

Description

Title of Invention: COOLING TOWER

Technical Field

[0001] The present invention relates to a cooling tower that causes a heat medium in a liquid phase that is to be recycled to perform heat exchange with air at a heat exchange portion and cools the heat medium, and particularly to a cooling tower of a cross flow type.

Background Art

[0002] In general, cooling towers are installed outdoors for the purpose of cooling heat media in a liquid phase such as water to be recycled in plants, air conditioning facilities, and the like. Cooling towers have a mechanism in which air (external air) taken from outside with operation of fans (blowers) and the heat media are caused to perform direct or indirect heat exchange at heat exchange portions inside the cooling towers, thereby cooling the heat media.

[0003] Among these, cooling towers of a cross flow type are devices that sprinkle circulating water, which is a heat medium, from above to fills with layered structures accommodated in tower bodies with square shapes while introducing external air from a lateral side, and cause heat exchange to be performed between crossing

circulating water and external air, and have been widely used.

As an example of the cooling towers of a cross flow type in the related art, there is a cooling tower disclosed in JP 6-307795 A.

Citation List

Patent Literature

[0004]

Patent Literature 1: JP 6-307795 A

Summary of Invention

Technical Problem

[0005] The cooling tower of the cross flow type in the related art has a configuration described in the above patent literature and has a mechanism in which water and external air flow in a crossing manner and thereby perform heat exchange at a fill which is a heat exchange portion.

The fill that is used in the related art in such a cooling tower of the cross flow type has an integrated block form obtained by attaching multiple fill sheets to each other with an adhesive and laminating the fill sheets. The fill having sufficient rigidity as a whole through adhesive integration can be handled as an integrated member as it is, and it is also possible to

dispose the fill in a tower body of the cooling tower without any special consideration.

[0006] However, it has become difficult to employ the laminated integration of the fill sheets by using an adhesive due to problems of a difficulty in securing a time and a space required for adhesive drying and curing processes and a difficulty in handling due to restriction regarding an organic solvent in an adhesive in recent years, and a method of integrating the fill sheets without using any adhesive has thus been proposed.

[0007] However, a fill obtained by applying such a method of not using any adhesive, for example, a method of integrating adjacent fill sheets through fitting of irregularities or welding generally has lower rigidity as compared with the fill integrated by using an adhesive, it is not possible to dispose the fill on the assumption of the rigidity of the fill as in the related art, disposition thereof requires special arrangement, and there is thus a problem that it takes time and effort to dispose the fill in the tower body, which leads to an increase in manufacturing costs.

[0008] The present invention has been made in order to solve the above problem, and an object thereof is to provide a cooling tower capable of facilitating disposition of fills in a tower body and detachment thereof from the tower body in regard to maintenance or the like and reducing costs for works related to the

fills by forming the fills in a multiple-split structure and enabling each split fill to be laterally taken out of and put in the tower body.

Solution to Problem

[0009] A cooling tower according to the present invention is an open cooling tower of a cross flow type which causes air from outside to be laterally distributed from a lateral side of fills through induced draft by a fan while sprinkling circulating water, which is a cooling target, to the fills inside a tower body of the cooling tower and thereby cause heat exchange to be performed between the air and the circulating water at least in the fills, in which the fills are formed by laminating fill sheets and are able to be disposed inside the tower body in an arrangement in which the fills overlap in a plurality of levels in an up-down direction such that a laminated direction is oriented laterally, predetermined support tools projecting outward are provided integrally with the fills at both ends in a sheet laminated direction in each level, one or more sets of support frames provided with grooves into which the support tools for each fill are able to be inserted are disposed at predetermined locations on both sides sandwiching a disposition location of the fills inside the tower body, and each fill is disposed inside the tower body by causing the fill to move from a lateral side of the tower

body at least in a direction in which the groove of the support frame continues with each of the support tools at both ends inserted into each groove of the support frame of the tower body and thereby support the fills by the support frames via the support tools.

[0010]In this manner, according to the present invention, it is possible to effortlessly and reliably support fills in each level, to cause the fills to move from a lateral side of a tower body to a disposition location inside the tower body and to dispose the fills at the disposition location, to easily perform detachment of the fills by pulling them out from the tower body, to improve efficiency of a work related to the fills such as assembly of the cooling tower and maintenance, and thereby reduce costs, since the fills formed through lamination of the fill sheets are adapted to overlap in the plurality of levels in the up-down direction, the support tools integrated with the fills are provided to project on the lateral side of the fills for the fills in each level, the support frames provided with the grooves to allow the support tools to be engaged therewith are disposed at the tower body, and the fills are allowed to move in a groove continuing direction with respect to the support frames with the support tools inserted into the grooves of the support frames on the side of the tower body to cause the support frames to support the fills.

[0011] Furthermore, in the cooling tower according to the present invention, the groove of the support frame corresponding to the support tool for the fill in the lowermost level from among the fills in the plurality of levels is provided such that a height at a groove end portion that is an insertion start position of the support tool is set to a predetermined height at which the fill is able to move along the groove on a side further upward than a position of a lateral end of a lower basin of cooling tower, the groove has a groove shape continuing in a lateral direction from the groove end portion to a position above a disposition location of the fill in the lowermost level inside the tower body, and the groove continuing to the upper position is further expanded downward from the upper position to a position of the support tool for the fill in a state where the fill is disposed at the disposition location, and once the fill in the lowermost level laterally moves from the lateral side of the tower body to inside of the tower body on a side further upward than a position of a lateral end of the lower basin and reaches a place above the disposition location inside the tower body, the support tool is able to be moved to the disposition location positioned below while the support tool is caused to follow the groove expanded part of the support frame, as needed.

[0012]In this manner, according to the present invention, the disposition location of the fill in the lowermost level inside the tower body ranges to the position that is lower than the lateral end portion of the lower basin, and it is possible to effortlessly cause the fill to move along the groove of the support frame and to reliably cause the fill to reach the disposition location inside the tower body even under a condition according to which it is not possible to dispose the fill inside the tower body only by moving the fill in the lateral direction, since the position of the groove from the groove end portion to the place above the disposition location of the fill inside the tower body is set such that the fill can move on the side further upward than the position of the lateral end of the lower basin for the groove of the support frame into which the support tool for the fill in the lowermost level is to be inserted, the groove is further expanded downward to enable the fill integrated with the support tool inserted into the groove to move to the disposition location inside the tower body, and the fill can be disposed in a form in which the fill is dropped into the disposition location inside the tower body when the fill is caused to move downward along the groove expanded part after the fill is caused to move along the groove of the support frame from the lateral side of the tower body and reaches the place above the disposition location inside the tower body.

[0013] Furthermore, in the cooling tower according to the present invention, a penetrating member that penetrates through the laminated fill sheets forming each of the fills in a sheet laminated direction and integrates the fill sheets is provided, and the support tool is coupled to each of both ends of the penetrating member, as needed.

[0014] In this manner, according to the present invention, it is possible to reliably integrate the laminated fill sheets, to maintain the integrated state, and to allow the fill sheets to reliably exhibit a function as the fills, since the penetrating member penetrates through the laminated fill sheets, the penetrating member restrains motion of each fill sheet in a direction perpendicularly intersecting the sheet laminated direction, and a state where the fill sheets are unlikely to shift in the direction perpendicularly intersecting the sheet laminated direction is achieved. In addition, a state where the penetrating member equally supports the weight of each fill sheet is achieved by the support tools engaged with the support frames and supporting the entire fills being coupled to the penetrating member, and it is possible to achieve firm and stable support of the fills without any concentration of a load on a part of the fill sheets.

[0015] Furthermore, in the cooling tower according to the present invention, the support frames are provided with a plurality of grooves into which the support tools are

able to be inserted, on both sides sandwiching the disposition location of the fills in the tower body, such that the fills in all levels vertically overlapping are able to be supported, as needed.

[0016] In this manner, according to the present invention, there is no need to perform a work of preparing and assembling a plurality of corresponding support frames for each fill, and it is possible to reduce time and effort related to disposition of the support frames, to enhance strength of the entire support frame correspondingly to the elimination of the coupling parts between the support frames with the support frames integrated from the beginning, and to appropriately support each fill, since in regard to the support frames disposed on both sides sandwiching the disposition location of the fills in the tower body, the grooves into which the support tools are to be inserted are provided to correspond to all the fills in the plurality of levels, the number of disposed support frames in the tower body is set to only one set, and the fills in the plurality of levels are supported by the one set of support frames.

[0017] Furthermore, in the cooling water according to the present invention, the support frames form continuous bodies with no clearance that collectively cover a lateral side of each of the fills in the plurality of levels and are integrally molded by a water-proofing material, as needed.

[0018] In this manner, according to the present invention, the support frames continuing with no clearance inhibit advancement of water to side further outward than the support frames even in a case where sprinkled water from above flows outside the fills in a cooling tower operating state, and it is possible to reliably prevent leakage and flight of water to the outside of the support frames, by forming the support frames as the integrally molded continuous bodies with no clearance and obtaining a state where the lateral side of the fills in each level disposed inside the tower body is covered.

Brief Description of Drawings

[0019]

[Figure 1] Figure 1 is a partially cut-off front view of a cooling tower according to an embodiment of the present invention.

[Figure 2] Figure 2 is a plan view of the cooling tower according to an embodiment of the present invention.

[Figure 3] Figure 3 is a schematic perspective view of a fill in the cooling tower according to an embodiment of the present invention.

[Figure 4] Figure 4 is a perspective view of a support frame in the cooling tower according to an embodiment of the present invention.

[Figure 5] Figure 5 is an explanatory diagram of a disposition state of the support frame at the time of

assembly of the cooling tower according to an embodiment of the present invention.

[Figure 6] Figure 6 is an explanatory diagram of a disposition start state of the fill in a lower level at the time of the assembly of the cooling tower according to an embodiment of the present invention.

[Figure 7] Figure 7 is an explanatory diagram of a lateral movement state of the fill in the lower level along a support frame groove portion at the time of the assembly of the cooling tower according to an embodiment of the present invention.

[Figure 8] Figure 8 is an explanatory diagram of a downward movement state of the fill in the lower level along the support frame groove portion at the time of the assembly of the cooling tower according to an embodiment of the present invention.

[Figure 9] Figure 9 is an explanatory diagram of a disposition start state of the fill in an upper level at the time of the assembly of the cooling tower according to an embodiment of the present invention.

[Figure 10] Figure 10 is an explanatory diagram of a fill support state in the upper level achieved by the support frame in the cooling tower according to an embodiment of the present invention.

[Figure 11] Figure 11 is an explanatory diagram of a disposition completed state of the fill at the time of

the assembly of the cooling tower according to an embodiment of the present invention.

Description of Embodiments

[0020] Hereinafter, a cooling tower according to an embodiment of the present invention will be described on the basis of Figures 1 to 11 described above.

As illustrated in each of the drawings, a cooling tower 1 according to the present embodiment has a configuration including a tower body 10 that allows circulating water that is a heat medium and air from outside to pass inside, fills 21 and 22 that serve as heat exchange portions and cause circulating water and air to perform heat exchange inside the tower body 10, an upper basin 30 that is disposed above the fill 21, is supplied with the circulating water, and sprinkles the circulating water to each part of the fills 21 and 22, a lower basin 50 that is disposed below the fill 22 and collects the circulating water after passing through the fills 21 and 22, and a water supply conduit 60 that feeds the circulating water extracted from the lower basin 50 and passing a predetermined circulation conduit 95 to the upper basin 30 again, and a fan 70 that is disposed at the upper center of the lower basin 50 and causes air from outside to pass through induced draft between the fill sheets 25 in the fills 21 and 22.

[0021] The cooling tower 1 according to the present embodiment is an open cooling tower of a cross flow type in which the upper basin 30 on the upper side sprinkles circulating water, which is a cooling target, to the fills 21 and 22 as the heat exchange portions inside the tower body 10, air from outside is taken from a lateral side to each of the fills 21 and 22 through induced draft by the fan 70, and heat exchange is caused to be performed between the circulating water and the air with the fills 21 and 22.

[0022] The tower body 10 has a shape surrounding an in-tower space with a rectangular sectional shape, and has a configuration in which two sets of fills 21 and 22 are disposed therein to face each other with a ventilation space portion at the center sandwiched therebetween, air from outside is taken by two side surfaces in a positional relationship in which the side surfaces face the fills 21 and 22 in each set, and air after the heat exchange with the fills 21 and 22 is discharged from the upper center.

Note that a configuration of each part other than the support structure of the fills 21 and 22 in the tower body 10 is similar to that in a tower body of a known open cooling tower of a cross flow type, and detailed description will thus be omitted.

[0023] Each support frame 15 for supporting each of the fills 21 and 22 is disposed at a predetermined part on

both sides sandwiching the disposition location of the fills 21 and 22 in the tower body 10. These support frames 15 are configured as substantially plate-shaped continuous bodies with no clearance that collectively cover a lateral side of each of upper and lower fills 21 and 22 and are integrally molded by a water-proofing material, such as FRP. Such support frames 15 are provided with grooves 16 and 17 that are used for attachment/detachment and support of each of the fills 21 and 22 such that the grooves 16 and 17 continue at least in the lateral direction for each of the fills 21 and 22, and the support frames 15 can support the two upper and lower fills 21 and 22.

[0024] There is no need to perform a work of preparing and assembling a plurality of support frames corresponding to each of the fills 21 and 22 by supporting the two upper and lower fills 21 and 22 with one set of support frames 15 in this manner, and it is thus possible to reduce time and efforts related to disposition of the support frames at the tower body, to enhance strength of the entire support frames correspondingly to elimination of coupling parts between the support frames with the support frames integrated from the beginning, and to more appropriately support each of the fills 21 and 22.

[0025] The fills 21 and 22 are formed by integrating multiple fill sheets 25 with substantially plate shapes

in a laminated state and are horizontally disposed inside the tower body 10 with the support frames 15 positioned on both sides of the laminated direction in an arrangement of overlapping in two levels in the up-down direction. Due to the arrangement in two levels, the fill in the uppermost level is the fill 21 in the upper level, and the fill in the lowermost level is the fill 22 in the lower level.

[0026] Predetermined support tools 27 projecting outward are provided at both ends of the fills 21 and 22 in the sheet laminated direction. Each support tool 27 can be inserted into the groove 16 or 17 of the support frames 15 disposed at the tower body 10. Each of the fills 21 and 22 is configured to be supported by the support frames 15 via the support tools 27 by inserting the support tools 27 at both ends into the grooves 16 and 17 of the support frames 15 and causing the support tools 27 to be engaged therewith.

[0027] Furthermore, each of the fills 21 and 22 is provided with a penetrating member 28 that penetrates, in the sheet laminated direction, the laminated fill sheets 25 forming the fills. The support tool 27 is coupled to each of both ends of the penetrating member 28, and the penetrating member 28 is integrated with the fills 21 and 22 (see Figure 3).

[0028] It is possible to integrate each fill sheet 25 as the fills 21 and 22 and to impart sufficient rigidity

with which the fills are unlikely to be deformed even with the structure in which no adhesion is made between the sheets, by the penetrating members 28 and the support tools 27 restraining each fill sheet 25 not to move in the laminated direction and by the penetrating members 28 restraining each fill sheet 25 in the direction perpendicularly intersecting the laminated direction as well.

[0029] Each of such fills 21 and 22 are disposed inside the tower body by being laterally moved from the lateral side of the tower body 10 while being supported by the support frames 15 via the support tools 27 with the support tools 27 at both ends inserted into the grooves 16 and 17 of the support frames 15 of the tower body 10.

[0030] Note that the support tool 27 for the fill 21 in the upper level is inserted into the groove 16 in the upper level of the support frame 15, and the support tool 27 for the fill 22 in the lower level is inserted into the groove 17 in the lower level of the support frame 15 for the grooves 16 and 17 of the support frame 15.

[0031] For the groove 17 corresponding to the support tool 27 for the fill 22 in the lower level in such a support frame 15, the height of the groove end portion that is an insertion start position of the support tool 27 is set to a predetermined height at which the fill 22 can move on the side further upward than the position of the lateral end of the lower basin 50.

[0032] Furthermore, the groove 17 has a groove shape continuing in the lateral direction from the groove end portion to an upper position above the disposition location of the fill 22 in the lower level inside the tower body and is configured such that the groove continuing to the upper position is further expanded downward from the upper position to the position of the support tool 27 for the fill 22 in a state where the fill 22 is disposed at the disposition location.

[0033] Additionally, the fill 22 in the lower level laterally moves from the lateral side of the tower body 10 to the inside of the tower body on a side further upward than the position of the lateral end of the lower basin 50, and can move the support tools 27 to the disposition location positioned below while causing the support tools 27 to follow the groove expanded parts of the support frame 15 once the fill 22 reaches the upper position above the disposition location of the fill 22 inside the tower body.

[0034] The other configuration of each part as the heat exchange portion in the fills 21 and 22 in regard to the point that heat exchange is caused to be performed between the circulating water flowing down along each fill sheet 25 and the air flowing in the direction perpendicularly intersecting the flowing-down direction of the circulating water through the clearance between the fill sheets 25 are similar to that of the fills in

the known open cooling tower of the cross flow type, and detailed description will thus be omitted.

[0035] The upper basin 30 is formed into a shallow box shape having multiple small holes at the bottom portion and is adapted to be disposed at a position above each of the fills 21 and 22 at the upper portion of the tower body 10. The upper basin 30 has a known configuration in which the upper basin 30 is connected to the water supply conduit 60, is supplied with the circulating water that has exited the lower basin 50 and has passed through the circulation conduit 95 connected to a refrigerator, an air conditioning device, and the like, and uniformly drips and dispenses the circulating water from the multiple holes at the bottom portion toward each part of the fill 21 positioned below by a predetermined amount of water, and detailed description will thus be omitted.

[0036] The lower basin 50 is disposed above a basin reinforcing frame 51 that is fixedly installed below the tower body 10, is adapted to receive, temporarily store, and collect the circulating water that has flowed down, and has a known configuration that allows each of a water supply portion (not illustrated) for supplementary water to be fed when the circulating water decreases, the circulation conduit 95 that causes the circulating water to flow into and out of the cooling tower, and the like to be connected thereto and that can store a

predetermined amount of circulating water, and detailed description will thus be omitted.

[0037] A strainer 57 is provided at an exit of water advancing to the circulation conduit 95 of the lower basin 50 and separates foreign matters such as scales precipitated in the water such that only the circulating water is distributed through the circulation conduit 95.

[0038] The water supply conduit 60 is provided inside the tower body 10 as a conduit that supplies, to the upper basin 30, the circulating water that has been refluxed to the cooling tower 1 through the circulation conduit 95.

Note that the fan 70 is a known fan that is disposed at an upper center of the tower body 10, laterally introduces air from outside to each of the fills 21 and 22 through induced draft via the ventilation space portion positioned below the fan 70, blows out upward the air that has passed through the fills 21 and 22, and discharges the air to the outside of the tower body 10, and detailed description will thus be omitted.

[0039] Next, a process of disposing the fills inside the tower body of the cooling tower according to the present embodiment will be described.

As an assumption, the tower body 10 of the cooling tower 1 is in a state where a column serving as a main part of the tower body 10 and a side portion outer plate 12 are assembled on the upper side of the lower basin 50 integrated with the basin reinforcing frame 51 and the

support frames 15 are disposed on both sides sandwiching the disposition location of the fills inside the tower body (see Figure 5).

[0040] Each of the fills 21 and 22 are in an integrated state with no adhesion made between adjacent sheets by the penetrating members 28 penetrating through the laminated fill sheets 25 forming the fill in the sheet laminated direction and the support tools 27 coupled to each of both ends of the penetrating members 28.

[0041] The fill 22 in the lower level out of such fills 21 and 22 is disposed first inside the tower body. First, the fill 22 is caused to laterally move from the lateral side of the tower body 10 to the inside of the tower body with the support tools 27 at both ends of the fill 22 inserted into each groove 17 of the support frames 15 of the tower body 10 and thereby achieve a state where the fill 22 is supported by the support frames 15 via the support tools 27 (see Figures 6 and 7).

[0042] The disposition location of the fill 22 in the lower level inside the tower body is right above the lower basin 50, and the lower end of the disposition location is lower than the position of the lateral end of the lower basin 50. Due to the presence of the lateral end portion of the lower basin 50, a structure in which the fill 22 cannot be caused to reach the disposition location inside the tower body only by causing the fill 22 to laterally move.

[0043] However, the grooves 17 of the support frames 15 are set at the predetermined height at which the fill 22 can move on the upper side than the position of the lateral end of the lower basin 50, and have a groove shape continuing in the lateral direction from the groove end portion to the upper position of the disposition location of the fill 22 in the lower level inside the tower body (see Figure 7).

[0044] Therefore, it is possible to cause the fill 22 in the lower level to laterally move from the lateral side of the tower body 10 to the inside of the tower body on the upper side than the position of the lateral end of the lower basin 50 and to cause the fill 22 in the lower level to reach the upper position of the disposition location of the fill 22 inside the tower body when the fill 22 in the lower level is caused to move in a way that the support tools 27 follow the grooves 17.

[0045] Moreover, the grooves 17 are further expanded downward from the upper position to the positions of the support tools 27 at both ends of the fill 22 in a state where the fill 22 is disposed at the disposition location of the fill 22 inside the tower body (see Figure 8).

In this manner, it is possible to cause the fill 22 in the lower level to move further downward such that the support tools 27 follow the parts expanded downward of the grooves 17 after causing the fill 22 in the lower level to reach the upper position, and to cause the fill

22 to reach the disposition location inside the tower body, which is a target position.

[0046] After the fill 22 in the lower level is disposed at an accurate disposition location inside the tower body, then the support tools 27 at both ends of the fill 21 are inserted into the corresponding grooves 16 of the support frames 15 to obtain a state where the fill 21 is supported by the support frames 15 via the support tools 27, and the fill 21 is caused to laterally move from the lateral side of the tower body 10, as a process of disposing the fill 21 in the upper level inside the tower body (see Figure 9).

[0047] The grooves 16 corresponding to the support tools 27 for the fill 21 in the upper level in the support frames 15 are set at a predetermined height at which the fill 21 can move on the upper side than the fill 22 in the lower level that has already been disposed, and have a groove shape continuing in the lateral direction from the groove end portion to the positions of the support tools 27 at both ends of the fill 21 in a state where the fill 21 is disposed at the disposition location of the fill 21 inside the tower body.

In this manner, it is possible to cause the fill 21 in the upper level to reach the disposition location of the fill 21 inside the tower body which is a target position when the fill 21 in the upper level is caused to

laterally move from the lateral side of the tower body 10 to the inside of the tower body.

[0048] In each of the fills 21 and 22, by the penetrating members 28 and the support tools 27 restraining each fill sheet 25 not to move in the laminated direction and by the penetrating members 28 restraining each fill sheet 25 not to move in the direction perpendicularly intersecting the laminated direction as well, it is possible to integrate each fill sheet 25 as the fills 21 and 22 even with the structure in which adhesion is not made between the sheets, and sufficient rigidity with which the fills are unlikely to be deformed is imparted. Therefore, it is possible to integrally handle the fills with no problems in handling related to the disposition of each of the fills 21 and 22 inside the tower body 10 and to efficiently perform the disposition work.

[0049] Furthermore, the penetrating members 28 engaged with each fill sheet 25 are coupled to the support tools 27 so that the penetrating members 28 equally support the weight of each fill sheet 25, and it is thus possible to obtain firm and stable support of the fills 21 and 22 via the support tools 27 with no concentration of a load on a part of the fill sheets 25. In addition, even if a force is applied to a part of the fill sheets 25 in the course of the disposition process, for example, the fill sheets 25 are not separated or deviated from each other, and

satisfactory easiness in handling the fills is also achieved.

[0050] As illustrated in Figure 11, members such as a beam forming a part of the tower body are attached as needed, and internal piping and the upper basin 30 are attached, similarly to the known cooling tower assembly process after the fills 21 and 22 are disposed inside the tower body. Then, protective members such as louvers covering the fills are attached to side surfaces of the tower body 10 from which the fills 21 and 22 are exposed, the fan 70 is finally attached to the upper portion of the tower body, and the cooling tower is thereby brought into a completed state.

[0051] Next, an operating state of the cooling tower according to the present embodiment will be described.

The circulating water as a heat medium distributed through the circulation conduit 95 including the cooling tower 1 receives heat through the refrigerator, the air conditioning device, and the like that are present in the path of the circulation conduit 95, raises its temperature, and reaches the cooling tower 1 in an ordinary cooling tower running state similarly to the known cooling tower. The circulating water that has been returned to the cooling tower 1 first enters the water supply conduit 60 inside the tower body 10 and is directed to the side of the upper basin 30 through the conduit.

[0052] The circulating water that has been introduced into the upper basin 30 via the water supply conduit 60 passes through each hole at the bottom portion of the upper basin 30 for a predetermined period of time, is dripped and dispensed to each part of the fill 21 positioned below, and reaches the fill 21. Note that the support frames 15 provided on both sides of the fill 21 to sandwich the fill 21 have upper portions reaching the lateral side of the upper basin 30, such that water dripped and sprinkled from the upper basin 30 does not cross over the support frames 15 and advance to the outside thereof.

[0053] The circulating water that has reached the fill 21 in the upper level advances each clearance between the fill sheets 25 forming the fill 21, flows down along the fill sheets 25, and comes into contact with air from outside introduced in the lateral direction into the fill 21 through induced draft by the fan 70. The circulating water is cooled by a cooling effect caused mainly by heat transmission (sensible heat) that accompanies a temperature difference between the air and the circulating water and a cooling effect caused by evaporation heat (latent heat) of the circulating water and raises the air temperature on the contrary through heat exchange.

[0054] The circulating water is cooled through the heat exchange with the air in the fill 21 in the upper level,

then reaches the fill 22 in the lower level, advances to each clearance between the fill sheets 25 forming the fill 22 similarly to the upper level, flows down along the fill sheets 25, and comes into contact with air from outside introduced in the lateral direction into the fill 22 through induced draft by the fan 70. The circulating water is cooled by a cooling effect caused mainly by heat transmission (sensible heat) that accompanies a temperature difference between the air and the circulating water and a cooling effect caused by evaporation heat (latent heat) of the circulating water and raises the air temperature on the contrary through heat exchange.

[0055] When the circulating water reaches the fills 21 and 22 from the upper basin 30 and flows down, the support frames 15 inhibit advancement of the circulating water to the side further outward than the support frames 15, and leakage and flight of the water to the outside of the cooling tower 1 can be curbed, even in a case where the circulating water sprinkled from above flows through the outside of the fills 21 and 22 since the support frames 15 which are continuous bodies with no clearance are located on lateral sides of the fills 21 and 22.

[0056] The circulating water is cooled through heat exchange with the air at the fill 22 and reaches the lower basin 50 in which the circulating water is collected. The circulating water stored in the lower

basin 50 passes through the strainer 57 at the exit of the lower basin, enters the circulation conduit 95 again, newly receives heat at the refrigerator, the air conditioning device, and the like as a heat medium, returns to the cooling tower 1, and enters the water supply conduit 60, and the above procedure is repeated.

[0057] On the other hand, the air at a temperature raised through the heat exchange with the circulating water laterally passes through the clearance between fill sheets 25 forming the fills 21 and 22 through attraction of the fan 70. The air that has passed between the fill sheets 25 and has exited the fills 21 and 22 is discharged to the outside of the cooling tower by the fan 70, and the discharged air is spread to the air from the outside.

[0058] The laminated fill sheets 25 forming each of the fills 21 and 22 are reliably integrated and the integrated state can be maintained by causing the penetrating members 28 to pass through the fill sheets 25 of each of the fills 21 and 22 and coupling the support tools 27 to both end portions of the penetrating members 28 to hold the laminated fill sheets 25, and the fills 21 and 22 can thus stably exhibit their functions when the cooling tower 1 is used.

[0059] Note that although the case where the single cooling tower 1 is used alone has been described in the present embodiment, a similar configuration can also be

employed in another case where a plurality of cooling towers are coupled in an aligned manner, disposition of the side portion outer plate of the tower body at the location sandwiched between the tower bodies is omitted, and the cooling towers are used in a state where the ventilation space portions at the center of the tower bodies are communicated with one another. In such a case where the plurality of cooling towers are provided in parallel, the support frames are located between the fills of the adjacent cooling towers, serve as a kind of partitioning plates, prevent leakage of air between the fills that are adjacent to each other with the support frames sandwiched therebetween, and can curb degradation of heat exchange efficiency.

[0060] In this manner, in the cooling tower according to the present embodiment, the fills 21 and 22 formed through lamination of the fill sheets 25 are adapted to overlap in the plurality of levels in the up-down direction, the support tools 27 integrated with the fills are provided to project on the lateral side of the fills for the fills 21 and 22 in each level while the support frames 15 provided with the grooves 16 and 17 to allow the support tools 27 to be engaged therewith are disposed at the tower body 10, and the fills 21 and 22 are allowed to move in a continuing direction of the grooves 16 and 17 with respect to the support frames 15 with the support tools 27 inserted into the grooves 16 and 17 of the

support frames 15 on the side of the tower body to cause the support frames 15 to support the fills 21 and 22. Therefore, it is possible to effortlessly and reliably support the fills 21 and 22 in each level, to cause the fills 21 and 22 to move from the lateral side of the tower body to the disposition location inside the tower body along the grooves 16 and 17 and to dispose the fills 21 and 22 at the disposition location, to easily perform detachment of the fills 21 and 22 by pulling them out from the tower body 10, to improve efficiency of a work related to the fills 21 and 22 such as assembly of the cooling tower and maintenance, and thereby reduce costs.

[0061] Note that although the fills 21 and 22 are provided in the two upper and lower levels in the cooling tower according to the above embodiment, this is not restrictive and it is also possible to employ a configuration in which a plurality of, namely three or more fills are provided in accordance with a cooling ability of the cooling tower and the size of the cooling tower according to the cooling ability.

[0062] Moreover, although the lower end position of the disposition location of the fill 22 in the lowermost level inside the tower body is lower than the position of the lateral end of the lower basin 50, and correspondingly, a configuration in which the lower grooves 17 in the support frames 15 are formed in a groove shape continuing in the lateral direction from the

groove end portion at the predetermined height to the upper position above the disposition location of the fill 22 inside the tower body and then expanding further downward is employed in the cooling tower according to the above embodiment. In a case where the lateral end portion of the lower basin is located further downward than the disposition location of the fill in the lowermost level inside the tower body, another groove shape in which the grooves in the support frames corresponding to the fill in the lowermost level having a groove shape simply laterally continuing may also be employed.

[0063] Furthermore, although the support frames 15 are substantially plate-shaped continuous bodies integrally molded with no clearance and are configured such that one support frame 15 can support the two upper and lower fills 21 and 22 and collectively covers the lateral side of each of the upper and lower fills 21 and 22 in the cooling tower according to the above embodiment. This is not restrictive and it is also possible to employ a configuration in which a plurality of parts are combined to form the support frames. For example, even if the sizes of the support frames increase in accordance with a case where the cooling tower has a large scale and the size of the entire fills also increases, it is possible to effortlessly dispose the support frames by assembling the parts with sizes that can be easily handled, and it

is possible to facilitate disposition of the support frames at the tower body as compared with a case where an integrally molded large-scaled support frames are handled.

Reference Signs List

[0064]

- 1 Cooling tower
- 10 Tower body
- 12 Side portion outer plate
- 15 Support frame
- 16, 17 Groove
- 21, 22 Fill
- 25 Fill sheet
- 27 Support tool
- 28 Penetrating member
- 30 Upper basin
- 50 Lower basin
- 51 Basin reinforcing frame
- 57 Strainer
- 60 Water supply conduit
- 70 Fan
- 95 Circulation conduit

Claims

[Claim 1]

An open cooling tower of a cross flow type which causes air from outside to be laterally distributed from a lateral side of fills through induced draft by a fan while sprinkling circulating water, which is a cooling target, to the fills inside a tower body of the cooling tower and thereby cause heat exchange to be performed between the air and the circulating water at least in the fills, wherein

the fills are formed by laminating fill sheets and are able to be disposed inside the tower body in an arrangement in which the fills overlap in a plurality of levels in an up-down direction such that a laminated direction is oriented laterally,

predetermined support tools projecting outward are provided integrally with the fills at both ends in a sheet laminated direction in each level,

one or more sets of support frames provided with grooves into which the support tools for each fill are able to be inserted are disposed at predetermined locations on both sides sandwiching a disposition location of the fills inside the tower body, and

each fill is disposed inside the tower body by causing the fill to move from a lateral side of the tower

body at least in a direction in which the groove of the support frame continues with each of the support tools at both ends inserted into each groove of the support frame of the tower body and thereby support the fills by the support frames via the support tools.

[Claim 2]

The cooling tower according to claim 1, wherein the groove of the support frame corresponding to the support tool for the fill in a lowermost level from among the fills in the plurality of levels is provided such that a height at a groove end portion that is an insertion start position of the support tool is set to a predetermined height at which the fill is able to move along the groove on a side further upward than a position of a lateral end of a lower basin of cooling tower, the groove has a groove shape continuing in a lateral direction from the groove end portion to a position above a disposition location of the fill in the lowermost level inside the tower body, and the groove continuing to the position is further expanded downward from the position to a position of the support tool for the fill in a state where the fill is disposed at the disposition location, and

once the fill in the lowermost level laterally moves from the lateral side of the tower body to inside of the tower body on a side further upward than a position of a lateral end of the lower basin and reaches a place above

the disposition location inside the tower body, the support tool is able to be moved to the disposition location positioned below while the support tool is caused to follow the groove expanded part of the support frame.

[Claim 3]

The cooling tower according to claim 1 or 2, wherein a penetrating member that penetrates through the laminated fill sheets forming each of the fills in a sheet laminated direction and integrates the fill sheets is provided, and

the support tool is coupled to each of both ends of the penetrating member.

[Claim 4]

The cooling tower according to any one of claims 1 to 3, wherein the support frames are provided with a plurality of grooves into which the support tools are able to be inserted, on both sides sandwiching the disposition location of the fills in the tower body, such that the fills in all levels vertically overlapping are able to be supported.

[Claim 5]

The cooling tower according to claim 4, wherein the support frames form continuous bodies with no clearance that collectively cover a lateral side of each of the fills in the plurality of levels and are integrally molded by a water-proofing material.