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APPARATUS FOR THE HEAT TREATMENT OF FLUIDS

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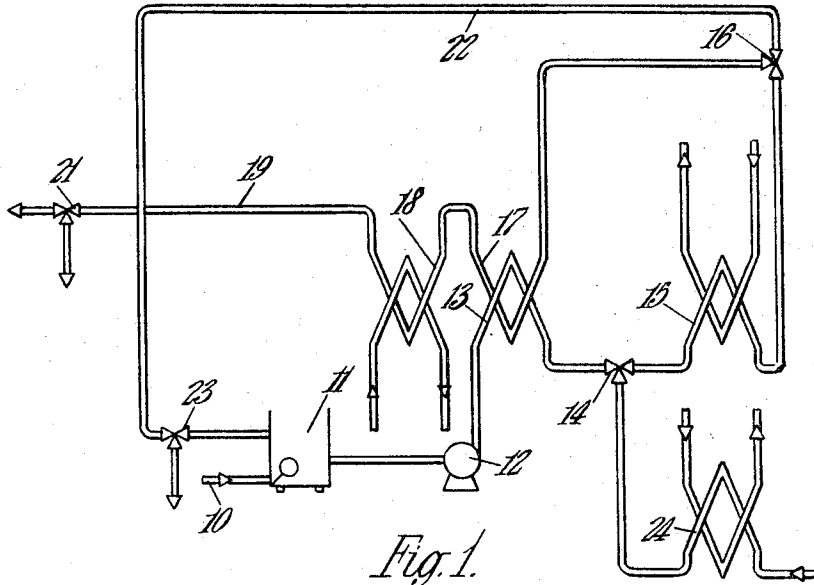


Fig. 1.

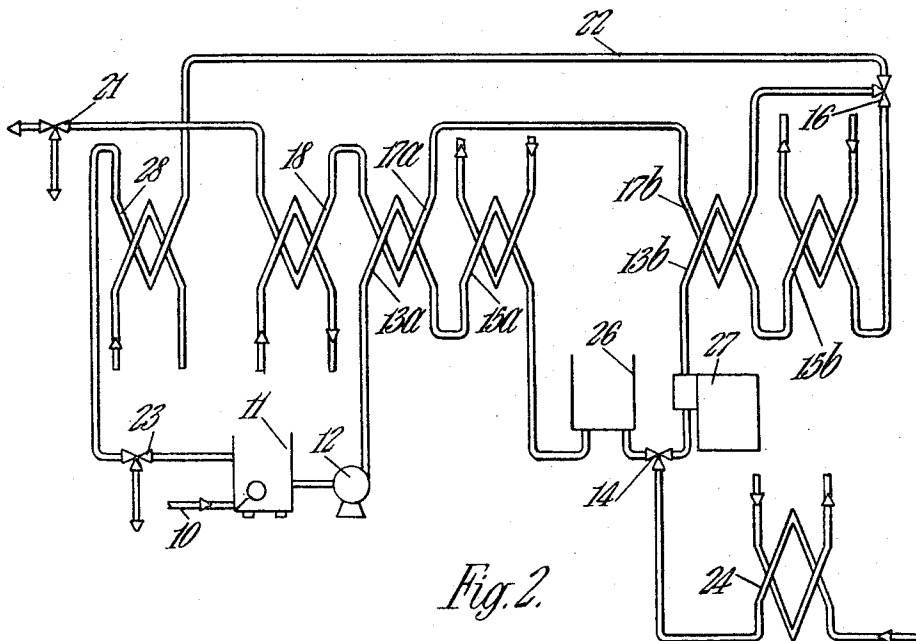


Fig. 2.

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APPARATUS FOR THE HEAT TREATMENT OF FLUIDS

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This invention relates to apparatus for the heat treatment of fluids involving one or more heat regeneration stages in which fluid passing to a heat treatment stage is passed in indirect heat exchange relationship with fluid which has been heat treated, and to a method of use of such apparatus.

A conventional heating and regeneration stage includes an automatic flow diversion valve which at normal operating temperature passes the fluid leaving a heat exchanger to the downstream side of the regenerator and to outlet, but which at temperatures below the required operating temperature recycles the fluid. The flow diversion valve is primarily designed to protect the sterile outlet side from contamination by incompletely treated milk or other fluid. During starting up the fluid is recycled so that there is no regeneration and all heating to bring the fluid up to the required temperature for the fluid to be passed out as treated has to be obtained from the heat exchanger.

In plant where the proportion of heat obtained by regeneration is high this means that the starting up period can be very long and to reduce this period it is normal for the heat exchanger to have more plates than are necessary for normal operation. In particular processes this can be deleterious as it involves the process fluid being held at high temperature for a longer period than is desirable leading to over-treatment, and possibly to increased deposition of denatured protein products on the heat exchanger plates.

This last difficulty arises particularly in the ultra high temperature (U.H.T.) treatment of milk where it is essential that the milk be held at the high temperature (c. 275° F.) for a very short time, and it is particularly, but not solely, to this process that the present invention relates.

The invention consists in apparatus for heat treating fluids, especially milk or other liquid food, comprising a regeneration heat exchanger through one side of which the process fluid passes on its way to a treatment heat exchanger, a flow diversion valve downstream of the treatment heat exchanger adapted selectively to recycle the process fluid or to pass it to the other side of the regeneration heat exchanger and a fluid outlet, an auxiliary fluid inlet between the said one side of the regeneration heat exchanger and the treatment heat exchanger, a drain outlet in the recycling line, and a further drain outlet in the output line downstream of the said other side of the regeneration heat exchanger.

Thus for starting, fluid, e.g. water, may be passed into the auxiliary inlet at a temperature substantially equal to that achieved by the process fluid at that point in normal operation, and the operating conditions are simulated so that the water leaving the treatment heat exchanger soon reaches normal output temperature and is passed via the flow diversion valve to the other side of the regeneration heat exchanger and out of the drain outlet in the output line. The process fluid, e.g. milk, may then be fed into the apparatus and is heated in the regeneration heat exchanger. When the process fluid reaches the auxiliary valve at the correct temperature this valve is changed over to allow process fluid instead of water to pass and the drain outlet in the output line is also changed

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over when process fluid starts to pass therethrough, to allow the process fluid to pass to the outlet.

An incidental advantage of this method of start up is that it also speeds up the sterilising of the output side of the plant. Water at treatment temperature can be passed through the plant for the time required to complete sterilising and the cooling medium for a cooling stage in the output side downstream of the regeneration heat exchanger can then be turned on.

The apparatus may be, and in the preferred form of a U.H.T. milk treatment plant is normally, in two or more stages of regeneration and external heating with a holder and a homogeniser between the stages. In such a plant the auxiliary outlet may be immediately downstream of the holder.

The hot water required during start-up may be produced in an auxiliary heat exchanger or by an additional section in the existing heat exchanger. Alternatively, water may be heated by direct injection of steam through an injector type heater.

The invention will be further described with reference to the accompanying diagrammatic drawings showing two embodiments of the invention.

In the drawings:

FIGURE 1 is a flow diagram of a single plant incorporating the invention, and

FIGURE 2 is a flow diagram of a preferred embodiment of the invention.

Referring first to FIGURE 1, the process fluid, e.g. milk, is fed via a line 10 into a float controlled balance tank 11 whence it is fed by a pump 12 to one side 13 of the regeneration heat exchanger. The process fluid then passes an auxiliary inlet valve 14 for use in starting up and into a treatment heat exchanger 15 in indirect heat exchange with a heating fluid in an external circuit. An automatic flow diversion valve 16 normally allows the process fluid to pass via the second side 17 of the regeneration heat exchanger and a cooling exchanger 18, through which a cooling medium passes, to an outlet line 19 which also includes a drain valve 21 for use in starting up.

When the process fluid leaving the heat exchanger 15 is not sufficiently hot the valve 16 diverts the flow via a recycling line 22 to the tank 11, whereby incompletely treated, non-sterile milk, is prevented from reaching the cooler sections of the output line. The line 22 includes a drain valve 23 for use in starting up.

The auxiliary inlet valve 14 is connected to an auxiliary heat exchanger 24, which may be an additional section of an existing heat exchanger, e.g. 15, arranged to heat water, or other fluid having similar heat transfer properties to the process fluid, for starting up purposes to a temperature equal to the temperature of the process fluid as it passes the valve 14 in normal operation.

In starting up, the water is passed through the heat exchanger 15 and diversion line 22 to the valve 23, where it is diverted to drain. The heating medium for exchange 15 is turned on and when the water reaches treatment temperature the automatic flow diversion valve 16 changes over and directs the water to the finished product side of the regeneration heat exchanger and to drain via valve 21.

Process fluid can now be brought into the balance tank 11 and passed through the regenerator 13, where it immediately acquires the correct temperature. As soon as process fluid reaches valve 14 this is turned over and the process fluid then follows water through the plant and eventually, when all the water is discharged from valve 21 this latter is turned over to direct the flow to the outlet.

FIGURE 2 shows a two stage plant arrangement, particularly designed for the ultra high temperature treatment of milk, and which has been modified in accordance with

the invention to improve and speed the starting-up procedure.

This type of plant incorporates two heating sections 15a and 15b and two regenerating sections 13a and 13b, with a holder tank 26 arranged to retain the product for a sufficient length of time and at a temperature whereat a large proportion of the product will become denatured.

The holder tank 26 in conventional plant has a considerable capacity (for milk it holds for six minutes) and consequently the start-up time is long. Start-up time can be reduced by increasing the plate area in the first and second stage heaters, but this is an unsatisfactory solution because it involves overholding the product during normal processing.

In the arrangement shown in FIGURE 2 the valve 14 has been placed between the two stages, and more precisely between the holder 26 and a homogeniser 27 which is immediately upstream of the regenerator section 13b and heating section 15b. The diversion line 22 includes a water cooled stage 28. The output line includes two regenerator sections 17b and 17a upstream of the cooler 18.

The proposed modification to this circuit is shown in FIGURE 2. As described in connection with FIGURE 1, hot water is introduced through valve 14 and is passed through the homogeniser 27 and second stage regenerator 13b and second heating section 15b, initially via the diversion line 22 and cooler 28, to drain via valve 23. When the heating medium is turned on in the second heater 15b, the product temperature quickly reaches the required value (for milk c. 275° F.) and the automatic flow diversion valve changes over and directs the flow to finished milk side of the exchanger and out to drain, via valve 21. Product can now be introduced into the float control balance tank 11 and can be heated to holding temperature, making full use of the first regeneration section 13a and the heating section 15a. The holder 26 can, thus, be filled with milk of the correct temperature and when it is full, the valve 14 can be changed over and milk will follow the water through the plant and eventually, when it reaches valve 21 this can be changed over to direct the flow to product outlet.

This arrangement enables the first heating section 15a to be plated to suit the duty on product and it need not incorporate additional plates required for start up from cold. This reduces the holding time during first stage heating and in turn reduces the deposition of denatured protein matter on the heating surface.

The plant may also include cleaning branch passages, and automatic control of cleaning and start up may be incorporated e.g. with the control valves pneumatically operated.

Various modifications may be made within the scope of the invention. While the preferred embodiment has been particularly described above with relation to milk it will be understood that plant incorporating the features of the invention may be used for any process fluid, whether liquid or gaseous.

We claim:

1. In a continuous process of heat treating a process fluid wherein the process fluid is passed successively in indirect heat exchange with outgoing treated process fluid in a regeneration heating stage, a heating fluid in a treatment stage, and with incoming process fluid in a regeneration cooling stage: a starting-up procedure comprising the steps of introducing an auxiliary fluid into the flow path of the process fluid at a point between the regeneration heating stage and the treatment stage at a temperature substantially identical to that of the process fluid at the said point in normal operation, continuously passing the said auxiliary fluid through the treatment stage and the regeneration cooling stage out of the system until the temperature stabilises, subsequently commencing to pass process fluid and cutting off the auxiliary fluid, continuing to pass auxiliary fluid and mixed auxiliary fluid and process fluid

out of the system and subsequently passing pure process fluid to a product outlet.

2. In a continuous process of heat treating a process fluid wherein the process fluid is passed successively through a regeneration heating stage a treatment heating stage, and a temperature sensitive diversion valve adapted to direct fluid selectively to a product output path including a regeneration cooling stage or to a recycling line if the process fluid leaving the treatment heating stage is too cool: a starting up procedure comprising the steps of introducing an auxiliary fluid into the flow path of the process fluid at a point between the the regeneration heating stage and the treatment stage at a temperature substantially identical to that of the process fluid at the said point in normal operation, continuously passing the said auxiliary fluid through the treatment stage, the diversion valve and the recycling line out of the system or the regeneration cooling stage out of the system until the temperature stabilises, subsequently commencing to pass process fluid and cutting off the auxiliary fluid, continuing to pass auxiliary fluid and mixed auxiliary fluid and process fluid out of the system and subsequently passing pure process fluid to a product outlet.

3. In a continuous process of heat treating a process fluid wherein the process fluid is passed successively through a first regenerating heating stage, a first treatment heating stage, a second regenerating heating stage, a second heating stage, and a product output line including a first and second regeneration cooling stage: a starting up procedure comprising the steps of introducing an auxiliary fluid into the flow path of the process fluid at a point between the first treatment heating stage and the second regeneration heating stage at a temperature substantially identical to that of the process fluid at the said point in normal operation, continuously passing the said auxiliary fluid through the second treatment heating stage and the regeneration cooling stage out of the system until the temperature stabilises, subsequently commencing to pass fluid and cutting off the auxiliary fluid, continuing to pass auxiliary fluid and mixed auxiliary fluid and process fluid out of the system and subsequently passing pure process fluid to a product outlet.

4. In a continuous process of heat treating a process fluid wherein the process fluid is passed successively through a first regenerating heating stage, a first treatment heating stage, a second regenerating heating stage, a second heating stage, and a temperature sensitive diversion valve adapted to direct fluid selectively to a recycling line or a product output line including a first and second regeneration cooling stage: a starting up procedure comprising the steps of introducing an auxiliary fluid into the flow path of the process fluid at a point between the first treatment heating stage and the second regeneration heating stage at a temperature substantially identical to that of the process fluid at the said point in normal operation, continuously passing the said auxiliary fluid through the second treatment heating stage, the diversion valve and the recycling line out of the system or the regeneration cooling stage out of the system until the temperature stabilises, subsequently commencing to pass process fluid and cutting off the auxiliary fluid, continuing to pass auxiliary fluid and mixed auxiliary fluid and process fluid out of the system and subsequently passing pure process fluid to a product outlet.

5. A process as claimed in claim 4, wherein the heat treatment includes a dwell stage between the first treatment heating stage and the second regeneration heating stage, the auxiliary fluid being introduced immediately downstream of the dwell stage.

6. A process as claimed in claim 5, wherein the process fluid is liquid milk and the auxiliary fluid is water.

7. Apparatus for continuously heat treating a process fluid comprising a treatment heat exchanger having a process fluid side with an upstream end and a downstream end, a regeneration heat exchanger having first and sec-

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ond sides, a piping connection between the first side of the regeneration heat exchanger and the upstream end of the process fluid side of the treatment heat exchanger, a flow diversion valve, a connection between the downstream end of the process fluid side of the treatment heat exchanger and the flow diversion valve, a process fluid outlet, a process fluid output line connecting the flow diversion valve through the second side of the regeneration heat exchanger to the process fluid outlet, and a recycling line connected to the flow diversion valve, the flow diversion valve being adapted selectively to recycle the process fluid emerging from the treatment heat exchanger via the recycling line or to pass this to the product output line depending on the temperature of the process fluid; comprising the improvement of an auxiliary fluid connection located in the piping connection before the first side of the regeneration heat exchanger; an auxiliary fluid heat exchanger for supplying hot auxiliary fluid, a piping connection between the auxiliary fluid heat exchanger and the auxiliary fluid connection whereby hot auxiliary fluid may be fed thereto, a drain outlet in the recycling line, and a further drain outlet in the output line downstream of the second side of the regeneration heat exchanger.

8. Apparatus for continuously heat treating a process fluid comprising a first and a second treatment heat exchanger each including a process first side having an upstream end and a downstream end, a first and a second regeneration heat exchanger each including a first side and a second side, a piping connection between the first side of the first regeneration heat exchanger and the upstream end of the process fluid side of the first treatment heat exchanger, a piping connection between the downstream end of the process fluid side of the first treatment heat exchanger and the first side of the second regeneration heat exchanger, a piping connection between the front side of the second regeneration heat exchanger

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with the upstream end of the process fluid side of the said treatment heat exchanger, a flow diversion valve, a connection between the downstream end of the process fluid side of the second treatment heat exchanger, a process fluid outlet, a process fluid output line connecting the flow diversion valve via the second side of the regeneration heat exchangers to the process fluid outlet, a recycling line, the flow diversion valve being adapted selectively to recycle the process fluid emerging from the downstream end of the process fluid side of the second treatment heat exchanger via the recycling line or to pass it to the outlet via the outlet line depending on the temperature of the process fluid: comprising the improvement of an auxiliary fluid connection located in the piping connection between the downstream end of the process fluid side of the first treatment heat exchanger and the first side of the said regeneration heat exchanger, a drain outlet in the recycling line, and a further drain outlet in the product outlet line downstream of the second sides of the regeneration heat exchanger.

9. Apparatus as claimed in claim 8, comprising a process fluid holder in the piping connection between the downstream end of the process fluid side of the first treatment heat exchanger and the first side of the second regeneration heat exchanger, the auxiliary fluid connection being between the said process fluid holder and the said first side of the second regeneration heat exchanger.

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