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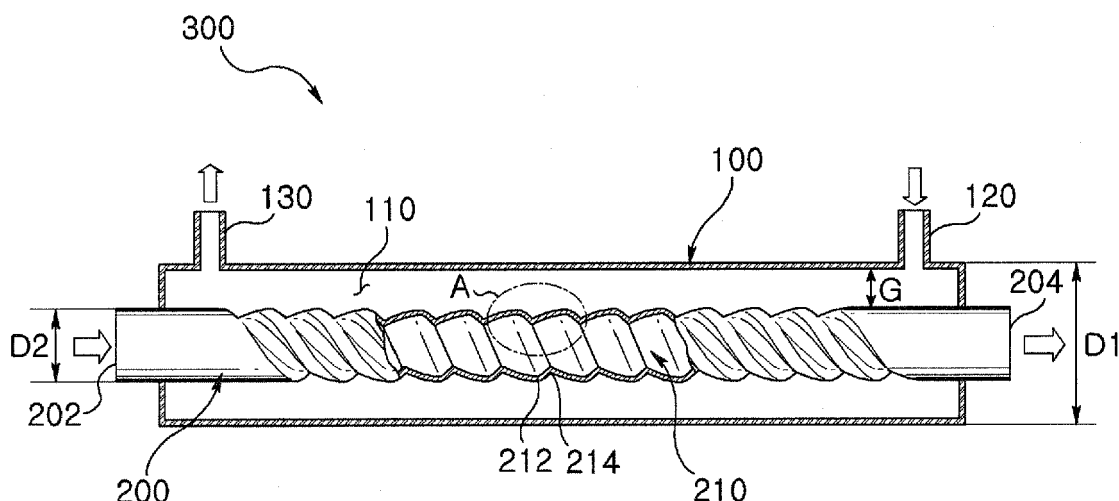
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(54) **Double-pipe heat exchanger**

(57) A double-pipe heat exchanger is provided. The double-pipe heat exchanger may include a first heat exchange tube having a first hollow portion, and a second heat exchange tube disposed inside the first heat ex-

change tube, so as to be co-axial with the first heat exchange tube and having a spiral part in which multiple ridges and grooves are formed at an inner surface of the spiral part.

Fig. 1



Description

[0001] A double-pipe heat exchanger is disclosed herein.

[0002] Heat exchangers are known. However, they suffer from various disadvantages.

[0003] It is the object of the present invention to provide a heat exchanger having improved characteristics. This object is solved with the features of the claims.

[0004] Embodiments will be described in detail with reference to the following drawings in which like reference numerals refer to like elements, wherein:

[0005] Fig. 1 is a cross-sectional view of a double-pipe heat exchanger according to an embodiment;

[0006] Fig. 2 is an enlarged view of portion A of Fig. 1; and

[0007] Fig. 3 is a graph showing a relationship between heat transfer performance and a pitch W of a spiral part in a double-pipe heat exchanger according to an embodiment.

[0008] The advantages, features and aspects will become apparent from the following description of the embodiments with reference to the accompanying drawings, which is set forth hereinafter. The terms and words used in the description below are not limited to typical or dictionary definitions, but can be interpreted with proper meanings and definitions consistent with the technical ideas.

[0009] A heat exchanger is a device that transfers thermal energy from a high temperature fluid to a relatively low temperature fluid, thereby cooling the high temperature fluid and heating the low temperature fluid. The heat exchanger may be used in, for example, a heater, a cooler, an evaporator, or a condenser.

[0010] A heat transfer medium used in the heat exchanger may be classified as a heating medium that transfers heat to a subject or target fluid, and a cooling medium that absorbs heat from the subject or target fluid. The cooling or heating medium may be used in the gaseous or liquid state.

[0011] As one type of heat exchanger, a double-pipe heat exchanger may include an internal tube into which a first fluid is introduced and flows, and an external tube disposed so as to enclose the internal tube and into which a second fluid is introduced and flows. A side wall of the internal tube may be used as a heat transfer wall that performs heat exchange between the first and second fluids.

[0012] In such a double-pipe heat exchanger, a heat transfer surface area between the second fluid and an outer wall of the internal tube may be small, and thus, heat exchange efficiency very low. In order to enhance the heat exchange efficiency, a scale of the heat exchanger or a length of the double pipe may be increased. However, it is difficult to increase the scale of the heat exchanger or the length of the double pipe due to problems of volume.

[0013] Fig. 1 is a cross-sectional view of a double-pipe

heat exchanger according to an embodiment, and Fig. 2 is an enlarged view of portion A of Fig. 1. Referring to Figs. 1 and 2, a double-pipe heat exchanger 300 according to this embodiment may include a first heat exchange tube 100 and a second heat exchange tube 200.

[0014] The first heat exchange tube 100 may be formed in a pipe shape having a first hollow portion 110. For example, the first heat exchange tube 100 may have a first diameter D1.

[0015] The first heat exchange tube 100 may include a first fluid inlet port 120 that communicates with the first heat exchange tube 100 and a first fluid outlet port 130 that communicates with the first heat exchange tube 100. A first fluid may be introduced into and flow through the first fluid inlet port 120, and may be discharged through the first fluid outlet port 130 after heat exchange.

[0016] In this exemplary embodiment, for example, the first fluid which is introduced through the first fluid inlet port 120 and is then discharged through the first fluid outlet port 130 may be a single-phase fluid, for example, cooling water. Further, the first fluid may have a first temperature.

[0017] The second heat exchange tube 200 may be disposed inside the first heat exchange tube 100, so that the first and second heat exchange tubes 100 and 200 are coaxial. For example, the second heat exchange tube 200 may have a second diameter D2 smaller than the first diameter D1 of the first heat exchange tube 100, and thus, a gap G may be formed between the first and second heat exchange tubes 100 and 200. The first fluid may pass through the gap G between the first and second heat exchange tubes 100 and 200. In this exemplary embodiment, for example, the second diameter D2 of the second heat exchange tube 200 may be about 19.05 mm.

[0018] The second heat exchange tube 200 disposed inside the first heat exchange tube 100 may have a spiral part 210. The spiral part 210 may be formed at a surface of the second heat exchange tube 200 so as to be in the form of a screw, and the screw-shaped spiral part 210 may have multiple ridges 212 and grooves 214.

[0019] The spiral part 210 may be formed at both inner and outer surfaces of the second heat exchange tube 200. The ridges 212 and grooves 214 of the spiral part 210 may be formed by, for example, a processing roller.

[0020] A second fluid inlet port 202, which may be cylindrical, may be formed at one end of the second heat exchange tube 200, and a second fluid outlet port 204, which may be cylindrical, may be formed at the other end thereof. A second fluid may be introduced into and flow through the second fluid inlet port 202 and may be discharged through the second fluid outlet port 204 after heat exchange.

[0021] In this exemplary embodiment, the second fluid provided in the second heat exchange tube 200 may be a two-phase fluid. For example, the second fluid may be converted from a liquid state to a gaseous state within the second heat exchange tube 200. Alternatively, the second fluid provided in the second heat exchange tube

200 may be a single-phase fluid.

[0022] In this exemplary embodiment, the second fluid may have a second temperature that is different from the first temperature of the first fluid. The first temperature of the first fluid may be higher than the second temperature of the second fluid. Alternatively, the first temperature of the first fluid may be lower than the second temperature of the second fluid.

[0023] A pitch W of the spiral part 210 of the second heat exchange tube 200 and a height difference H_c between the ridges 212 and grooves 214 formed by the spiral part 210 have a great influence on the heat transfer performance of the first and second heat exchange tubes 100 and 200. If the height difference H_c and the pitch W of the spiral part 210 are not optimized, the heat transfer performance may be reduced or deteriorated.

[0024] Fig. 3 is a graph showing a relationship between heat transfer performance and a pitch W of a spiral part in a double-pipe heat exchanger according to an embodiment. The X axis of the graph in Fig. 3 designates the pitch W of the spiral part 210 and the Y axis designates the heat transfer performance.

[0025] Referring to Fig. 3, as the pitch W of the spiral part 210 gradually increases, the heat transfer performance of the double-pipe heat exchanger 300 in Fig. 1, in turn, decreases. When the pitch W of the spiral part 210 is about 4–10 mm, a heat transfer characteristic of the double-pipe heat exchanger 300 is within an allowable range.

[0026] However, when the pitch W of the spiral part 210 of the second heat exchange tube 200 is less than about 4 mm, the heat transfer characteristic increases, but it is difficult to manufacture and process the pitch W of the spiral part 210. When the pitch W of the spiral part 210 of the second heat exchange tube 200 is larger than about 10 mm, the heat transfer characteristic decreases. Therefore, the pitch W of the spiral part 210 may be about 4–10 mm in consideration of working and heat transfer characteristics.

[0027] As shown in Fig. 2, the height difference H_c between the ridges 212 and grooves 214 of the spiral part 210 of the second heat transfer pipe 200 may be about 1–3 mm. When the height difference H_c between the ridges 212 and grooves 214 is less than about 1 mm, heat transfer efficiency decreases remarkably. When the height difference H_c between the ridges 212 and grooves 214 is larger than about 3 mm, the heat transfer efficiency increases, but it is difficult to manufacture and process the pitch W of the spiral part 210. Therefore, the height difference H_c between the ridges 212 and grooves 214 of the spiral part 210 may be about 1–3 mm in order to satisfy working and heat transfer characteristics.

[0028] In order to form the ridges 212 and grooves 214 of the spiral part 210 of the second heat transfer pipe 200, a ratio A/W , which is a distance A between a half point $W/2$ of the pitch W and a top portion P of the ridge 212 divided by the pitch W may be less than about 0.15. In this exemplary embodiment, if the second fluid, which

is converted from liquid phase to gaseous phase, is provided in the second heat exchange tube 200, the second fluid may be rotated at a high speed by the spiral part 210 of the second heat transfer tube 200. At this point, the liquid-phase second fluid having a higher density than the gaseous-phase second fluid may be mainly distributed at an inner side surface of the spiral part 210, and the gaseous-phase second fluid having a relatively low density may be mostly distributed at a center portion of the spiral part 210.

[0029] Accordingly, the liquid-phase second fluid and the gaseous-phase second fluid may be separated from each other by a cyclone effect. The liquid-phase second fluid distributed at the inner side surface of the spiral part 210 may be actively heat-exchanged with the first fluid provided in the first heat exchange tube 100, and thus, the heat exchange characteristics between the first and second fluids may be further improved.

[0030] According to embodiments disclosed herein, the spiral part may be formed on a surface of the second heat exchange tube disposed inside the first heat exchange tube, and the pitch and height of the spiral portion may be optimized, improving considerably the heat transfer efficiency.

[0031] Embodiments disclosed herein provide a double-pipe heat exchanger in which a heat exchange tube disposed at a relatively inner side may be formed in a spiral shape in which ridges and grooves may be continuously formed, thereby increasing a heat transfer performance.

[0032] Further, embodiments disclosed herein provide a double-pipe heat exchanger that may include a first heat exchange tube having a first hollow portion, and a second heat exchange tube disposed inside the first heat exchange tube so as to be co-axial with the first heat exchange tube and having a spiral part in which multiple ridges and grooves may be formed at an inner surface of the spiral part.

[0033] The second heat exchange tube may include a cylindrical second fluid inlet port, which may be inserted into or provided at one side of the first heat exchange tube and through which a second fluid may pass; a cylindrical second fluid outlet port, which may be inserted into or provided at the other side of the first heat exchange tube and through which the second fluid may be discharged; and a screw-shaped spiral part continuously formed between the second fluid inlet port and the second fluid outlet port.

[0034] A ratio A/W of a pitch W that is a length between adjacent grooves of the second heat exchange tube to a distance A between a center portion of the pitch W and a top portion P of the ridge may be less than about approximately 0.15.

[0035] The pitch W may be approximately 4 mm < W < 10 mm, and a height difference H_c between the adjacent ridges and grooves may be approximately 1 mm < H_c < 3 mm.

[0036] A temperature of a first fluid provided between

the first and second heat exchange tubes may be different from that of a second fluid provided in the second heat exchange tube. The second fluid provided in the second heat exchange tube may be one of a single-phase fluid or a two-phase fluid.

[0037] Any reference in this specification to "one embodiment," "an embodiment," "example embodiment," etc., means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the invention. The appearances of such phrases in various places in the specification are not necessarily all referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with any embodiment, it is submitted that it is within the purview of one skilled in the art to effect such feature, structure, or characteristic in connection with other ones of the embodiments.

[0038] Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

Claims

1. A double-pipe heat exchanger, **characterized by:**

a first heat exchange tube having a first hollow portion; and
a second heat exchange tube disposed inside the first heat exchange tube and having a spiral part in which multiple ridges and grooves are formed at an inner surface thereof.

2. The double-pipe heat exchanger of claim 1, **characterized in that** the second heat exchange tube is disposed inside the heat exchange tube so as to be coaxial with the first heat exchange tube.

3. The double-pipe heat exchanger of claim 1 or 2, **characterized in that** the first heat exchange tube comprises:

a first fluid inlet port through which a first fluid is introduced into the first heat exchange tube; and
a first fluid outlet port through which the first fluid is discharged from the first heat exchange tube.

4. The double-pipe heat exchanger of any of claims 1 to 3, **characterized in that** the second heat exchange tube comprises:

a second fluid inlet port through which a second fluid is introduced into the second heat exchange tube;
a second fluid outlet port through which the second fluid is discharged from the second heat exchange tube; and
the spiral part which extends between the second fluid inlet port and the second fluid outlet port.

5. The double-pipe heat exchanger of claim 4, **characterized in that** the second fluid inlet port extends through a first side wall of the first heat exchange tube, and the second fluid outlet port extends through a second side wall of the heat exchange tube.

6. The double-pipe heat exchanger of claim 5, **characterized in that** the second side wall is opposite the first side wall.

7. The double-pipe heat exchanger of any of claims 4 to 6, **characterized in that** the second fluid inlet pipe and second fluid outlet pipe are cylindrical.

8. The double-pipe heat exchanger of any of claims 1 to 7, **characterized in that** a ratio A/W of a pitch W , which is a length between adjacent grooves of the second heat exchange tube, to a distance A between a center portion of the pitch W and a top portion P of the ridge is less than about 0.15.

9. The double-pipe heat exchanger of any of claims 1 to 8, **characterized in that** the pitch W is approximately $4\text{ mm} < W < 10\text{ mm}$, and a height difference H_c between an adjacent ridge and groove is approximately $1\text{ mm} < H_c < 3\text{ mm}$.

10. The double-pipe heat exchanger of any of claims 1 to 9, **characterized in that** a temperature of a first fluid provided between the first and second heat exchange tubes is different from a temperature of a second fluid provided in the second heat exchange tube.

11. The double-pipe heat exchanger of any of claims 4 to 10, **characterized in that** the second fluid is one of a single-phase fluid or a two-phase fluid.

12. A double-pipe heat exchanger, **characterized by:**

a first heat exchange tube having a first hollow portion; and
a second heat exchange tube disposed inside the first heat exchange tube so as to be coaxial

with the first heat exchange tube and having a spiral part in which multiple ridges and grooves are formed at an inner surface thereof, wherein the second heat exchange tube comprises:

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a second fluid inlet port the second heat exchange tube through which a second fluid is introduced into the second heat exchange tube;

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a second fluid outlet port through which the second fluid is discharged from the second heat exchange tube; and

the spiral part which extends between the second fluid inlet port and the second fluid outlet port.

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13. The double-pipe heat exchanger of claim 12, **characterized in that** the second fluid inlet port extends through a first side wall of the first heat exchange tube, and the second fluid outlet port extends through a second side wall of the heat exchange tube.

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14. A double-pipe heat exchanger, **characterized by:**

a first heat exchange tube having a first hollow portion; and

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a second heat exchange tube disposed inside the first heat exchange tube so as to be coaxial with the first heat exchange tube and having a spiral part in which multiple ridges and grooves are formed at an inner surface thereof, wherein the pitch W , which is a length between adjacent grooves of the second heat exchange tube, is approximately $4\text{ mm} < W < 10\text{ mm}$, and a height difference H_c between an adjacent ridge and groove is approximately $1\text{ mm} < H_c < 3\text{ mm}$.

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Fig. 1

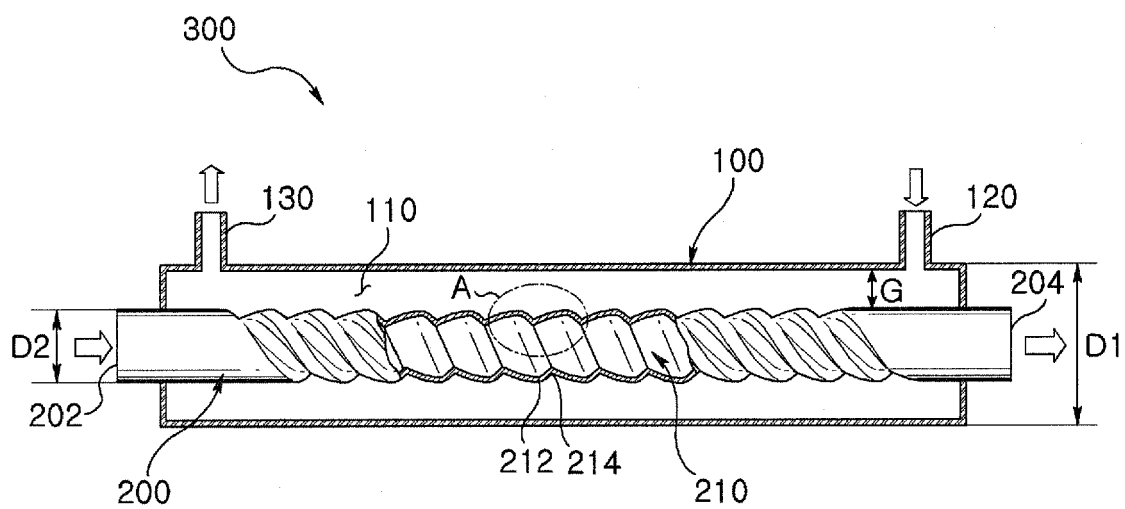


Fig. 2

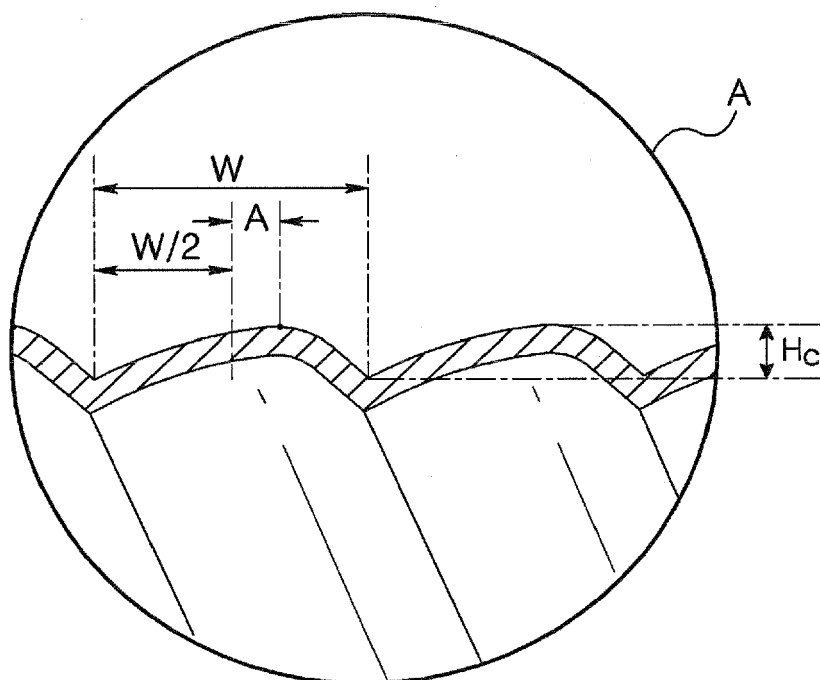


Fig. 3

