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(54) SHELL MEMBER FOR HEAT EXCHANGER

(57) The invention proposes a shell member for a heat exchanger (100, 200), wherein the shell member is configured to form a shell (110) of the heat exchanger (100, 200), wherein the shell (110) is configured to accommodate at least one fluid conduit (120) therein, and wherein the shell (110) is configured to receive a fluid, wherein the shell member has at least one surface enlarging element (112, 212) on an inner wall, which inner wall is configured to be oriented in the direction of the at least one fluid conduit (120). Furthermore, a corresponding shell (110) and a heat exchanger (100, 200) are proposed.

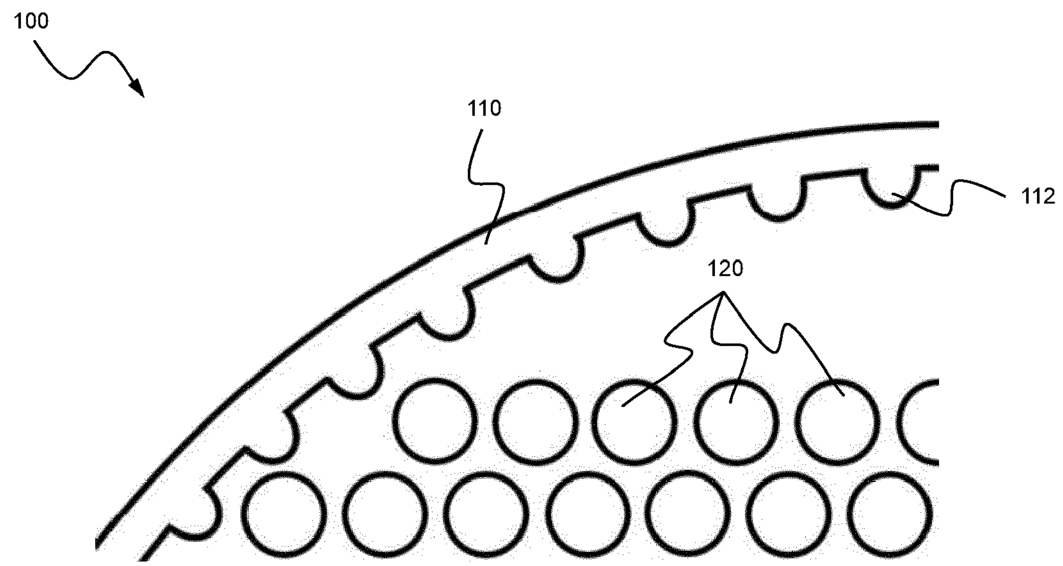

Fig. 1

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Description

[0001] The invention relates to a shell member for a heat exchanger, to a shell for such a heat exchanger and to a heat exchanger having such a shell.

[0002] In the mechanical design of heat exchangers, for example straight tube heat exchangers fixedly welded on both sides (Fixed Tubesheet Shell & Tube Heat Exchangers), all possible operating conditions must be analysed in accordance with the applicable requirements of the design code (e.g. ASME Section VIII Div. 1 UHX 13.4) with regard to the occurring temperature differences and resulting induced stresses, e.g. between tube bundle and shell material. If the calculated stresses exceed the values specified by the design code, the design must be adapted, e.g. via an increase in tube sheet thicknesses, tube diameters, the number of baffles or the use of an expansion compensator.

[0003] Modifications to the mechanical design due to thermally induced stresses are generally associated with additional costs, especially if an expansion compensator is required. In addition, depending on the design pressure, size of the apparatus or customer specifications, it may not be possible to use a compensator or the loads may exceed what would still be permissible according to the design code even with a compensator. Accordingly, there are cases for which there is no sufficiently stable mechanical design.

Disclosure of the invention

[0004] Against this background, the present invention proposes a shell member for heat exchangers with a shell, as well as a corresponding shell and a heat exchanger according to the independent claims. Heat exchanger shells are also referred to as heat exchanger jackets. Advantageous embodiments are subject-matter of the respective dependent claims as well as the following description.

[0005] The invention uses a surface enlarging element on an inner wall of the shell. This allows the temperature of the shell to adjust more quickly to changing fluid temperatures. Typically, the highest temperature differences (using a shell-and-tube heat exchanger as an example) between the tube bundle material and the shell material occur during transient operating conditions. The tube bundle typically responds more quickly to changing process conditions because the tube bundle often has a larger surface area compared to the shell and/or the heat transfer between the shell-side fluid and the shell may be less than that between the shell-side fluid and the tube bundle, depending on the application. Typically, therefore, the shell is the component whose temperature adapts most slowly to changing fluid temperatures, causing thermal stresses, particularly between the shell and fluid conduits (e.g. tube bundle) therein. However, since the present invention allows the shell to adapt its temperature dynamics to that of the other components in thermal exchange with the fluid, the generation of thermal stresses is prevented or at least reduced.

[0006] In detail, according to the invention, a shell member for a heat exchanger is proposed, wherein the shell member is configured to form a shell of the heat exchanger, wherein the shell is configured to accommodate at least one fluid conduit therein, and wherein the shell is configured to receive a fluid, wherein the shell member has at least one surface enlarging element on an inner wall, which inner wall is configured to be oriented in the direction of the at least one fluid conduit. As mentioned above, the surface enlarging element serves to reduce thermal stresses in dynamic operating conditions.

[0007] In at least one embodiment, the surface enlarging element comprises a surface texture (also referred to as surface structure) integrated into the inner wall. The integration of the surface enlarging element into the inner wall results in a mechanically particularly stable arrangement, so that a long service life can be expected. In particular, the surface texture/structure can comprise knobs, nubs, dimples, ridges, ribs, a waffle structure or a combination of any thereof. These are structures that are particularly easy to manufacture and can be produced, for example, by casting, welding, rolling, embossing, forging, extruding, machining, cutting or other common manufacturing processes. In an embodiment, the surface texture is a protruding structure like ridges or ribs extending in the axial direction of the shell.

[0008] Alternatively or additionally, the surface enlarging element may comprise a member applied to the inner wall. In particular, the element applied to the inner wall may comprise a grid, a mesh, a net, a non-woven textile or a combination of any thereof. Thus, complex structures can be used that are adapted, for example, to the particular fluid being used and/or to other operating conditions. Furthermore, the use of a substantially separate component also allows retrofitting, i.e., subsequent equipment of already existing systems. Such a member applied to the inner wall can in particular be welded, soldered, riveted, screwed on or otherwise mechanically and/or chemically connected to the inner wall. Depending on the mechanical stability of the member applied to the inner wall, (thermal) shrink-fitting may also be considered. In some cases, the member does not have to be in surface contact, but can be placed near the inner wall to ensure that turbulence in the fluid flowing through the shell makes heat transfer between shell and fluid more efficient.

[0009] In at least one embodiment, the surface enlarging element comprises a first material that differs in composition from a second material that forms at least a portion of the remainder of the shell member. In particular, the first material may have a higher thermal conductivity than the second material and/or a lower thermal capacity than the second material. In this way, the surface enlarging element can be optimized with respect to the improvement of heat transfer in one further degree of freedom (namely the choice of material) in addition to its geometric design.

[0010] A shell for a heat exchanger according to the invention, comprises at least one shell member as described herein before. That is, the heat exchanger shell can consist of only one shell member, which is e.g. cylindrically formed. The heat exchanger shell may also comprise one or more shell members according to the invention (and may or may not comprise other shell members according to the prior art). Thus, it is possible to have a heat exchanger shell, which is only partly formed of shell members according to the present invention. In particular, the shell may also comprise end caps attached to one or more axially extending shell members, for example, such that the shell may be an essentially closed vessel in itself. Furthermore, such a shell may further comprise at least one first connector for supplying the shell with a first fluid as the fluid to be received by the shell and/or at least one second connector configured to supply the at least one fluid conduit accommodated in the shell with a second fluid. Particularly, the second connector(s) may provide the second fluid into a manifold accommodated, for example, in a head of the heat exchanger which may be provided within the shell. The manifold then directs the second fluid further into the fluid conduit(s). Thus, the shell according to the invention benefits correspondingly from the advantages of the shell member just explained.

[0011] According to the invention, a heat exchanger comprises at least one shell member and/or a shell as just described.

[0012] In particular, the heat exchanger may be configured as a straight tube heat exchanger, a plate heat exchanger, a spiral heat exchanger, a shell-and-tube heat exchanger, a tube-in-tube heat exchanger or a combination of any thereof. These are designs that particularly benefit from the invention because they are especially prone to thermally induced stresses under dynamic operating conditions.

[0013] In at least one embodiment of the heat exchanger, the at least one shell member is fixedly welded to the at least one fluid conduit. In such an embodiment, thermal stresses are particularly relevant, since on the one hand there can be a weak point in the material due to the material connection in the welded joint and on the other hand stresses or deformations of one component can be transferred particularly effectively to another component.

[0014] In the following, further advantages and embodiments of the invention are explained with reference to the accompanying drawings by means of exemplary embodiments. Components appearing in several figures, which are essentially identical to each other regarding their function, are referenced with identical reference numerals and are not necessarily explained repeatedly. An explanation with reference to one figure accordingly applies mutatis mutandis to further figures representing or containing the respective component.

Brief description of the figures

[0015]

Figure 1 schematically shows a portion of a cross-section through a shell-and-tube heat exchanger according to a first embodiment of the invention.

Figure 2 schematically shows a portion of a cross-section through a shell-and-tube heat exchanger according to a second embodiment of the invention.

Embodiments of the invention

[0016] Figure 1 schematically shows a portion of a cross-section through a tube bundle heat exchanger according to a first embodiment of the invention, that is generally denoted 100. The heat exchanger 100 comprises a shell 110 and a tube bundle 120 comprising a plurality of individual tubes (fluid conduits). During operation of the heat exchanger 100, a first fluid, for example water or steam, is provided in a shell space of the heat exchanger 100, which is located inside the shell 110 but outside the tubes of the tube bundle 120, while on the tube side, i.e. inside the tubes of the tube bundle 120, a second fluid, for example a process fluid to be tempered, for example a reactant or product stream of a chemical reaction, is provided.

[0017] The shell 110 may comprise one or more shell members, which are not separately shown in the figure. In the simplest case, a shell member may comprise, for example, a shell tube or a tube segment (e.g., a circular arcuate sheet). Other examples of shell members may include flanges, tube sheets, and end caps.

[0018] In order to reduce the relative difference in surfaces between tube bundle 120 and shell 110 and thus the delayed (thermal) response of the shell 110 to certain changes in process conditions, particularly changing process temperatures, a surface enlarging element is provided on the inner wall (inner side) of shell 110. This allows temperature changes to be transferred more quickly to the shell material and reduces the temperature differences between the tube bundle 120 and the shell 110.

[0019] In the exemplary embodiment shown in Fig. 1, this surface enlarging element is provided in the form of a surface texture 112 integrated into the inner wall. For example, this surface texture may include dimples, ribs, a waffle texture, or a combination of one or more thereof, such as axially oriented ribs (with respect to the orientation of the shell 110). Such surface structuring can be produced, for example, by extrusion (e.g., as part of the production of the shell tube) directly together with the shell member, or subsequently (i.e., when the raw component or shell member per se already exists) integrated into the inner wall, e.g., by machining processes or embossing or also by welding or other additive processes.

[0020] Figure 2 schematically shows a portion of a cross-section through a shell-and-tube heat exchanger according to a second embodiment of the invention in general designated 200. The heat exchanger 200 as shown in Figure 2 differs from the heat exchanger 100 shown in Figure 1 particularly in the design of the surface enlarging element, which in the case of the heat exchanger 200 is provided in the form of a member 212 applied to the inner wall of the shell 110, for example as a grid, net, mesh, fabric or non-woven textile.

[0021] Surface enlarging elements 112, 221 may be made of or comprise the same material as the inner wall of the shell 110, or may comprise one or more materials different therefrom. In particular, the material of the respective surface enlarging element 112, 212 may be selected to be stable in the environment of the fluid flowing through the shell 110 during its intended operation and to promote heat transfer between the fluid and the shell 110. For example, a material having a higher thermal conductivity than the shell material and/or a lower thermal capacity than the shell material may be selected for this purpose. Particularly suitable materials may include pure or alloyed metals, ceramics and polymers, for example.

[0022] In addition to increasing the surface area of the inner wall of the shell 110 involved in thermal exchange, the surface enlarging element may also be configured to influence the movement of the fluid in the vicinity of the inner wall of the shell 110 in a manner that is conducive to heat flow. For example, the surface enlarging element 112, 212 can be specifically designed to induce turbulence in the fluid, particularly at a flow velocity expected during operation, in order to improve the thermal exchange between the inner wall of the shell 110 and the fluid.

[0023] In principle, the surface enlarging elements 112 and 212 can also be combined with one another, but this is not shown in the figures for clarity.

Claims

1. A shell member for a heat exchanger (100, 200), wherein the shell member is configured to form a shell (110) of the heat exchanger (100, 200), wherein the shell (110) is configured to accommodate at least one fluid conduit (120) therein, and wherein the shell (110) is configured to receive a fluid, wherein the shell member has at least one surface enlarging element (112, 212) on an inner wall, which inner wall is configured to be oriented in the direction of the at least one fluid conduit (120).

2. The shell member of claim 1, wherein the surface enlarging element (112, 212) comprises a surface texture (112) integrated into the inner wall.

3. The shell member of claim 2, wherein the surface texture (112) comprises knobs, dimples, nubs, ridges, ribs, a waffle texture, or a combination of any thereof.

4. The shell member according to any one of the preceding claims, wherein the surface enlarging element (112, 212) comprises a member (212) applied to the inner wall.

5. The shell member of claim 4, wherein the member (212) applied to the inner wall comprises a grid, a mesh, a net, a non-woven textile, or a combination of any thereof.

6. The shell member according to any one of the preceding claims, wherein the surface enlarging element (112, 212) comprises a first material that is different in composition from a second material that forms at least a portion of the remainder of the shell member.

7. The shell member of claim 6, wherein the first material has a higher thermal conductivity than the second material and/or a lower thermal capacity than the second material.

8. A shell (110) for a heat exchanger (100, 200), comprising at least one shell member according to any one of the preceding claims, in particular further comprising at least one first connector for supplying the shell (110) with a first fluid as the fluid to be received by the shell (110) and/or at least one second connector configured to supply the at least one fluid conduit (120) accommodated in the shell (110) with a second fluid.

9. A heat exchanger (100, 200) comprising at least one shell member according to any one of claims 1 to 7 and/or comprising a shell (110) according to claim 8.

10. The heat exchanger (100, 200) of claim 9, configured as a straight tube heat exchanger, plate heat exchanger, spiral heat exchanger, shell-and-tube heat exchanger, a tube-in-tube heat exchanger or a combination of any thereof.

11. The heat exchanger (100, 200) of claim 9 or 10, wherein the at least one shell member is fixedly welded to the at least one fluid conduit (120).

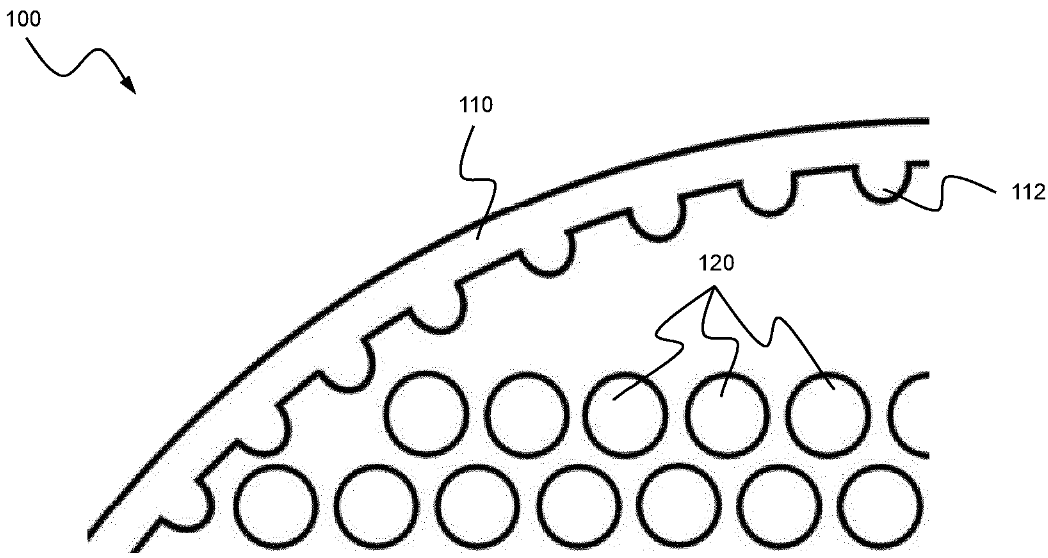

Fig. 1

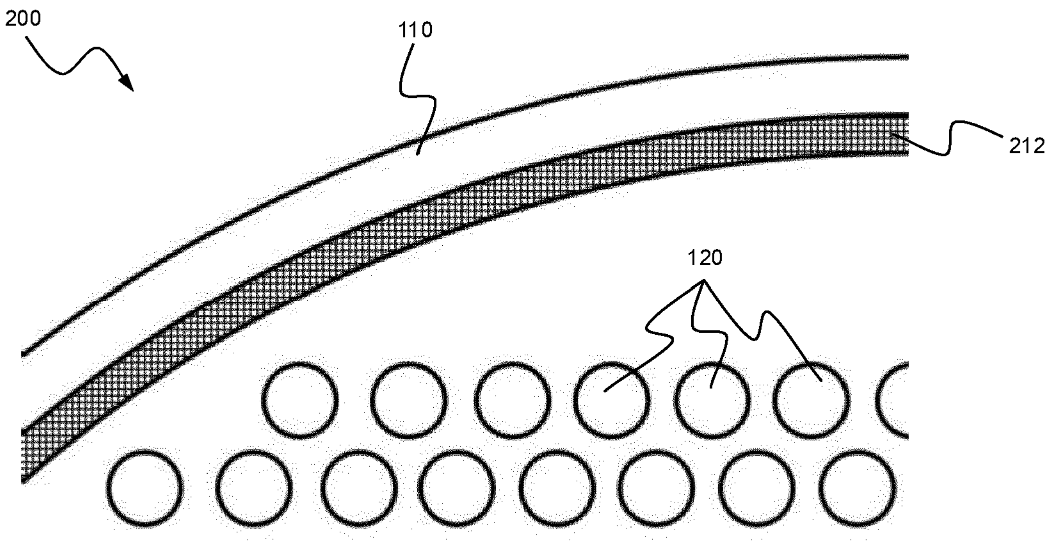

Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 23 02 0383

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2006/016586 A1 (NAIL CLAUDE [FR]) 26 January 2006 (2006-01-26) * figures 2,3 *	1-3,8-11	INV. F28F9/00 F28F13/00 F28F13/12 ADD. F28F1/40
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X	US 2 303 247 A (WOODS JOHN E) 24 November 1942 (1942-11-24) * figures 1,2 *	1,4-11	
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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	2 February 2024	Vassoille, Bruno

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 23 02 0383

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