SYSTEM FOR FILLING AND EMPTYING OF HEAT EXCHANGERS

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Abstract

With outdoor erected surface heat exchangers care has to be taken of filling up and emptying in cold weather since the cooler liquid may freeze in in the heat exchanger tubes and destroy them. Thus, quick filling up and emptying is necessary.

This is obtained by employing a communication line with a regulating flap between a supply conduit connected to the inlets of the heat exchangers, and a reflux conduit connected to the outlet thereof. The communication conduit has an oblique position inclined towards the supply conduit so that the regulating flap in it will be closed only in normal operation of the system where the flap of the device is pressed down on its seat by the overpressure prevailing in the supply conduit with respect to the reflux conduit.

The advantage of the arrangement consists in that the heat exchangers can be filled up in the reverse direction and emptied through a drain conduit quickly and with simultaneous deaerating and air introduction, respectively. Moreover, a relatively lesser number of component parts is required.

5 Claims, 4 Drawing Figures
SYSTEM FOR FILLING AND EMPTYING OF HEAT EXCHANGERS

This invention relates to a system for filling and emptying of heat exchangers, particularly of the double-flow type.

As is known, the employment of air cooled surface heat exchangers for recooling the cooling water e.g., of steam turbine power plants is rapidly gaining ground. Their operation or starting is a relatively simple matter in fair weather. However, if the weather is cold the starting of heat exchangers especially of the multi-flow type may strike upon serious difficulties and may even cause damages. Namely, the heat exchangers comprise a great number of parallelly connected tubes. The bank of tubes in which the water flows downwards in operation may freeze in if the heat exchanger is not properly deaerated and the air trapped in the tubes happens to interrupt the flow of water.

In order to obtain a suitable deaeration the heat exchangers ought to be filled up with water slowly. With slow filling up, however, the water introduced into the cold heat exchangers may freeze in in the tubes or in a part thereof during such filling. Therefore, in cold weather, filling up has to be carried out quickly and with ensuring a perfect deaeration.

It has been suggested to obtain such deaeration by filling up the heat exchangers in the reverse direction. It means that e.g., double-flow heat exchangers provided with inlet and outlet valves and erected in the open air are filled up in such a manner that first the outlet valve of the heat exchanger is opened so that, thereby, first the return branch thereof is filled up in a direction which is opposite to the direction of normal operational water flow. The inlet valve of the heat exchanger is opened only subsequently and with a certain delay. By such method, all banks of tubes (flows) of the heat exchanger the filling up liquid will flow in upward direction and will push out the air in front of it. Such displaced air may withdraw through air escape valves provided on top the heat exchangers and no air will be trapped in the return flows or branches thereof which might cause operitional troubles and deteriorate the heat transmission capacity or cause the cooling water to freeze in individual tubes and destroy the heat exchanger in cold weather.

Obviously, if air bubbles are trapped in the forward branch or flow of the heat exchanger, they will be carried towards the air escape valves once normal water flow sets in. On the other hand, an air bubble in the return branch or flow would try to approach the air escape valve by flowing in a direction which is opposite to the direction of normal flow and would be prevented from such upward displacement by the downwardly directed normal flow of the cooling medium. The result is that the air bubble stays at the place where it has been trapped and forms an air plug which stops the water flow in the respective tube. By filling up in the reverse direction referred to above such stopping by air bubbles may be obviated.

Current practice of filling up in the reverse direction consists in providing individual double flow heat exchangers or groups of such parallelly connected heat exchangers with four shut-off means such as valves operated manually or automatically. Of these means, a pair is destined to serve for shutting-off the cooler liquid at the entrance and the exit of the heat exchangers while another pair serves for draining the cooler liquid from both flows thereof. In case of automatic program control, an opening of the shut-off means at the entrance is, e.g., by employing a time switch, delayed with respect to the opening of the shut-off means at the exit.

It has been found that such filling up in the reverse direction is handicapped by that the pressure prevailing on the exit side of the heat exchanger is smaller than the corresponding value on the entrance side. Consequently, the return side of the heat exchanger is filled up with cooler liquid at a slower speed than the other one. Thus, a still greater delay has to be employed in which also the lead of the forward branch or side is suitably considered. It means that the time period during which the shut-off means on the entrance side is open, has to be selected too high. In case of employing a plurality of heat exchangers or groups of such units the aforesaid pressure difference necessarily changes as the individual heat exchangers or heat exchanger groups are being filled up one after the other. Thus, the delay in opening the entrance shut-off means can in before be adjusted to an average value only which ensures a complete deaeration at filling up all heat exchangers and heat exchanger groups without, however, permitting to obtain the shortest possible period of filling time.

Though, filling up in the reverse direction and increasing the delay in opening the entrance side shut-off means increases the reliability of deaeration, such delay entails temperature strains in the heat exchangers since one of their flows is filled up by warm cooling water employed for filling up purposes while the other flow will be warmed up later due to the delay referred to above.

The main object of the present invention is to obviate the aforesaid difficulties without abandoning the principle of reverse filling up which may be carried out quickly and without temperature strains caused by operational delays.

The system for filling up and emptying heat exchangers of the multiflow type comprises, in combination, a heat exchanger with an inlet and an outlet for a cooling liquid, associated each with another flow of the heat exchanger, a supply conduit connected to said inlet, a return conduit connected to said outlet, and a drain conduit branching off said supply conduit; shut-off means being provided in each of said supply conduit, return conduit and drain conduit. According to the main feature of the present invention a regulating flap is provided in a communication conduit connecting said supply conduit with said return conduit, said regulating flap being arranged for permitting a flow rom said return conduit into said supply conduit and to prevent a flow in opposite direction.

Further details will be described by taking reference to the accompanying drawings which show, by way of example, various embodiments of the system according to the invention and in which:

FIG. 1 is a connection diagram showing one embodiment of the system according to the invention.
FIG. 2 is a longitudinal sectional view of a regulating flap.
FIGS. 3 and 4 are connection diagrams of further exemplified embodiments of the system according to the invention.

Same reference characters refer to similar details throughout the drawings.
In the drawing, FIG. 1 shown a system comprising a series of heat exchangers 8 connected in parallel between a supply conduit or distributing line 6 and a return conduit or collecting line 7. A drain conduit 17 branches off the supply conduit 6. All three conduits 6, 7 and 17 are provided with shut off means such as valves 1, 2 and 3, respectively. Reference numeral 5 refers to automatic air escape valves on top the heat exchangers 8.

In compliance with the invention, a communication conduit 9 is provided between the supply conduit 6 and the return conduit 7 which comprises a regulating flap 4 arranged for permitting a flow from the return conduit 7 into the supply conduit 6 whereas a flow in the opposite direction is prevented thereby. With the represented embodiment, this is obtained by that the regulating flap 4 is disposed in an oblique portion of the communication conduit inclined toward the supply conduit 6 as shown in FIG. 1.

Such inclined position of the communication conduit 9 permits to employ simple regulating flaps such as shown in FIG. 2 the valve disk and valve seat of which are referred to by reference characters 10 and 11, respectively. Obviously, the valve disk 10 will not occupy its position on the valve seat 11 if there is no pressure difference between the supply conduit 6 and the return conduit 7. It means that the regulating flap is open. On the other hand, a pressure increase in the supply conduit 6 will cause the valve disk 10 to settle down on its seat 11 and to interrupt the flow path along the communication conduit 9.

In operation, a cooler liquid such as cooling water is admitted through the open shut off valve 1 into the supply conduit 6. After having traversed the heat exchangers 8 the cooling water withdraws through the return conduit 7 and the open shut off valve 2 is indicated by arrows. The regulating flap 4 in the communication conduit 9 is closed so that no cooling water will flow from the return conduit 7 into the supply conduit 6 through the communication conduit 9 which would mean a short-circuiting of the system.

If the system has to be emptied, shut off valves 1 and 2 are closed and the shut off valve 3 is opened. Then, the cooler liquid will be drained from the heat exchangers 8 through both the supply conduit 6 and the return conduit 7 as well as the communication conduit 9 and the drain conduit 17. Ambient air is automatically permitted to enter the heat exchangers 8 through the air escape valves 5 so as to prevent the generation of vacuum in the system and, thereby, to prevent the water from flowing out of the heat exchangers 8.

On the other hand, when the system is to be filled up, the shut off valve 3 in the drain conduit 17 is closed while the shut off valve 2 in the return conduit 7 is opened with the shut off valve 1 in the supply conduit 6 left closed. Then, warm cooling water will enter the exit sides or flows (banks of tubes) of the heat exchangers 8 through the return conduit 7 pushing the air in front of them out of the conduits 6, 17, 5 into the ambiance.

Meanwhile, the warm cooling water flows through the communication conduit 9 and its open valve 4 also into the supply conduit 6 above the closed shut off valve 1 and begins to fill up the entrance side or flow (bank of tubes) of the heat exchanger 8 as well. Such filling up is delayed by the resistance of the regulating flap 4 and the communication conduit 9 which will have been selected accordingly. The rising water dispels the air also from the entrance sides or flows of the heat exchangers 8 through the air escape valves 5.

When the heat exchangers 8 are completely filled up with warm cooling liquid, the shut off valve 1 will be opened at an optional speed whereby circulation of the cooling liquid is set in. At the same time, the regulating flap 4 is closed by the pressure difference which appears between the pressure prevailing in the supply conduit 6 and the pressure prevailing in the return conduit 7, the former being higher than the latter due to the pressure drop along the conduits and the heat exchangers.

FIG. 3 shows an embodiment of the system according to the invention which differs from the previous one in several respects. It will be seen that, instead of one regulating flap 4, there is a pair of such flaps in parallel connection. Obviously, more than two parallelly connected regulating flaps 4 might be employed as well. The employment of more than one regulating flaps 4 with their associated communication conduits 9 results in an increased reliability of operation.

Furthermore, in the instant case the system is provided with a time pattern control means such as program control unit 12 which is operatively connected to the shut off valves 1, 2 and 3 by means of actuators 13, 14 and 15, respectively, as suggested by dotted lines in the drawing. The program control unit 12 ensures an automatic operation of the system in such a manner that after the shut off valve 3 being closed, first the actuator 13 of shut off valve 2 is given an opening impulse whereafter with a certain delay obtained e.g., by means of a time relay the actuator 14 of shut off valve 1 is operated so that the above described sequence of valve operation is obtained automatically.

FIG. 4 illustrates an exemplified embodiment which is distinguished from the previous one, apart from employing a single regulating flap 4, by the program control unit 12 being connected to a feeder 16 for ascertaining the level of cooling water in the heat exchangers 8. When the heat exchangers 8 are all filled up with water, opening impulse is given by the program control unit 12 to the shut off valve 1 in the supply conduit 6, whereupon normal operation of the system is entailed as described above.

Hereinbefore, the invention has been described in connection with three heat exchangers 8. Obviously, more or less heat exchangers or groups of such heat exchangers might be provided with a filling up and emptying system according to the invention.

Moreover, the represented embodiments have been provided with automatic air escape valves. Instead of such valves, stand pipes connected to individual conduits or to a common conduit might be arranged on top the heat exchangers.

It will be seen that the system according to the invention is distinguished by a series of advantages.

The various flows and more particularly the banks of tubes of the heat exchangers connected to the supply conduit and to the return conduit, respectively, will be filled up by a cooler liquid or cooling water of uniform temperature. Thus, no temperature strains or only minimum values thereof will appear in the heat exchangers when they are being filled up.

Filling up of the supply conduit or distributing line 6 is suitably delayed by the regulating flap 4 with respect
to the return conduit 7 whereby first the return conduit 7 of the heat exchangers and their associated flows or banks of tubes will be filled up with warm cooling water. It means that, first, filling up is carried out in parts with which deaeration is relatively more important. By that way, the heat exchangers will surely be perfectly deaerated.

Moreover, it is excluded that, due to changes in the pressure relations or to adjustments of the opening times of the shut off valves, first the flows of the heat exchangers associated with and connected to the supply conduit 6 be filled up with cooling water which, then, spilling over into the downstream flows would reach the return conduit and would prevent a proper deaeration of that part of the system.

The time period of opening of the shut off valve 1 may be selected optionally and has not to be adapted to filling conditions.

Filled up condition of the heat exchangers may be ascertained by relatively simple means such as swimmers which operate switches. Moreover, in case of automatic control, impulses given by such swimmer operated switches may be used for triggering the opening procedure of shut off valve 1.

If a plurality of heat exchangers or groups thereof are employed in parallel connection, the system according to the invention permits a reliable deaeration even if individual heat exchangers or groups thereof are started in sequence.

In addition, the amount of the cooler liquid traversing already started heat exchangers will not be altered by the amount of cooler liquid used for and by the speed of filling up.

In order to ensure complete emptying of the system the communication conduit 9 comprising the regulating flap 4 is connected to the deepest point of the return conduit 7 and is disposed at an inclined position with respect to the supply conduit 6 so that the valve disk 10 normally does not engage its seat 11 as has been explained above. Therefore, the regulating flap 4 does not require any pressure difference for being opened and for the cooler liquid being entirely drained off the return conduit 7. The inclination of the regulating flap 4 is selected so that the pressure difference appearing in normal operation of the system and caused mainly by the flow resistance in the heat exchangers will keep the regulating flap 4 in its closed position.

Finally, the system according to the invention has the advantage that only three shut off means rather than four have to be operated manually or distance controlled.

What we claim is:

1. A system for filling and emptying of multiflow heat exchangers comprising, in combination, a heat exchanger with an inlet and an outlet for a cooling liquid, associated each with another flow of the heat exchanger, a supply conduit connected to said inlet, a return conduit connected to said outlet, a drain conduit branching off said supply conduit, shut off means in each of said supply conduit, return conduit and drain conduit, a communication conduit connecting said supply conduit with said return conduit, and a regulating flap in said communication conduit arranged for permitting a flow from said return conduit into said supply conduit, and to prevent a flow in the opposite direction.

2. In a system for filling and emptying of multiflow heat exchangers as claimed in claim 1 the further improvement of said regulating flap being disposed in an oblique portion of said communication conduit inclined toward said supply conduit so as to be opened in inoperational position of the system and closed in operation thereof where the pressure prevailing in said supply conduit is higher than the pressure in said return conduit due to the pressure drop in the heat exchangers.

3. In a system for filling and emptying of multiflow heat exchangers as claimed in claim 1, the further improvement of the provision of means for opening the shut off means in said return conduit prior to opening the shut off means in said supply conduit so as to fill up the heat exchangers through said return conduit.

4. In a system for filling an emptying of multiflow heat exchangers as claimed in claim 3 the further improvement of the provision of a time pattern control means comprising a feeler for triggering the opening of the shut off means in said supply conduit, said feeler being arranged for yielding a triggering impulse upon said heat exchangers being filled up with cooler liquid.

5. In a system for filling and emptying of multiflow heat exchangers as claimed in claim 2 the further improvement of a number of said regulating flaps being provided in parallel connection.