besitzen, wobei der bewegliche Teil (18) zum Zweck des Weiterdrehens im oder um den festen Teil (17) mit einem Steuermittel (19, 26) ausgestattet ist, um den Wasserdurchfluß durch jene Teile der Löcher (27) des festen und des beweglichen Teils (17, 18), die übereinstimmen, zu erhöhen oder zu senken, damit das Wasser auf den Boden der Vorverteilerschale (8), durch deren Öffnungen und von dort in das Schwerkraftverteilungssystem (9) fließen kann.

2. Verdampfungswärme- und Massenaustauschgerät nach Anspruch 1, dadurch gekennzeichnet, daß besagtes Gerät ein Verdampfungskondensator mit zumindest einem integralen Ventil (17, 18) und einer Vorverteilerschale (8) ist.

3. Verdampfungswärme- und Massenaustauschgerät nach Anspruch 1, dadurch gekennzeichnet, daß besagtes Gerät ein in sich geschlossenes Fluidkühlgerät mit zumindest einem integralen Ventil (17, 18) und einer Vorverteilerschale (8) ist.

4. Verdampfungswärme- und Massenaustauschgerät nach Anspruch 1, dadurch gekennzeichnet, daß besagtes Gerät ein Durchströmkühlturm mit zumindest einem integralen Ventil (17, 18) und einer Vorverteilerschale (8) ist.

5. Verdampfungswärme- und Massenaustauschgerät nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß besagte Löcher (27) über den Umfang des festen (17) und des beweglichen Teils (18) gleich verteilt sind.

6. Verdampfungswärme- und Massenaustauschgerät nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß besagte Löcher (27) nicht gleichmäßig über den Umfang des festen (17) und des beweglichen Teils (18) verteilt sind.

7. Verdampfungswärme- und Massenaustauschgerät nach einem der Ansprüche 1 bis 6, dadurch gekennzeichnet, daß besagte Löcher (27) am festen (17) und am beweglichen Teil (18) sowohl die gleiche Größe als auch die gleiche Form besitzen.

8. Verdampfungswärme- und Massenaustauschgerät nach einem der Ansprüche 1 bis 7, dadurch gekennzeichnet, daß besagte Löcher (27) rechteckig sind.

9. Verdampfungswärme- und Massenaustauschgerät nach einem der Ansprüche 1 bis 6, dadurch gekennzeichnet, daß besagte Löcher (27) in einem Teil die gleiche Form und Größe besitzen und im anderen Teil eine andere Form und Größe.



10. Verdampfungswärme- und Massenaustauschgerät nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß zur Sicherung der Position des besagten beweglichen Teils (18) eine Sperreinrichtung (26) vorgesehen ist.

Revendications

1. Appareil d'échange de chaleur et de masse par évaporation, ayant une entrée d'eau chaude reliée à un circuit (9) de distribution d'eau par gravité dans un matériau de remplissage (4) dans lequel l'air ambiant est chassé à force sur la surface du matériau de remplissage (4) par un dispositif (2) de distribution d'air afin que l'eau subisse un refroidissement par évaporation lorsqu'elle se déplace vers le collecteur d'eau froide, l'appareil comprenant une vanne rotative d'équilibrage (17, 18) et de réglage de débit comprenant une partie fixe (17) de forme cylindrique et une partie mobile (18) placée concentriquement, caractérisé en ce que la vanne (17, 18) est placée dans une cuvette (8) de distribution préalable, l'entrée d'eau chaude étant fixée à la partie supérieure de la cuvette de distribution préalable, plusieurs ouvertures (21) étant formées au fond de la cuvette (8) de distribution préalable, la partie fixe (17) étant fixée à la cuvette (8) de distribution préalable, et les deux parties (17, 18) ayant une hauteur pratiquement égale à la hauteur interne de la cuvette (8) de distribution préalable, et en ce que les deux parties de vanne (17, 18) ont des trous (27) qui les traversent, la partie mobile (18) ayant un dispositif de commande (19, 26) destiné à faire tourner progressivement la partie mobile (18) dans la partie fixe (17) ou autour de celle-ci afin que le débit d'eau dans les parties des trous (27) des parties fixe et mobile (17, 18) qui sont alignées soit augmenté ou réduit, et que l'eau puisse s'écouler sur le fond de la cuvette (8) de distribution préalable, par les ouvertures de celle-ci puis dans le circuit (9) de distribution par gravité.

2. Appareil d'échange de chaleur et de masse par évaporation selon la revendication 1, caractérisé en ce que l'appareil constitue un condenseur

à évaporation ayant au moins une vanne (17, 18) et une cuvette de distribution préalable (8) qui sont solidaires.

3. Appareil d'échange de chaleur et de masse par évaporation selon la revendication 1, caractérisé en ce que l'appareil constitue un refroidisseur de fluide en circuit fermé ayant au moins une vanne (17, 18) et une cuvette de distribution préalable (8) qui sont solidaires.

4. Appareil d'échange de chaleur et de masse par évaporation selon la revendication 1, caractérisé en ce que l'appareil est une tour de refroidissement à circulation croisée ayant au moins une vanne (17, 18) et une cuvette de distribution préalable (8) qui sont solidaires.

5. Appareil d'échange de chaleur et de masse par évaporation selon l'une quelconque des revendications 1 à 4, caractérisé en ce que les trous (27) sont uniformément répartis à la périphérie des parties fixe (17) et mobile (18).

6. Appareil d'échange de chaleur et de masse par évaporation selon l'une quelconque des revendications 1 à 4, caractérisé en ce que les trous (27) sont répartis de manière non uniforme à la périphérie des parties fixes (17) et mobile (18).

7. Appareil d'échange de chaleur et de masse par évaporation selon l'une quelconque des revendications 1 à 6, caractérisé en ce que les trous (27) ont la même dimension et la même configuration dans les parties fixe (17) et mobile (18).

8. Appareil d'échange de chaleur et de masse par évaporation selon l'une quelconque des revendications 1 à 7, caractérisé en ce que les trous (27) ont une forme rectangulaire.

9. Appareil d'échange de chaleur et de masse par évaporation selon l'une quelconque des revendications 1 à 6, caractérisé en ce que les trous (27) ont une première configuration et une première dimension dans une première partie, et une autre configuration et une autre dimension dans l'autre partie.

10. Appareil d'échange de chaleur et de masse par évaporation selon l'une quelconque des revendications précédentes, caractérisé en ce qu'il comporte un dispositif de blocage (26) destiné à fixer la position de la partie mobile (18).



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