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(54) "IMPROVEMENTS IN OR RELATING TO HEAT EXCHANGERS"

(71) We, UNITED KINGDOM ATOMIC ENERGY AUTHORITY LONDON, a British Authority do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to heat exchangers and in particular to the kind known as tube-in-shell heat exchangers in which a cluster of heat exchange tubes are connected by tube plates disposed one at each end and housed within a shell or container to which the tube plates are sealingly secured, a first fluid heat exchange medium being arranged to flow through the tubes and a second fluid heat exchange medium being arranged to flow through the shell.

In a tube-in-shell heat exchanger of the hereinbefore described kind wherein change of state of the second medium occurs at a considerably lower temperature than the temperature of the first medium, for example, in a heat exchanger where liquid sodium flows through the tubes and water flows through the shell, a condition can arise wherein the sodium passing through the tube plate at the water inlet end of the heat exchanger may be above the saturation temperature of the water. Although resultant boiling of the water in the region of the tube plate would tend to counter stagnation there is, nevertheless, a possibility that sub-cooled boiling associated with stagnation will occur in the central area of the tube plate. Such behaviour could be a source of corrosive effects during the life of a heat exchanger and the present invention is directed towards a solution of this problem.

According to the invention in a tube-inshell heat exchanger for effecting heat exchange between liquid metal and water, the heat exchanger comprising an elongate shell having two spaced transverse tube plates sealed to the shell to define end and intermediate chambers, a bundle of spaced parallel heat exchange tubes extending between the tube plates and interconnecting the end chambers for liquid metal flow, an inlet port for liquid metal flow to one of the end chambers, an outlet port for liquid metal flow from the other of the end chambers and an inlet port and an outlet port for flow of water through the intermediate chamber, the inlet and outlet ports for flow of water being at opposed ends of the intermediate chamber to define inlet and outlet end regions of the intermediate chamber, there is a tube member closed to liquid metal flow and extending from tube plate to tube plate in the intermediate chamber, the tube member having an inlet port for water adjacent the tube plate at the inlet end region of the intermediate chamber and an outlet port in the outlet end region of the intermediate chamber. The tube acts as a link for conducting water from the tube plate at the water inlet end region of the intermediate chamber to the other end region of the intermediate chamber and thereby prevents total stagnation of water on the surface of the tube plate at the water inlet end region of the heat exchanger; by preventing stagnation of water on the surface of the tube plate sub-cooled boiling and consequential corrosive effects are reduced.

Constructional embodiments of the invention are described, by way of example, with reference to the accompanying diagrammatic drawing wherein a sectional view of a tube-in-shell heat exchanger is illustrated.

The tube-in-shell heat exchanger shown in the drawing is for use as an evaporator in steam generating plant used in a nuclear reactor installation wherein primary and secondary reactor coolants are liquid sodium; steam is generated by heat exchange between water and the secondary reactor coolant.

The tube-in-shell heat exchangers each comprise an elongate shell 1 having two spaced transverse tube plates 2 and 3. The tube plates are circumferentially sealed to the shell to define end and intermediate chambers 4, 5 and 6, and there is a bundle of spaced parallel heat exchange tubes 7 extending between the tube plates to interconnect the end chambers 4, 5 for liquid metal flow. There is an inlet port 8 for liquid metal flow into the end chamber 5 and an outlet port 9 for liquid metal flow from the end chamber 4. Inlet and outlet ports 10, 11, for flow of water through the intermediate chamber, are disposed at opposed ends of the intermediate chamber thereby defining inlet and outlet end regions 12, 13.

There is a tube member 14 which is closed to liquid metal flow and which extends from tube plate to tube plate in the intermediate chamber. The tube member 14 has an inlet port 15 for water adjacent the tube plate 2 and an outlet port 16 in the outlet end region 13 of the intermediate chamber. The tube member 14 provides a link for conducting water from the surface of the tube plate 2 to the region 13 of the intermediate chamber thereby to reduce stagnation and consequential corrosive effects on the water contacting surface of the tube plate 2.

In a first construction of heat exchanger the ends of the tube member 14 are open. The tube member 14 is of larger outside diameter than the heat exchange tubes 7 and is latterally supported by neighbouring heat exchange tubes 7.

In an alternative construction the tube member 14, has closed ends and is end supported by penetration of the tube plates. The end regions of the tube member 14 are perforated within the intermediate chamber adjacent the tube plate 2 and in the end region 13 to provide inlet and outlet ports 15, 16 for flow of water.

Each of the described heat exchangers may have a plurality of tube members 14 dispersed throughout the bundle of heat exchange tubes.

WHAT WE CLAIM IS:—

1. A tube-in-shell heat exchanger for effecting heat exchange between liquid metal and water, the heat exchanger comprising an elongate shell having two spaced transverse tube plates sealed to the shell to define end and intermediate chambers, a bundle of spaced parallel heat exchange tubes extending between the tube plates and interconnecting the end chambers for liquid metal flow, an inlet port for liquid metal flow to one of the end chambers, an outlet port for liquid metal flow from the other of the end chambers and an inlet port and an outlet port for flow of water through the intermediate chamber, the inlet and outlet ports for flow of water being at opposed ends of the intermediate chamber to define inlet and outlet end regions of the intermediate chamber, and wherein there is a tube member closed to liquid metal flow extending from tube plate to tube plate in the intermediate chamber, the tube member having an inlet port for water adjacent the tube plate at the inlet end region of the intermediate chamber and an outlet port in the outlet end region of the intermediate chamber.

2. A tube-in-shell heat exchanger according to claim 1 wherein the tube member has open ends and is laterally supported by neighbouring heat exchange tubes.

3. A tube-in-shell heat exchanger according to claim 1 wherein the tube member has closed ends and is end supported by penetration of the tube plates, the inlet and outlet ports for flow of water being perforations in the wall of the tube member.

4. A tube-in-shell heat exchanger substantially as hereinbefore described.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*