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METHOD AND APPARATUS FOR REPLACING A SEAL IN AN EXPANDABLE
HEAT EXCHANGER SHELL
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FIG. 1

FIG. 2
This invention relates to a heat exchanger construction and particularly to method and apparatus for replacing the seal in a double bonnet heat exchanger construction.

Double bonnet heat exchangers per se are well known in the art. Within the shell of such heat exchangers, there are a plurality of longitudinally extending heat exchange tubes rigidly connected at opposite ends to a pair of laterally spaced tube-sheets having a plurality of bores adapted to receive the tubes. The tubes are rigidly secured in the tube-sheet bores, as for example, by force-fitting, force-rolling or welding.

The tubes of such heat exchangers are surrounded by the heat exchange shell. The tube-sheets are rigidly connected, as for example by welding, at opposite ends to the heat exchanger shell, thereby forming an integral rigid structure including the tubes, tube-sheets and the surrounding heat exchanger shell.

While it has been considered highly desirable to provide a construction whereby the outer shell of a double bonnet heat exchanger did not have to be rigidly mounted to the tube-sheets, as for example, by interposing a gasket between the opposite ends of the shell and each of the tube-sheets, it has not been practical to do so because when the gasket expires and leaks, it has been necessary to dismantle one of the tube-sheets from the plurality of tubes in order to replace an expired gasket.

This invention provides a shell construction which overcomes the problem above described. This invention provides a heat exchanger having seals interposed between opposite ends of the shell and each of the tube-sheets and a method and means for conveniently replacing the seals. Such method and construction permits the use of a desirable material for the shell which cannot be welded or otherwise rigidly connected in a leak-proof manner to a material which is particularly desirable for tube-sheets. With the use of this invention, it is practical to use a carbon steel shell and titanium tube-sheets. By providing a heat exchange shell having an expansion joint, preferably a compressible flexible expansion joint, the replacement of seals between the outer heat exchange shell and the tube-sheets may be done with relative speed and ease.

Therefore, it is one object of this invention to provide an improved heat exchanger construction and more particularly a double bonnet heat exchanger shell construction.

It is a further object of this invention to provide an improved heat exchanger shell and method permitting convenient replacement of a seal between the opposite ends of the heat exchanger shell and the inner surfaces of the tube-sheets at opposite ends of the heat exchanger shell.

It is another object of this invention to provide a heat exchanger construction and method which makes it practical to manufacture the shell of a material which is not compatible for rigid jointer with the particular material out of which the tube-sheets are manufactured.

Another problem common to all heat exchangers, even when the shell is welded to or otherwise integral with the tube-sheets, is the differential in expansion and contraction between the tubes and shell of a heat exchanger. My invention overcomes this problem by providing an expandable shell which compensates for any such expansion or contraction.

Other objects and advantages of this invention will be particularly set forth in the claims and will be apparent from the following description of this one embodiment of the invention, when taken in connection with the accompanying drawings in which:

FIG. 1 is a side elevational view of one embodiment of this invention, partly in section, and with parts broken away.

FIG. 2 is an enlarged sectional view of the circled area of FIG. 1 with parts removed and parts added.

With reference to the figures, the illustrated embodiment of this invention includes a plurality of longitudinally extending horizontal heat exchange tubes opposite ends of which are rigidly mounted, as for example, for press-rolling in a pair of titanium tube-sheets or closure members 12. A substantially cylindrical heat exchanger shell generally indicated by the numeral 14, defining a heat exchange chamber, peripherally surrounds and encloses the plurality of heat exchange tubes.

The heat exchange shell 14 is mounted between the pair of tube-sheets or closure members 12. There are a pair of heat exchanger bonnets, generally indicated by the numerals 16 and 17 rigidly mountable to the heat exchange shell 14, as for example by nuts 18 and bolts 20. Radial flanges 26 and 28 are provided on the bonnets 16, 17 and opposing ends of the shell 14 respectively. These flanges 26 and 28 have axially aligned bores 22 and 24 respectively which receive bolts 20.

One of the heat exchange fluids enters an inlet 30 in the bottom of the shell 14 and passes over the tubes 10 and out an outlet 32 at the top of the shell 14. The other heat exchange fluid passes through an inlet 34 in bonnet 16 through the tubes 10 and out an outlet 36 in bonnet 17.

The novelty of this invention resides in providing a heat exchanger construction including a longitudinal expansion member or joint generally indicated by the numeral 38 which is an integral part of the shell 14. In the illustrated embodiment, the longitudinal expansion joint 38 is a flexible compression joint protruding radially or laterally from the sidewall of shell 14 which is compressible axially or longitudinally of the shell 14 where the expansion joint 38 joins the sidewall of the shell 14 as indicated by the double arrow 40.

With reference to FIG. 2, the shell 14, preferably constructed of carbon steel, is provided with the radial flanges 26, rigidly mounted at opposite ends thereof, as for example, by welds 42 and 44; each of the bonnets 16 and 17 is also preferably constructed of carbon steel, having a radial flange 26 formed integral therewith, as for example, by welds 46 and 48. Each of the boles is provided with an internal rubber liner 50 extending over the left-hand face, as viewed in FIG. 2, of the radial flange 26. A groove or slot 52, shown in cross-section in the drawings, formed in the left-hand or inner face 54 of each of the tube-sheets 12 is a circular groove extending perpendicularly around the shell 14 and permits the outer or opposite face 55 of the tube-sheets to expand as viewed in FIG. 2 of the radial flange 26.

Groove 52 receives a resilient O-ring seal 56 for sealing the tube-sheets 12 to opposite ends of the shell 14. A gasket 58 is interposed between the internal rubber bonnet lining 59 and the right-hand or outer surface 60 of the tube-sheets 12; thus, when the bolt 20 is inserted through the bores 22 and 24 of flanges 26 and 28 respectively and axial pressure is applied through the bolt 20 as a nut 18 is threaded onto the left end of bolt 20, as
viewed in FIG. 2, the heat exchanger construction becomes a complete sealed unit with the bonnets 16 and 17 being sealed to the outer surface 60 of the tube sheets 12 and the inner surface 54 of the tube sheets 12 being sealed to opposite ends of the shell 14 at the outer surfaces 55 of radial flanges 28.

When the O-ring seal 56, between the opposite ends of the shell 14 and tube sheets 12 expires and becomes necessary to replace the seal, the bonnet 17 is removed and the shell 14, by reason of the expansion joint 38, is retracted from the inner surface 54 of the tube-sheet or closure member 12 at the end where it is necessary to replace the seal 56. Thus, the expansion joint maintains the open ends of the shell in substantially closed position with the closure members or tube sheets 12. When the shell 14 is retracted in opposition to the expansion joint, the expired seal 56 may be removed and a new seal inserted. It will be understood that the O-ring seal 56 is slipped over the tube-sheet 12 and is then inserted into the groove 52.

In the illustrated embodiment of this invention, axial or longitudinal compressional force 40 is applied to the radial flange 28 of the shell 14, as for example, by a vise, generally indicated by the numeral 62 as shown in FIG. 2. The expansion joint as illustrated in FIG. 1 is comprised as indicated by the double arrow 40 from the solid line position 38 to a position similar to the broken line position 63 which is exaggerated for purposes of illustration. The compression joint 38 is retracted sufficiently to permit removal of the old seal and replacement with a new seal.

After replacement of the seal, the compressional force applied by the vise 62 is released and the compression expansion joint 38 returns the cylindrical sidewalls of the shell 14 to the position illustrated in FIG. 1 whereby the outer surfaces 55 of opposite ends of the shell 14 may again be sealed to the inner surface 54 of the tube-sheet 12.

It will be understood that a flexible expansion member automatically compensates for expansion and contraction of the tubes 10 and/or the shell 14 during operation of the heat exchanger.

It will be understood that this invention is not restricted to the illustrated type of flexible compression expansion joint, but contemplates other types of expansion joints suitable for retracting the outer surfaces 55 of opposite ends of shell 14 from the inner surface 54 of the tube-sheets 12 to permit ready replacement of the seal incorporated therebetween.

While I have shown and described the preferred form of mechanism of my invention, it will be apparent that various modifications and changes may be made therein, particularly in the form and relation of parts, without departing from the spirit of my invention as set forth in the appended claims.

I claim:

1. In a heat exchanger or like construction,
(a) a shell defining a chamber having an open end,
(b) a closure member adapted to overlie said shell open end for closure thereof,
(c) seal means between said shell open end and said closure member,
(d) means including an expansion joint on said shell maintaining said closure member in substantially closed relationship with said shell open end, and
(e) separation means engaging said shell and adapted for compressing said expansion joint for separating said shell open end from said closure member a sufficient distance to permit replacement of said seal means.

2. In a heat exchanger or like construction,
(a) a shell defining a chamber having an open end,
(b) a closure member adapted to overlie said shell open end for closure thereof,
(c) seal means between said shell open end and said closure member,
(d) means including an expansion joint for maintaining said closure member in substantially closed relationship with said shell open end, and
(e) means engaging said shell and adapted for compressing said expansion joint for separating said shell open end from said closure member a sufficient distance to permit replacement of said seal means.

3. In a heat exchanger or like construction,
(a) a shell defining a chamber having an open end,
(b) a closure member adapted to overlie said shell open end for closure thereof,
(c) seal means between said shell open end and said closure member,
(d) means including a longitudinal expansion joint for maintaining said closure member in substantially closed relationship with said shell open end, and
(e) vise means engaging said shell and adapted for compressing said expansion joint for separating said shell open end from said closure member a sufficient distance to permit replacement of said seal means.

4. In a heat exchanger or like construction,
(a) a shell defining a heat exchanger chamber having an open end,
(b) a tube sheet adapted to overlie said shell open end for closure thereof,
(c) seal means between said shell open end and said tube sheet,
(d) means including an expansion joint on said shell for maintaining said shell sheet in substantially closed relationship with said shell open end, and
(e) means engaging said shell and adapted for compressing said expansion joint for separating said shell sheet end from said closure member a sufficient distance to permit replacement of said seal means.

5. In a heat exchanger or like construction,
(a) a shell having an expansion joint and defining chamber having opposite open ends,
(b) a pair of closure members adapted to overlie said shell open ends for closure thereof,
(c) seal means between each of said shell open ends and each of said closure members,
(d) means interconnecting said closure members in substantially closed relationship with said shell open ends, and
(e) separation means engaging said shell and adapted for varying the length of said shell in opposition to said maintaining means for separating said shell open end from said shell sheet a sufficient distance to permit replacement of said seal means.

6. A heat exchanger construction in accordance with claim 5 in which said separation means includes means for longitudinally compressing said shell in opposition to said expansion joint.

7. In a heat exchanger or like construction,
(a) a shell having an expansion joint and defining a heat exchanger chamber having an open end,
(b) a tube sheet adapted to overlie said shell open end for closure thereof,
(c) seal means between said shell open end and said tube sheet,
(d) a heat exchanger tube extending through said shell and rigidly secured to said tube sheet, and
(e) means engaging said shell and adapted for varying the length of said shell for separating said joint open end from said tube sheet a sufficient distance to permit replacement of said seal means.

8. In a heat exchanger or like construction,
(a) a shell defining a heat exchanger chamber having an open end,
(b) a tube sheet adapted to overlie said shell open end for closure thereof,
(c) seal means between said shell open end and said tube sheet,
(d) a heat exchange tube extending through said shell and rigidly secured to said tube sheet, and
(e) means including an expansion joint on said shell and means engaging said shell adapted for longitudinally expanding and contracting said joint for separating said shell open end from said tube sheet a sufficient distance to permit replacement of said seal means.

9. In a heat exchanger or like construction,
(a) a shell having an expansion joint and defining a heat exchanger chamber having opposite open ends,
(b) a pair of tube sheets adapted to overlie said shell open ends for closure thereof,
(c) seal means between each of said shell open ends and each of said tube sheets,
(d) a heat exchange tube extending through said shell and rigidly secured at opposite ends to said tube sheets, and of such length to maintain said tube sheets in substantially closed relationship with said open ends, and
(e) means engaging said shell and adapted for compressing said joint longitudinally for separating one of said shell open ends from an adjacent one of said tube sheets a sufficient distance to permit replacement of said seal means.

10. A method for replacing a seal in a heat exchanger or like construction having a shell defining a chamber having an open end, a closure member adapted to overlie said shell open end for closure thereof, seal means between said shell open end and said closure member, means maintaining said closure member in substantially closed relationship with said shell open end including heat exchange tubes rigidly connected to said closure member and an expansion joint on said shell, comprising the steps of: separating said shell open end from said closure member by varying the length of said shell in opposition to said expansion joint a sufficient distance to permit replacement of said seal means, and replacing said seal.

11. A method for replacing a seal in a heat exchanger or like construction having a shell defining a chamber having an expansion joint and an open end, a closure member adapted to overlie and being maintained in closed relationship with said shell open end for closure thereof, and heat exchange tubes rigidly connected to said closure member, seal means between said shell open end and said closure member comprising the steps of: temporarily compressing said expansion joint a sufficient distance to permit replacement of said seal means and replacing said seal.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,231,012
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Carl W. Norris

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 65, for "joint" read -- shell --.

Signed and sealed this 17th day of January 1967.

(SEAL)
Attest:

ERNEST W. SWIDER
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Commissioner of Patents