

PATENT SPECIFICATION (11)

1 319 552

DRAWINGS ATTACHED

- (21) Application No. 20150/71 (22) Filed 19 April 1971 (19)
(31) Convention Application No. 10233 (32) Filed 10 Feb. 1970 in
(33) United States of America (US)
(44) Complete Specification published 6 June 1973
(51) International Classification B01D 1/26 5/00
(52) Index at acceptance
B1B 2H 4B



(54) PREHEATERS

(71) We, AEROMET-GENERAL CORPORATION, a corporation duly organized and existing under the laws of the State of Ohio, United States of America, of 9100 East Flair Drive, El Monte, State of California, United States of America, 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 multiple effect evaporator apparatus, and particularly to preheaters for preheating feed liquor for multiple effect systems.

The present invention is concerned with a preheater for preheating feed liquor for multiple effect evaporator systems. The preheater in accordance with the present invention is particularly useful in connection with the multiple effect evaporator described and claimed in the copending Application No. 20456/71 (Serial No. 1,319,553). The preheater in accordance with the present invention may be utilized with the evaporator described in the aforementioned Application 20456/71 (Serial No. 1,319,553) in the manner described in copending Application No. 21480/71 (Serial No. 1,319,554).

As described in the aforementioned Application No. 21480/71 (Serial No. 1,319,554), a multiple effect distillation system comprises several evaporator effects serially arranged so that feed liquor is partially vaporized in each evaporator effect sequentially. Ordinarily, each evaporator effect utilizes a falling film evaporator wherein the liquor forms a thin film on a heat transfer wall and flows by means of gravity down one side thereof. Hot vapor is applied to the opposite side of the heat transfer wall so that condensation of the vapor occurs on one side of the wall and evaporation of the liquor occurs on the other. The hot vapor (condensate) condensed on the heat transfer wall transfers heat to the thin film of liquor on the opposite side thereof to thereby vaporize some of the liquor. The enriched liquor (concentrate) is usually fed to the subsequent effect of the

evaporator where it is further partially vaporized. A feed heater receives condensate from either an evaporator effect or from a previous feed heater stage or both. The feed heater is operated at a pressure below the pressure corresponding to the boiling point of the received condensate so that a portion of the condensate spontaneously evaporates in the presence of tubes carrying feed liquor to transfer heat to the feed liquor.

The present invention is particularly concerned with a preheater wherein superheated condensate, such as water, from a previous effect is spontaneously, partially evaporated to heat feed liquor.

In accordance with the present invention a preheater for use with a multiple effect evaporator comprises a housing having a plurality of sequentially placed chambers, conduit means extending longitudinally of the preheater through the several chambers for carrying feed liquor to the multiple effect evaporator, said conduit means being constructed of heat conductive material and comprising a bundle of tubes suitable for condensing vapour coming into contact therewith, first inlet means for introducing hot vapour into at least one of said chambers having an inlet from a respective effect of said multiple effect evaporator, second inlet means for introducing hot condensate to each of said chambers to form a condensate pool; outlet means for removing condensate from each of said chambers; and a downwardly-facing baffle trough in each chamber about the tube bundle therein with the apex of the trough opening through the housing to provide a vent for removal of vapour non-condensibles from the chamber, said baffle trough and contained tube bundle being treated at an opposite side of the chamber from the first inlet means, thus causing the introduced vapour to flow across the surface of the condensate pool before reaching the tube bundle.

The housing is preferably of substantially cylindrical configuration with the first inlet means opening into an upper first quadrant of the housing and the baffle trough located

principally in an adjacent upper second quadrant of the housing.

The nature of the invention should however be more fully understood from the following detailed description of a preferred embodiment which is illustrated in the accompanying drawings, in which:

Fig. 1 is a section view of a preheater in accordance with the presently preferred embodiment of the present invention;

Fig. 2 is a section view of the preheater illustrated in Fig. 1 taken at line 2—2 in Fig. 1, and

Fig. 3 is a schematic diagram of the operation of one stage of the preheater illustrated in Figs. 1 and 2.

Referring to the drawings, and particularly to Figs. 1 and 2, there is illustrated a preheater 10 which comprises a substantially cylindrical, or alternatively elliptical, housing 11 having end walls 12 and 13 and internal vertical bulkheads 14 and 15 dividing the housing into chambers 16, 17 and 18, respectively. Baffles 19 and 20 extend through housing 11 between end wall 12, bulkheads 14 and 15, and end wall 13. Baffles 19 and 20 define a downwardly-facing baffle trough in each chamber containing a bundle 21 of substantially cylindrical heat-conductive tubes. Each end of the tubes of bundle 21 are in fluid communication with manifolds 22 and 23 supported by end walls 12 and 13, respectively. Outlet conduit 24 is in fluid communication with manifold 22 and inlet conduit 25 is in fluid communication with manifold 23. Baffles 19 and 20 confine bundle 21 of tubes into a substantially triangular shape so that the lower portion or base of the triangular configuration of the bundle is exposed to chambers 16, 17 and 18 and the upper portion of the triangular configuration is in fluid communication through apertures 26 to manifolds 27, 28 and 29 above each chamber 16, 17 and 18, respectively. Each of manifolds 27, 28 and 29 include vent tubes 30, 31, 32, adapted to be vented to a lower pressure region such as a vacuum header or vacuum system (not shown).

Inlet conduits 33, 34 and 35 are arranged to introduce condensate from previous preheater stages and from evaporator effects where appropriate, as described in the aforementioned Application 21480/71 (Serial No. 1,319,554), into each respective chamber 16, 17 and 18. Likewise, conduits 36, 37 and 38 are adapted to introduce hot vapour, such as steam, from a respective evaporator effect where appropriate. In some cases each and every stage will introduce hot vapor and in others, only selected stages will receive vapor from an effect. Conduits 39, 40 and 41 are arranged to remove accumulated condensate from chambers 16, 17 and 18, respectively.

The operation of each stage of the pre-

heater in accordance with the present invention may be explained with reference to the schematic diagram of Fig. 3 wherein the reference numerals refer to corresponding portions of the structure illustrated in Figs. 1 and 2. Fig. 3 is a schematic diagram of one of the stages; it being understood that the other stages operate in the same manner. As illustrated in Fig. 3, the feed liquor which is admitted through inlet conduit 25, flows through the heating portion of tube bundle 21 in each one of the successive stages or chambers 18 and 17 (Fig. 2), and enters stage 16 as stream 25a and is exited from stage 16 through conduit 24. Hot vapor, such as steam from an evaporator effect of the evaporator described in the aforementioned Application 20456/71 (Serial No. 1,319,553), is admitted through inlet conduit 36 and directed at the heater portion or tube bundle 21 to heat the liquor therein.

Superheated condensate from a previous preheater stage or evaporator effect, as described in the Application 21480/71 (Serial No. 1,219,554), is admitted through inlet conduit 33 into chamber 16a of the preheater stage. The condensate in conduit 33 is preferably at a pressure substantially above the pressure in chamber 16a so that as the superheated condensate is introduced into chamber 16a, a portion of the condensate spontaneously evaporates, thereby cooling the remainder of the condensate. Although shown separately in Fig. 3 for purposes of explanation, chambers 16a and 16 comprise the same chamber in the physical embodiment as shown in Figs. 1 and 2.

The vapor in region 16a mixes in region 16 with hot steam introduced through conduit 36. The combined vapors are directed by baffles 19 and 20 to flow in a specific direction as the vapour condenses to heat the feed liquor in tube bundle 21. These baffles 19, 20 also force the vapor to flow across the surface of the liquid condensate 42, 43, thereby desuperheating the vapor. After the hot vapor condenses on the outside surface of the tubes of bundle 21 the condensate drips from the tubes and is collected at 42 in each chamber. The cooled condensate produced by condensing vapor on tube bundle 21 is combined with cooled condensate from the operation in region 16a and the combined condensate is exited through conduit 39.

The condensate collected in chamber 16 is withdrawn through conduit 39 and may be joined with condensate from the evaporator effect for introduction into a subsequent stage of the feed heater, such as through conduit 34 for chamber 17, and so on for continual operation as described.

To effectuate removal of non-condensable gas from the outside surfaces of the tubes

in bundle 21, the distance between the outermost tubes and the baffles 19 and 20 should not exceed the smallest distance between two adjacent tubes of the bundle. Furthermore, by maintaining the spacing between tubes and between the tubes and baffles uniform, the vapor flow in the tube bundle remains relatively uniform and turbulent over the entire transverse area at any point in the bundle and differential flow paths are substantially eliminated so the tubes are heated uniformly.

Tube bundle 21 is so disposed and arranged that the area of vapor flow within the tube bundle continuously decreases along the direction of the vapor flow. Thus, as vapor condenses on the tubes of the tube bundle and the mass of vapor continuously decreases due to the condensation of the vapor, the decreasing area of the flow somewhat offsets the reduction of the mass of the vapor so that the velocity of the vapor exceeds a predetermined minimum in all downstream portions of the tube bundle. For this purpose, the tube bundle is preferably substantially triangular with the apex of the triangle being vented through manifolds 27, 28, 29 and tubes 30, 31 and 32.

The present invention thus provides a preheater for a multiple effect evaporator system which is effective in operation and effectively transfers heat from condensate and from hot vapor to the feed liquor for such multiple effect evaporator system. Although the present invention has been described in connection with three stages of feed heating, it is to be understood that as many stages as desirable may be utilized, and that the specific example is not to be considered by way of limitation.

This invention is not to be limited by the embodiments shown in the drawings and described in the description, which is given by way of example and not of limitation.

WHAT WE CLAIM IS:—

1. A preheater for use with a multiple effect evaporator comprising:

a housing having a plurality of sequentially-placed chambers, conduit means extending longitudinally of the preheater through the several chambers for carrying feed liquor to the multiple effect evaporator, said conduit means being constructed of

heat conductive material and comprising a bundle of tubes suitable for condensing vapour coming into contact therewith;

first inlet means for introducing hot vapour into at least one of said chambers having an inlet from a respective effect of said multiple effect evaporator;

second inlet means for introducing hot condensate to each of said chambers to form a condensate pool;

outlet means for removing condensate from each of said chambers; and

a downwardly-facing baffle trough in each chamber about the tube bundle therein with the apex of the trough opening through the housing to provide a vent for removal of vapour non-condensibles from the chamber, said baffle trough and contained tube bundle being located at an opposite side of the chamber from the first inlet means, thus causing the introduced vapour to flow across the surface of the condensate pool before reaching the tube bundle.

2. A preheater in accordance with claim 1 wherein the housing is of substantially cylindrical configuration.

3. A preheater in accordance with claim 1 or 2 wherein the first inlet means opens into an upper first quadrant of the housing and the baffle trough is located principally in an adjacent upper second quadrant of the housing.

4. A preheater in accordance with any of claims 1, 2 or 3 wherein the bundle of tubes is so disposed and arranged within the baffle trough that the vapour flow area of the vapour flowing in said tube bundle towards the apex of the trough continuously diminishes in the direction of vapour flow.

5. A preheater in accordance with any of claims 1 to 4 wherein the distance between the respective walls of the downwardly-facing baffle trough and the immediate first tube row of said bundle is not greater than the average distance between adjacent tubes of the bundle.

6. A preheater for use with a multiple effect evaporator substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

MARKS & CLERK,
Chartered Patent Agents,
Agents for the Applicants.

in bundle 21, the distance between the outermost tubes and the baffles 19 and 20 should not exceed the smallest distance between two adjacent tubes of the bundle. Furthermore, by maintaining the spacing between tubes and between the tubes and baffles uniform, the vapor flow in the tube bundle remains relatively uniform and turbulent over the entire transverse area at any point in the bundle and differential flow paths are substantially eliminated so the tubes are heated uniformly.

Tube bundle 21 is so disposed and arranged that the area of vapor flow within the tube bundle continuously decreases along the direction of the vapor flow. Thus, as vapor condenses on the tubes of the tube bundle and the mass of vapor continuously decreases due to the condensation of the vapor, the decreasing area of the flow somewhat offsets the reduction of the mass of the vapor so that the velocity of the vapor exceeds a predetermined minimum in all downstream portions of the tube bundle. For this purpose, the tube bundle is preferably substantially triangular with the apex of the triangle being vented through manifolds 27, 28, 29 and tubes 30, 31 and 32.

The present invention thus provides a preheater for a multiple effect evaporator system which is effective in operation and effectively transfers heat from condensate and from hot vapor to the feed liquor for such multiple effect evaporator system. Although the present invention has been described in connection with three stages of feed heating, it is to be understood that as many stages as desirable may be utilized, and that the specific example is not to be considered by way of limitation.

This invention is not to be limited by the embodiments shown in the drawings and described in the description, which is given by way of example and not of limitation.

WHAT WE CLAIM IS:—

1. A preheater for use with a multiple effect evaporator comprising:
a housing having a plurality of sequentially-placed chambers, conduit means extending longitudinally of the preheater through the several chambers for carrying feed liquor to the multiple effect evaporator, said conduit means being constructed of

heat conductive material and comprising a bundle of tubes suitable for condensing vapour coming into contact therewith;

first inlet means for introducing hot vapour into at least one of said chambers having an inlet from a respective effect of said multiple effect evaporator;

second inlet means for introducing hot condensate to each of said chambers to form a condensate pool;

outlet means for removing condensate from each of said chambers; and

a downwardly-facing baffle trough in each chamber about the tube bundle therein with the apex of the trough opening through the housing to provide a vent for removal of vapour non-condensibles from the chamber, said baffle trough and contained tube bundle being located at an opposite side of the chamber from the first inlet means, thus causing the introduced vapour to flow across the surface of the condensate pool before reaching the tube bundle.

2. A preheater in accordance with claim 1 wherein the housing is of substantially cylindrical configuration.

3. A preheater in accordance with claim 1 or 2 wherein the first inlet means opens into an upper first quadrant of the housing and the baffle trough is located principally in an adjacent upper second quadrant of the housing.

4. A preheater in accordance with any of claims 1, 2 or 3 wherein the bundle of tubes is so disposed and arranged within the baffle trough that the vapour flow area of the vapour flowing in said tube bundle towards the apex of the trough continuously diminishes in the direction of vapour flow.

5. A preheater in accordance with any of claims 1 to 4 wherein the distance between the respective walls of the downwardly-facing baffle trough and the immediate first tube row of said bundle is not greater than the average distance between adjacent tubes of the bundle.

6. A preheater for use with a multiple effect evaporator substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

MARKS & CLERK,
Chartered Patent Agents,
Agents for the Applicants.

