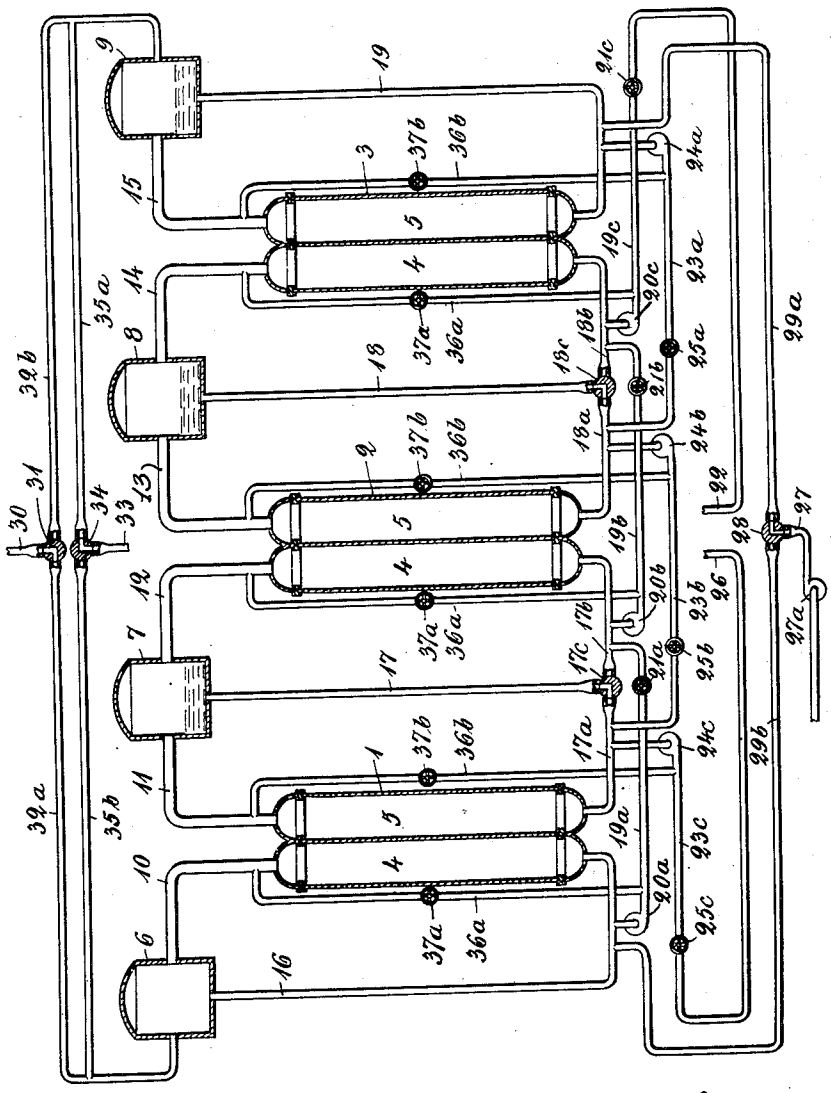
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HEAT TREATING A FLUID SUBSTANCE

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HEAT TREATING A FLUID SUBSTANCE

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This invention relates to heat treating and more particularly to a method and apparatus for heat treating a fluid substance tending to deposit scale in a multiple stage system including a plurality of heat exchangers. In plants of this kind each heat exchanger has passages for conducting the said substance and a vaporized heating medium in heat exchange relation.

It is desired, in such plants, to interchange the paths of flow of the fluid to be treated and the heating medium through the heat exchangers so that, at predetermined intervals of time, the latter medium is conducted through the passages which during the preceding cycle have served to conduct the fluid to be treated. In that manner, scale deposited from the fluid during its flow in the latter passages will be dissolved and removed by the action of the vapor and condensate conducted through the same passages during the succeeding cycle so as to keep the heat exchanging surfaces clean. This rinsing method has proved to be very effective and practical but a disadvantage is that in large plants the requisite changing valves for the supply of vapor will be very bulky and expensive.

It is therefore an object of this invention to enable an interchange of the paths of flow of the fluid and the heating medium in a more simple manner and to reduce the number of the requisite valves to a minimum.

It is a further object of the invention to change periodically the order in which said fluid to be treated and said heating medium are passed in succession from one heat exchanger to the other in the system, and at the same time to interchange the paths of flow of said fluid and heating medium through the individual heat exchangers and also through the associated conduits, valves, pumps, etc.

A still further object of the invention is to reverse the direction of flow of the heating vapor and if desired also the flow of the said fluid through the system so as to alternate the first and last stages in the system, i. e. to cause the first heat exchanger in the series of stages to be the last heat exchanger in the succeeding cycle of operation, at the same time enabling an interchange of the passages of the fluid and the heating medium in the individual heat exchangers without the necessity of providing changing valves in the inlets of the heating medium (vapor).

A further object of the invention is to provide a flash chamber intermediate each stage of the system and also an additional flash chamber connected to the first stage of the system and to enable the first and the last flash chambers in the series of stages to be connected alternatively to a common inlet for heating vapor and to a common outlet for the exhaust vapor, if desired communicating with a condenser for the exhaust vapor.

It is also an object of the invention to reverse the flow of the heating medium simultaneously with reversing the path of flow of the fluid to be treated, for instance so as to apply the countercurrent principle in the heat exchangers in all operation stages of the system, and to provide valved interconnection conduits between the individual stages for this purpose.

Further objects and advantages of the invention will be apparent from the following description, taken in conjunction with the accompanying drawing, wherein the single figure is a view partially in section diagrammatically illustrating the application of this invention to a multiple stage evaporation plant. Parts of identical function are indicated by the same reference characters.

The drawing illustrates as an example an embodiment of a multiple stage system for evaporating a fluid substance, with three heating stages, each comprising a heat exchanger 1, 2, and 3, respectively. Each heat exchanger has separate passages 4 and 5 for passing from the top to the bottom through one passage a vaporized heating medium in heat exchange relation with the fluid substance which is passed from the bottom to the top through the other passage. A piping 10 connects a chamber or vessel 6 to the top of the passage 4 of the first heat exchanger 1 and a piping 16 connects said chamber 6 to the bottom of said passage 4. Through a piping 15 a chamber or vessel 9 communicates with the top of the passage 5 of the last heat exchanger 3 of the system. By means of pipings 11 and 12 a further chamber or vessel 7 is connected to the top of the passage 5 of the heat exchanger 1 and to the passage 4 of the heat exchanger 2, respectively. A piping 17*a* from the bottom of the passage 5 of the heat exchanger 1 and a piping 17*b* from the bottom of the passage 4 of the heat exchanger 2 are adapted alternatively to be connected to a piping 17 communicating with the chamber 7. For this purpose a three way valve 17*c* is provided in the piping system 17, 17*a*, 17*b*. In a similar manner pipings 13 and 14 connect a chamber or vessel 8 to the top of the passage 5 of the heat exchanger 2 and to the passage 4 of the heat exchanger 3, respectively, and a three way valve 18*c* is adapted alternatively to connect a piping 18 from said chamber 8 to either of pipings 18*a* and 18*b* communicating with the bottom of passage 5 of the heat exchanger 2 and with the bottom of passage 4 of the heat exchanger 3, respectively.

A pump 20*a* is provided in a piping 19*a* having a regulating valve 21*a* and adapted to interconnect the passages 4 of the heat exchangers 1 and 2. In a similar manner a pump 20*b* is provided in a piping 19*b* having a regulating valve 21*b* and adapted to interconnect the passages 4 of the heat exchangers 2 and 3. There is also provided a pump 20*c* in a piping 19*c* having a regulating valve 21*c* and adapted to connect the passage 4 of the heat exchanger 3 to an outlet 22. Thus, these pipings 19*a*, 19*b*, 19*c* interconnect in series the passages 4 of the heat exchangers in the order 1 to 2 to 3 and finally to the outlet 22 from the plant. A piping 23*a* having a regulating valve 25*a* and a pump 24*a* interconnects the passages 5 of the heat exchangers 3 and 2, and a piping 23*b* with a regulating valve 25*b* and a pump 24*b* interconnects the passages 5 of the heat exchangers 2 and 1, while a piping 23*c* with a regulating valve 25*c* and a pump 24*c* connects the passage 5 of the heat exchanger 1 to an outlet 26. Thus, the pipings 23*a*, 23*b*, and 23*c* interconnect in series the passages 5 of the heat exchangers in the order 3 to 2 to 1 and finally to the outlet 26 from the plant.

An inlet 27 to the plant with a pump 27*a* is connected to a three way valve 28 adapted alternatively to connect said inlet to either of two branch conduits 29*a* or 29*b*, of which the conduit 29*a* communicates with the passage 5 of the heat exchanger 3 while the conduit 29*b* communicates with the passage 4 of the heat exchanger 1. As aforesaid the passage 5 of the heat exchanger 3 is connected in series with the passages 5 of the heat exchangers 2 and 1 through the pipings 23*a*, 23*b* and 23*c* while the passage 4 of the heat exchanger is connected in series with the passages 4 of the heat exchangers 2 and 3 through the pipings 19*a*, 19*b*, 19*c*.

A further inlet 30 to the plant is connected to a three way valve 31 adapted alternatively to connect this inlet to either of two branch conduits 32*a* or 32*b* communicating with the chambers 6 and 9 respectively. Thus, by setting the three way valve 31 in one position or the other the inlet 30 may be connected alternatively to either of the passage 4 of the heat exchanger 1 or the passage 5 of the heat exchanger 3.

An outlet 33 from the plant is connected to a three way valve 34 adapted alternatively to connect said outlet 33 to either of the chambers 9 or 6 through branch conduits 35*a* and 35*b*, respectively.

A modification of the plant may be made by providing conduits 36*a* and 36*b* having valves 37*a* and 37*b*, respectively, and adapted to connect the piping systems 19*a*, 19*b*, 19*c* and 23*a*, 23*b*, 23*c* with the tops of the passages 4 and 5, respectively.

In the operation of the plant now described and assuming that the valves 17*c*, 18*c*, 28, 31 and 34 are set in the positions shown in the drawing a diluted fluid substance (for instance sulphite waste liquor) is supplied from an external source and fed into the heating system through the inlet 27 and the piping 29*a* to the passage 5 of the heat exchanger 3 and from this passage through the pipings 23*a* and 23*b* to the passages 5 of the other exchangers 2 and 1.

A vaporized heating medium is supplied to the passage 4 of the heat exchanger through the inlet 30, the branch conduit 32*a*, the chamber 6 and the piping 10. In the heat exchanger 1 the heating vapor is condensed and the fluid substance supplied to the passage 5 of the same heat exchanger is heated and partially vaporized, causing a mixture of vapor and liquid to escape from the top of the passage 5 and to flow through piping 11 to chamber 7 in which vapor and liquid are separated and from which the liquid is returned to circulation through the piping system 17 and 17*a* to the bottom of said passage 5.

From chamber 7 the vapor is supplied as heating medium through piping 12 to passage 4 of the heat exchanger 2 in which an analogous heat exchanging process concerning the heating medium and the fluid to be heated will take place similarly as described with reference to the heat exchanger 1. Vapor is passed from chamber 8 to the heat exchanger 3 in which said process is repeated once again and, finally, vapor is withdrawn from the chamber 9 and the heating system through the branch conduit 35*a* and the outlet 33. The piping 18, 18*a* serve as a circulation system similar to that provided by the piping 17 and 17*a*.

The concentrated fluid substance is withdrawn from the heating system through the outlet 26 by means of the piping 23*c*, the rate of withdrawal being regulated by valve 25*c*. The feeding of fluid substance from stage to stage is regulated by valves 25*a* and 25*b*, respectively.

Condensate from the individual passages 4 is withdrawn from the outlet 22 through the piping system 19*a*, 19*b* and 19*c*, the flow through the individual conduits being regulated by the valves 21*a*, 21*b* and 21*c*, respectively.

It will be understood that changing of the paths of flow according to the invention may be accomplished by operating five valves only for the whole plant, namely, by turning over the three-way valves 31, 34, 28, 17*c* and 18*c* from the positions shown so that the inlet 30 will be connected to the branch conduit 32*b* while the outlet 33 will be connected to the branch conduit 35*b*, the inlet 27 to the branch conduit 29*b*, and the pipings 17 and 18 will be connected to the pipings 17*b* and 18*b*, respectively.

The result will be that not only are the paths of flow of the heating medium and the heated fluid interchanged in each heat exchanger but also the position of the pressure stages and the temperature stages will be reversed so that the whole scheme of flow of the different media from one heat exchanger to the other will be changed in a "mirror image" relation, thus equalizing the working conditions which are apt to influence the degree of the tendency of deposition of scale. The sense of the expression "mirror image relation" may be explained by reference to an example. Assuming that during one cycle of operation one or both media are passed through a system of four stages 1, 2, 3, 4 in the order 3-4-2-1, then a change of the order into a "mirror image relation" during the next cycle of operation will mean that the media will pass through the system in the

order 2-1-3-4. To arrive at this "mirror image order" one may imagine that the numeration of the series 1, 2, 3, 4 be reversed into 4, 3, 2, 1 and that in this series the media be passed in the same numerical succession as during the first cycle. It will be appreciated that the result will be a new order 2-1-3-4 as aforesaid.

It will also be appreciated that on interchanging the paths of flow of the heating medium and the scale forming fluid not only the passages of the heat exchangers but also the feeding pumps and most parts of the piping system of the plant will carry opposite media and benefit from the scale dissolving properties of the condensate.

By-pass conduits 36*a* and 36*b* having valves 37*a* and 37*b*, respectively, may be connected between the pipings 10 and 19*a*, 11 and 23*c*, 12 and 19*b*, 13 and 23*b*, 14 and 19*c*, 15 and 23*a*, respectively, to circulate condensate through the heating medium passages so as to strengthen the scale dissolving effect therein.

While the drawing shows an installation by which the invention may be practised, it will be understood that the changing of the paths of flow as described above is not limited to the operation of the device shown but may be accomplished by other modified means.

What I claim is:

A multiple stage heat treating system comprising a plurality of heat exchangers, for indirectly exchanging heat between a vaporized heating medium and a fluid substance tending to deposit scale, each heat exchanger having a first passage for conducting one of the heat exchanging media and a second passage for conducting the other of the heat exchanging media in heat exchange relation, a first separation chamber having a top space connected to the top part of said first passage of the heat exchanger of one end stage in the system and a bottom space connected to the bottom part of the same passage, a further separation chamber intermediate each adjacent pair of stages of the system having a top space connected to the top part of the second passage of the preceding heat exchanger and also connected to the top part of the first passage of the succeeding heat exchanger, a bottom space in the latter separation chamber, pipe connections from said last mentioned bottom space to the bottom parts of the two last mentioned passages, means for alternatively connecting the pipe connections from said last mentioned bottom space to either of said two last mentioned passages, a last separation chamber having a top space connected to the top part of the second passage of the heat exchanger of the other end stage in the system and also having a bottom space connected to the bottom part of the same passage, a first conduit system interconnecting the first passages of the individual heat exchangers, a second conduit system interconnecting the second passages of the individual heat exchangers, an outlet from each of said conduit systems, valved connections for alternate supply of the fluid substance from an external source to the second or to the first passages of the heat exchangers, valved connections for alternate supply of vaporized heating medium from an external source to the first separation chamber or to the last separation chamber and valved connections for alternate withdrawing of fluid substance vapour from the last separation chamber or from the first separation chamber.

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