

FIN AND TUBE HEAT EXCHANGER

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BACKGROUND

5 [0001] The subject invention relates to heat exchangers of the fin-and-tube type with an improved louver configuration.

[0002] Fin-and-tube type heat exchangers are well known in the art. These heat exchangers include a number of fins with heat transfer tubes passing therethrough. The fins typically incorporate a number of louvers to redirect and mix the air flow across the fins to increase the heat transfer between the surfaces of the heat
10 exchanger, which include the surfaces of the fins and the outside surfaces of the tubes, and the air flow. One issue that arises when disrupting the air flow is a pressure drop across the fins. A significant increase in the pressure drop across the fins is the penalty paid for the increased heat transfer.

[0003] Therefore, there is a need for improved louvered fin designs for fin and tube
15 heat exchangers that improve heat dissipation characteristics while reducing pressure drop in fluid flowing across the fin. Those skilled in the art will better understand the present invention from a review of the preferred embodiment and drawings that appear below and the claims that determine the full scope of the invention.

20 SUMMARY OF THE INVENTION

[0004] In accordance with certain embodiments, a cooler for multiple tube banks features a series of parallel and planar fins that have upstream louvers to direct incoming air through a fin near a first row of tubes and a downstream set of louvers near an adjacent tube row to direct air back through the same fin before the air exits.
25 The upstream louvers can have the negative slopes of the downstream louvers, and a constant angle from louver to louver within a bank can be provided. Moreover, a constant length in a section view is also contemplated.

DETAILED DESCRIPTION OF THE DRAWINGS

[0005] These and other features, aspects, and advantages of the present invention will become better understood when the following detailed description is read with reference to the accompanying drawings in which like characters represent like parts throughout the drawings, wherein:

[0006] Figure 1 is a plan view of a single, exemplary fin showing the louver layout and the tube openings;

[0007] Figure 2 is a section through the louvers in Figure 1;

[0008] Figure 3 is an alternative, exemplary embodiment to Figure 1 using louvers of shorter widths and gaps between them in a given bank of tubes;

[0009] Figure 4 is a section view through the louvers of Figure 3;

[0010] Figure 5 is a detail around an opening for a tube; and

[0011] Figure 6 is an alternative, exemplary embodiment to Figure 3 showing a different gap layout in the louvers.

DETAILED DESCRIPTION

[0012] Air coolers are generally known to those skilled in the art. They comprise cooling tubes disposed parallel to each other in rows and the rows being parallel to each other. A collection of fins are generally stacked parallel to each other with a typical, exemplary fin 10 shown in Figure 1. Again, Figure 1 is but a partial view of an exemplary fin for illustrative purposes to show a row of holes 12, 14, 16 and 18 for receiving tubes therethrough. A second parallel row of holes 20, 22, 24 and 26 for receiving tubes is also shown. Edge 30 is the upstream or air inlet edge and edge 32 is the downstream or air outlet side. Advantageously, each illustrated edge has a series of bent triangular shapes 34 to add to the rigidity of the edges.

[0013] The upstream louvers are generally 36 and the downstream louvers are generally 38. These two louver banks 36, 38 align generally with a row of tubes.

This forces air that comes in between openings 24 and 26 to work its way around opening 16 since the tubes (not shown) that go in their respective holes are offset from one row to the next. The louvers can be punched out of the fin 10. As illustrated, they all extend above and below a fin but variations can be used where
5 some or all louvers in the upstream bank 36 extend only from the top and some up to all louvers in bank 38 extend only from the bottom.

[0014] Now looking at Figure 2, the orientation of the upstream louvers 36 and the downstream louvers 38 can more clearly be seen. As illustrated, both banks are at a common angle 40, such as 25°, with respect to fin 10 but in mirror image. As a
10 result, the slope of the louvers in bank 36 is the negative of the louver slope in bank 38. The louvers in bank 36 extend above and below the planar surface of the fin 10, although some to all of the louvers could extend toward the region marked top in Figure 2. In bank 38 the louvers extend above and below the planar surface of fin 10 but optionally some to all the louvers there could extend only in the region marked
15 bottom in Figure 2. As illustrated, the angle of inclination of each louver in a bank such as 36 or 38 is the same or close to the same as an adjacent louver in that bank. However, this inclination angle of the louvers within each bank may vary with respect to one another, if desired. The total dimension of the louver in a bank, as seen in Figure 2, is the same or nearly the same, and this dimensioning may carry
20 forward as being the same or nearly the same as between different banks that have negative slopes with respect to one another. However, it is worth noting that banks having varying dimensioning, with respect the banks and within the banks, are envisaged.

[0015] The desired effect at a single fin 10 is in part illustrated in Figure 2. Air that
25 comes in over edge 30 is shown entering in part by arrow 42. After engaging the louvers, it flows through them and toward the region labeled bottom where it can mix with entering air (arrow 44) coming in below fin 10. Some of the air stream 42 continues parallel to fin 10 as indicated by arrow 46. Eventually a portion of stream 44 that originated below fin 10 and parts of stream 42 directed below fin 10 engage
30 the louvers in bank 38 and go back up above fin 10 (as indicated by arrow 48) now in general alignment with the cooling tubes (not shown) in openings 12-18. While flow

around a single fin 10 is illustrated, those skilled in the art will appreciate that there are a plurality of fins like 10 above and below it whose spacing can be optimized to alter the tip to tip gap of louvers of adjacent fins thus regulating how big a portion of the incoming stream to a particular fin can pass straight through in the direction of arrow 44. Moreover, the width of the aperture defined by each louver or the width of each louver itself may be varied or maintained constant. Additionally, flow through the louvers from above represented by arrow 42 goes below the fin to make turbulent flow with the stream trying to get past under the louvers in bank 36. Similarly, any flow represented by arrow 46 has to mix with flow passing down through louvers in the next fin above fin 10. Thereafter as zone 50 is crossed, stream 46 encounters stream 48 coming up from below fin 10 for further mixing. These effects are repeated as between the pairs of adjacent fins 10. Spacers 5, which extend from the fin 10 surface to facilitate spacing of adjacent fins, can be optionally used in zone 50, for example. (See Figure 1.) With respect to the orientation of FIG. 2, the first bank of louvers 36 are said to have a positive slope, while the second bank of louvers 38 have a negative slope, with the fin 10 defining the X-axis and with the Y-axis extending through a location between the first and second banks of louvers.

[0016] Figures 3 and 4 represent an alternative embodiment that in most ways is the same as Figures 1 and 2. One difference can be seen in banks 36' and 38'. Starting from edge 30', breaks 52 and 54 are illustrated as converging away from edge 30', in effect creating shorter louvers measured in a direction perpendicular to the incoming air as indicated by arrow 42'. In the same bank 36' two more breaks 56 and 58 diverge in the direction of incoming air shown by arrow 42'. Bank 38' can have the same treatment but offset from bank 36' due to the layout of the cooling tubes.

Using shorter widths of leading and trailing louvers in a given bank tends to make such louvers stiffer and distort less when subjected to air flow conditions. An alternative is shown in Figure 6 where a break 59 is aligned with the direction of air flow and with the tube in the bank behind it passing through, for example opening 16. Bank 38 can also have such breaks such as 61 that align with an opening such as 22 that is in front of it. Indeed, a variety of configurations for the breaks, such as convergence and divergence and angles therefor, are envisaged. Furthermore, Figure

4 shows that openings such as 12' and 20' have raised flanges 60 and 62. Flanges 60 and 62 also act to maintain a predetermined distance between parallel fins.

Optionally, spacers 64 shown in Figure 3 and disposed between rows of holes can also be used to maintain the separation distance between fins 10. Referring to Figure 5, a section through raised opening 66 is shown. It has a flange 68 spaced from and generally parallel to the plane of fin 10. A protrusion 70 is in or near the plane of the fin 10 and prevents warping of the fin 10 when a tube (not shown) is expanded into sealing contact with an opening such as 12.

[0017] Those skilled in the art will appreciate that changes can be made in the optimization process. What is optimized is a collection of variables that relate to cost, pressure drop, overall size and thermal performance. Commonality of patterns such as louver dimensions and angles saves cost; hence the preferred embodiment emphasizes such patterns. In the present invention the mixing of the air stream in an over, under and back to over pattern helps the thermal performance. Using planar fins saves cost. Spreading out the over, under and over pattern through two or more rows of tubes also promotes thermal performance and saves cost. The Figure 3 and 6 designs add strength to some of the louvers and reduce distortion from flexing or vibration from air flow and to some extent reduces pressure drop of the air.

[0018] Again, the above description is illustrative of exemplary embodiments, and many modifications may be made by those skilled in the art without departing from the invention whose scope is to be determined from the literal and equivalent scope of the claims below.

CLAIMS:

1. A heat exchanger, comprising:

a plurality of rows of tubes intersecting a plurality of substantially planar fins, said fins further comprising a top and bottom side and an upstream bank of louvers to initially receive fluid to be cooled and a downstream bank of louvers adjacent said upstream bank of louvers, said louvers configured to direct fluid from the top of a fin to the bottom of that fin and back to the top of said fin as the fluid passes along said fin past at least two said rows of tubes, wherein the slope of louvers in said upstream bank has the negative slope of louvers in said downstream bank.

2. The heat exchanger of claim 1, wherein: wherein at least one louver in both said banks extend above said top and below said bottom of said fin.

3. The heat exchanger of claim 1, wherein: all louvers in said upstream or downstream bank extend an equal distance from said top or bottom of said fin.

4. The heat exchanger of claim 1, wherein: said louvers in said upstream bank extend only from the said top of said fin.

5. The heat exchanger of claim 1, wherein: said louvers in said downstream bank extend only from said bottom of said fin.

6. The heat exchanger of claim 1, wherein: said louvers are formed integrally with said fin.

7. The heat exchanger of claim 1, wherein: said fins comprise raised openings to accept said tubes and said raised openings space adjacent fins at a predetermined distance from each other.

8. The heat exchanger of claim 1, wherein: at least one end of said fins is bent out of the plane of said planar fins to provide strength to said end.

9. The heat exchanger of claim 8, wherein: said end is corrugated.

10. The heat exchanger of claim 1, wherein: at least one louver in a bank extends either from said top or said bottom of said fin.

11. The heat exchanger of claim 1, wherein: all louvers in either of said banks are parallel to each other.

12. The heat exchanger of claim 1, wherein: at least some said louvers in at least one of said banks define at least one break within at least one row of a plurality of rows of louvers that form said bank.

13. The heat exchanger of claim 12, wherein: said at least one break comprises a plurality of breaks that converge as fluid enters said bank and diverge as fluid exits that bank.

14. The heat exchanger of claim 1 wherein: said banks are spaced apart on said fin and spacers to separate said fins are disposed between said banks.

15. The heat exchanger of claim 7, wherein:

said raised opening defines a flange substantially parallel to said fin and a protrusion in or adjacent the plane of said planar fin.

16. A heat exchanger, comprising:

a first plurality of louvers defining a first row crosswise to an air flow direction, wherein all of the first plurality of louvers having a first slope;

a second plurality of louvers defining a second row crosswise to the air flow direction and downstream from the first row, wherein all of the second plurality of louvers have a second slope different from the first slope;

a first plurality of tubes extending through only the first row crosswise to the air flow direction, wherein each tube of the first plurality of tubes has only one passage; and

a second plurality of tubes extending through only the second row crosswise to the air flow direction, wherein each tube of the second plurality of tubes has only one passage.

17. The heat exchanger of claim 16, wherein the first slope is positive and the second slope is negative, or the first slope is negative and the second slope is positive.

18. The heat exchanger of claim 16, wherein each tube of the first plurality of tubes is offset with respect to each tube of the second plurality of tubes.

19. The heat exchanger of claim 16, wherein each tube of the first plurality of tubes is aligned with each tube of the second plurality of tubes.