A tubular heat exchanger having a fluid flow tube with transverse minor and major dimensions and an elongated agitator fin turbulator in the tube also having minor and major dimensions in which the minor dimension of the turbulator spans the minor dimension of the tube and the major dimension of the turbulator is less than the major dimension of the tube but with the turbulator in its major dimension contacting opposite sides of the interior of the tube in its major dimension at contact areas spaced from each other along the length of the turbulator. In one preferred form the turbulator is bowed with the two ends of the turbulator in contact with one side of the tube relative to the major dimension, an intermediate point of the turbulator contacting the other side of the tube and the thickness or minor dimension of the turbulator extending across the minor dimension of the tube.

10 Claims, 4 Drawing Figures
HEAT EXCHANGER WITH INTERNAL TURBULATOR

BACKGROUND OF THE INVENTION

The field of the invention is in fluid heat exchangers in which a liquid is conducted through one or more tubes with each having a fin turbulator or agitator therein for improving heat transfer and with a fluid, either gas or liquid, being in contact with the outer surface of the tube for heat transfer through the wall of the tube or tubes. In general, the internal turbulators increase the flow resistance of the liquid through the tube so that the fluid flow characteristics are sacrificed to a certain extent for improved heat transfer performance. The heat exchanger of this invention with its internal turbulator achieves improved heat transfer performance with relatively minor restriction to flow of the liquid through the tube and the turbulator. Thus, the heat exchanger of this invention improves heat transfer performance without materially affecting the liquid flow characteristics through the tube and in addition reduces the amount of material used to make the turbulator.

DESCRIPTION OF THE PRIOR ART

A prior U.S. Pat. is Reissue No. 20,016 which discloses a refrigerating coil heat exchanger having tubes with major and minor transverse dimensions and an internal turbulator with major and minor dimensions. Here, however, the arrangement of the turbulator with respect to the tube is just opposite to that of the present invention in that the turbulator spans the tube in the major dimension rather than the minor and contacts opposite sides of the tube in the minor dimension rather than the major dimension of the present invention. In this prior patent therefore the restriction to flow is more pronounced than in the present invention. In addition, in the present invention a preferred type of turbulator is much more effective than the perforated metal sheet type of turbulator of this reference.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of a flat tube heat exchanger embodying the invention and with the elongated internal agitator fin turbulator being shown in broken lines.

FIG. 2 is an end elevational view of the heat exchanger of FIG. 1.

FIG. 3 is a fragmentary plan view of a preferred turbulator.

FIG. 4 is an enlarged sectional view taken substantially along line 4--4 of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the heat exchanger 10 shown in the accompanying drawings there is an elongated fluid flow tube 11 having transverse minor and major dimensions. In the illustrated embodiment the minor dimension is the dimension between the side walls 12 while the major dimension is the distance between the end or edge walls 13. As can be seen from FIG. 2, the tube 11 is of roughly oval or elliptical shape as is customary in the heat transfer art with the side walls 12 being substantially parallel to each other.

The heat exchanger also includes an elongated internal agitator fin turbulator 14 also having minor and major dimensions. Thus the major dimension is the distance between the top and bottom edges 15 and 16, respectively, while the minor dimension is the thickness of the turbulator. Thus in FIG. 3 the major dimension is the distance between the edges 15 and 16 while the minor dimension as shown in FIG. 4 is the thickness between the opposite surfaces 17 and 18.

The turbulator 14 within the tube 11 spans the interior of the tube in the minor dimension in that the surfaces 17 and 18 are in heat transfer contact with the interior surfaces of the side walls 12. The turbulator is shorter than the tube interior in the major dimension which as illustrated in FIGS. 1 and 2 is the vertical height. The turbulator 14 contacts the opposite sides or end walls 13 of the tube in the tube major dimension at contact areas spaced from each other along the length of the turbulator. Thus in the embodiment illustrated in FIGS. 1 and 2 the turbulator 14 is in contact with the bottom end or edge wall 13 at the opposite ends 19 of the turbulator and contacts the opposite or upper end or edge wall 13 at an area 20 of the turbulator between the ends 19.

As can be seen from the above description the major dimension of the turbulator 14 which is the distance between the opposite edges 15 and 16 is less at all points along the turbulator than the corresponding major dimension of the interior of the tube which is the distance between the end or edge walls 13. In preferred instances this major dimension of the turbulator is about 50–75 percent of the corresponding major dimension of the tube 11. In the preferred construction as shown the contact areas 21 on one side of the turbulator 14 are at the opposite ends 19 of the turbulator while the other contact area of the turbulator is the intermediate area 20 on the other edge 15 of the turbulator. In the preferred construction the turbulator 14 is bowed or arched between its two ends with the intermediate contact area 20 being located about midway between the two ends 19 and the curving or bowing being at a constant radius.

A preferred type of turbulator is disclosed in FIGS. 3 and 4. As is shown there, the turbulator comprises a sheet of metal 22 having spaced integral strips 23 struck therefrom and extending in a common direction away from the plane of the remainder of the metal sheet 22. As is shown in FIG. 4 each strip 23 is of generally U-shape with parallel sides and the longitudinally successive strips in each longitudinal series is staggered back and forth. When in position on the interior of the tube 11 the surfaces 17 that are in contact with one side wall 12 of the tube compromises the remainder 22 of the sheet of metal while the opposite surface 18 which is in contact with the opposite side wall 12 of the tube comprises the flat peaks of the strips 23 as shown in FIG. 4.

With the above construction the turbulator 14 is in heat transfer contact with the internal surface areas of the tube at the minor dimensions of the tube and the turbulator. The metal strips 23 are arranged generally longitudinally to the direction of fluid flow through the tube which is from one end to the other but because of the staggered relationship of the contact areas 20 and 21 are at a small angle to the length of the turbulator. This angular relationship particularly of the sides 24 of the strips 23 to the length of the turbulator increases
the turbulence. Thus the flat sides 24 of the strips extend completely across the width or minor dimension of the tube and are angled so as to increase turbulence. Thus with flow from right to left as indicated by the arrow 25 the strips 24 between the end 26 and the intermediate area 20 are angled upwardly with relation to the direction of flow 25. The remaining strips on the other side of the intermediate area 20 are correspondingly angled downwardly. This causes greater turbulence than if all strips were aligned with the direction of flow 25.

Because much of the major dimension on the interior of the tube 11 is not occupied by the turbulator 14 at all points along the turbulator and the tube the restriction to flow of the liquid through the tube is much less than if the turbulator extended the full length of the major dimension. Thus as shown in the drawings the liquid 25 entering the tube has the entire space above the turbulator 14 free of flow restrictions. Then, as flow continues through the tube from right to left this space narrows until it is substantially eliminated at the intermediate area 20. During this flow the liquid has also been forced downwardly and forwardly through the spaces between the strips 23 in the turbulator 14. This likewise increases the turbulence and achieves a more effective heat transfer while because so much of the tube is open or free of turbulator at every point along its length the restriction to flow is kept small.

1. A tubular heat exchanger with a turbulator therein offering low resistance to internal fluid flow, comprising: a fluid flow tube having inside surfaces and transverse minor and major dimensions; and an elongated internal agitator fin turbulator in said tube also having transverse minor and major dimensions and substantially completely spanning said tube interior in the minor dimension and only partially spanning said tube interior in the major dimension, said turbulator contacting said inside surfaces on opposite sides of said tube in said major dimension only at contact areas spaced from each other along the length of said turbulator, the turbulator being otherwise substantially out of contact with said inside surfaces of said tube in said major dimension.

2. The heat exchanger of claim 1 wherein said turbulator in said major dimension is about 50-75 percent of the corresponding major dimension of said tube.

3. The heat exchanger of claim 1 wherein said contact areas comprise a pair of said areas on one side of said turbulator and an intermediate area on the other side of said turbulator.

4. The heat exchanger of claim 3 wherein said turbulator is bowed between said pair of areas to include said intermediate area.

5. The heat exchanger of claim 3 wherein said intermediate area is substantially equally spaced between said pair of areas.

6. The heat exchanger of claim 5 wherein said pair of areas are located at opposite ends of said turbulator.

7. The heat exchanger of claim 6 wherein said turbulator is bowed between said pair of areas to include said intermediate area.

8. The heat exchanger of claim 1 wherein said turbulator comprises a metal sheet with spaced integral strips extending laterally of the sheet in the minor dimension and contacting said tube.

9. A tubular heat exchanger with a turbulator therein offering low resistance to internal fluid flow, comprising: a fluid flow tube having inside surfaces and transverse minor and major dimensions; and an elongated internal agitator fin turbulator in said tube also having transverse minor and major dimensions and substantially completely spanning said tube interior in the minor dimension and only partially spanning said tube interior in the major dimension, said turbulator contacting said inside surfaces on opposite sides of said tube in said major dimension at contact areas spaced from each other along the length of said turbulator, the turbulator being otherwise substantially out of contact with said inside surfaces of said tube in said major dimension, said contact areas comprising a pair of said areas on one side of said turbulator and an intermediate area on the other side of said turbulator and said turbulator is bowed between said pair of areas to include said intermediate area and said intermediate area is substantially equally spaced between said pair of areas.

10. The heat exchanger of claim 9 wherein said pair of areas are located at opposite ends of said turbulator.