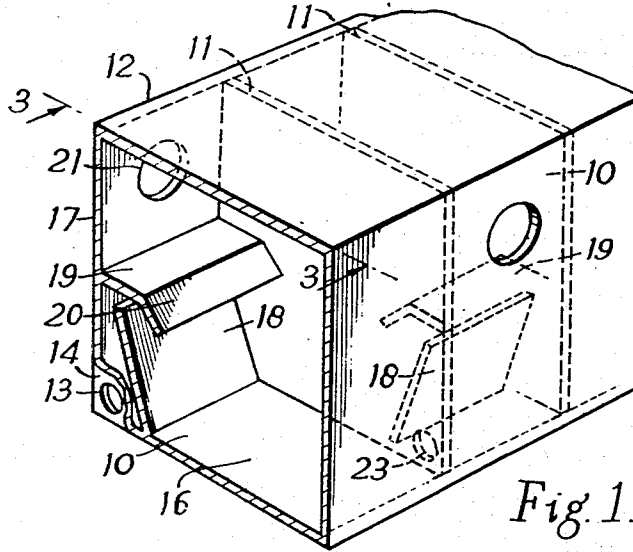
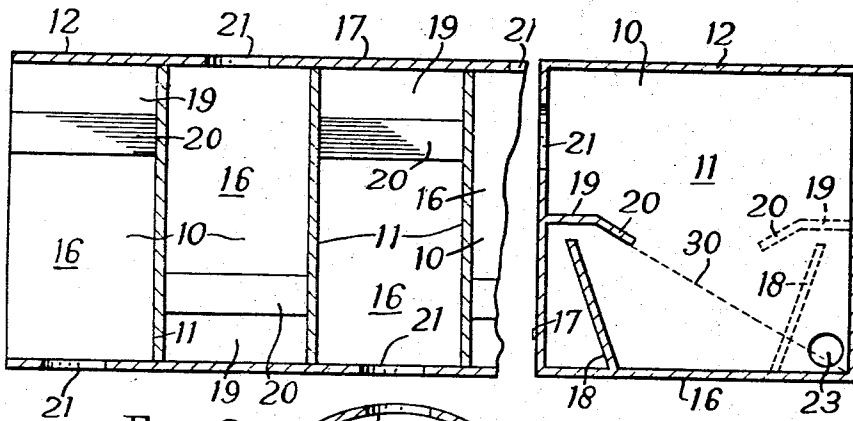
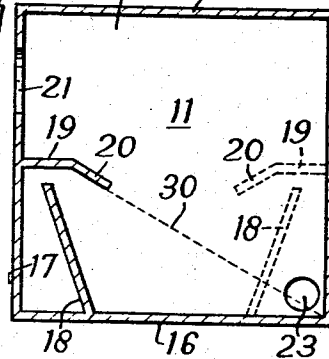
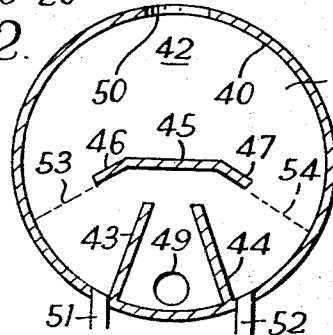


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MULTISTAGE EVAPORATOR WITH EVAGINATED
VENTURI INLET FOR EACH STAGE
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MULTISTAGE EVAPORATOR WITH EVAGINATED VENTURI INLET FOR EACH STAGE

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ABSTRACT OF THE DISCLOSURE

A stage for a multistage flash distillation unit having an entrance surrounded by a venturi flow control device comprising an upward wall and a horizontally extending wall defining between them a narrow unobstructed opening across the stage causing the incoming fluid to flow in a horizontal sheet across the bottom wall.

This invention relates in general to distillation apparatus and, more particularly, to a particular configuration for a flash evaporator stage.

An object of this invention is to provide an evaporator stage which is more stable and efficient in its operation over a wider range of operating conditions.

Another object of this invention is to provide a brine flow control device between flash evaporator stages which will prevent steam blowby from one evaporator stage to another.

A further object of this invention is to provide an evaporator stage configuration for which design calculations may be more easily made.

A feature of this invention is the provision of an evaginated venturi which will compensate for pressure changes without allowing vapour to leak from a preceding stage.

Many other objects, advantages and features of invention reside in the particular construction, combination and arrangement of parts involved in the embodiments of this invention and its practice as will be understood from the following description and accompanying drawing wherein:

FIGURE 1 is a perspective view of a fragment of a multi-stage evaporator which has been cut in a transverse vertical section;

FIGURE 2 is a horizontal longitudinal section taken on line 2—2 of FIGURE 1;

FIGURE 3 is a transverse vertical section through an evaporator stage of this invention; and

FIGURE 4 is a transverse vertical section through an evaporator stage according to a second embodiment of this invention.

Referring to the drawing in detail, FIGURES 1, 2 and 3 show an evaporator according to a first embodiment of this invention. The evaporator consists of a number of evaporator stages 10 which are formed by the partition 11 which extend transversely across the rectangular shell 12. Heated brine enters the endmost evaporator stage 10 through an aperture 13 in an end plate 14 of which a fragment is shown. This heated brine flows into the bottom portion of an evaginated venturi formed by a side wall 17 of the shell 12, an upstanding plate 18, a top plate 19, and a downwardly bent lip 20. Plate 18 extends upward from the floor 16 of shell 12, and plate 18, top plate 19 and lip 20 extend completely across each stage 10.

As the brine passes through the evaginated venturi, it flashes into steam in a manner which will be described. This steam is withdrawn from each stage 10 through an opening 21 in shell 12. Each opening 21 would lead to a condenser (not shown). Brine or other liquid, which is

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being evaporated and which does not flash into vapor in a given stage 10, passes through an aperture 23 to flow into the next stage 10 and pass through another evaginated venturi formed by a wall of shell 12, a plate 18, a top plate 19, and a lip 20.

The stages 10 of this invention must be designed within certain critical limits. First, the plate 18 and the wall 17, as shown in FIGURE 3, should form an angle between them of from 7 degrees to 25 degrees. Thus, if wall 17 is vertical, plate 18 may be inclined at an angle from the vertical of between 7 and 25 degrees. The distance between the upper edge of top plate 18 and wall 17 should be substantially the same as the distance between the upper edge of plate 18 and top plate 19. Lip 20 should form an angle between 7 and 30 degrees with plate 18. Thus, depending on the angle of plate 18, lip 20 may be inclined from the vertical between 14 and 55 degrees.

This evaginated venturi provides a very efficient brine flow control device which prevents steam blowby and provides stable and efficient operation over a wide range of operating conditions. The shift in the zone of change from liquid to two-phase flow in the venturi arrangement causes a radical change in pressure drop. If one set of conditions requires a lower delta t and a corresponding low pressure loss between stages, flashing will occur near the lip of the exit from the venturi. The flow of pure liquid through the venturi will result in a low pressure loss. However, if conditions change requiring a higher production rate with a greater delta t and hence a greater delta p between stages, then two-phase flow will occur further back in the venturi to compensate for the pressure change without allowing vapor to leak through from the preceding stage. In practice, it has been found that a venturi arrangement will compensate for as high as ten-fold pressure differentials between the entrance to the venturi where the pressure is at a maximum and the exit of the venturi where the pressure is at a minimum.

A further unique effect results from the particular configuration of the evaporator stages of this invention. As shown in FIGURE 3, dotted line 30 represents the approximate location of an actual area of phase change when this invention is in operation. Below line 30 liquid emerges from the lip of the venturi as a sheet of a suspension of particles as in a fog or a mist. Vapor release occurs completely within the spray and passes upward within each stage 10 so that, during steady state operation, visible mist does not rise above line 30. Thus line 30 represents an actual area of phase change or the boundary of an area of phase change.

While FIGURES 1 to 3 show the progression of fluid in a zig-zag path because of the placement of the stages as shown, the stages may be rearranged so that the stages flow sequentially in a straight line path in which case the liquid might pass from stage to stage under the wall of the bulkhead separating the stages.

In the design of apparatus according to this invention, it has been found that, with a 5 degree F. delta t between stages, 1 pound of steam per hour may be produced for each square inch of the sheet or boundary designated by the dotted line 30. The steam production varies directly as the delta t involved. For example, with a 10 degree F. delta t , two pounds of steam per hour will be produced for each square inch provided for the boundary area. Also, a 15 degree F. delta t allows three pounds of steam per hour to be produced for each square inch of the boundary area. The stages 10 may be operated with a delta t as low as 2 degrees F. Fluctuations in the flow rate of brine may cause the boundary area to sweep upwards or downwards from lip 20 without destroying the stability of the boundary area of steam production.

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Referring now to FIGURE 4, a double evaginated venturi may be used according to this invention. A cylindrical shell 40 is divided into stages 41 by means of transverse bulkheads 42. A double evaginated venturi is formed by the two plates 43 and 44, the top plate 45, and the downward turned lips 46 and 47. Plates 43 and 44 incline between 7 and 25 degrees from the vertical and the lips 46 and 47 form an angle between 7 and 30 degrees with the plates 43 and 44. Plate 45 is disposed above the upper edges of plates 43 and 44 a distance substantially equal to one half the distance between the upper edges of plates 43 and 44.

Brine enters between plates 43 and 44 through an aperture 49 in a bulkhead 42. Steam passes to a condenser through an opening 50 in each stage 41. Brine is drawn from the stage 41 through the outlet tubes 51 and 52. The dotted lines 53 and 54 represent the same sort of phase change area as did line 30 in the first embodiment of this invention. The same design factors should be observed in the second as in the first embodiment of this invention. Thus, with a delta t of 5 degrees F., one pound of steam per hour may be produced for each square inch of the area designated by the lines 53 and 54. This unusual design factor, wherein one square inch of the sheet of phase change produces one pound of steam per hour with a delta t of 5 degrees F., greatly simplifies the design of multi-stage evaporators according to this invention.

While this invention has been shown and described in the best forms known, it will nevertheless be understood that these are purely exemplary and that modifications may be made without departing from the spirit and scope of the invention.

What is claimed is:

1. In a multistage evaporator, a stage comprising an outer shell multistage bottom and side walls and an inlet for the introduction of fluid therein and an outlet for the removal of unvaporized fluid, an evaginated venturi means disposed about the inlet of each stage for controlling the flow of liquid through said stages, said venturi means being formed by converging wall portions which extend within said shell and provide in conjunction with said shell an inlet chamber about said inlet, said converging wall portions comprising a top wall member which extend inwardly of the side walls of said evaporator stage and terminates in a downwardly turned section and a wall portion extending upward from said bottom wall of the shell terminating adjacent said downwardly turned opening for fluid flowing from the inlet into the evaporator stage, said downwardly turned section and said upwardly extending wall coacting to cause the fluid to be effected horizontally and downwardly toward said bottom wall.

2. An evaporator stage as claimed in claim 1, wherein said converging walls converge at an angle between 7 and 25 degrees, a single lip extending from said top wall and diverging from one of said converging walls at an angle between 7 and 30 degrees.

3. An evaporator stage as claimed in claim 1, wherein said converging walls converge at an angle between 14 and 50 degrees, each lip diverging from one of said converging walls at an angle between 7 and 30 degrees.

4. An evaporator, comprising a shell, transverse partitions across said shell forming side walls for defining

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evaporator stages within said shell, openings in said shell through which steam may be drawn, an upstanding plate in each stage, each of said upstanding plates having a top edge and being inclined at an angle from the vertical of 7 to 25 degrees, a top plate in each of said stages arranged above said upstanding plate, said top plate having a horizontally extending flat section and a downwardly sloping section terminating in a lip, said lip extending downwards from each top plate at an angle to said upstanding plate of 7 to 30 degrees, one of each of said upstanding plates, top plates and lips together forming an evaginated venturi means, said plates and lips extending transversely of said shell adjacent said partitions, said venturi means being positioned in staggered relationship in adjacent stages to provide a zig-zag path and means for conducting fluid to a subsequent stage.

5. An evaporator as claimed in claim 4, wherein said shell is rectangular having side walls and a floor, said upstanding plates extending upward from said floor, said upstanding plates in adjacent stages being inclined to opposite side walls, said top plate extending from one of said side walls, said venturi being formed along one of said side walls and said means for conducting fluid comprising apertures in the transverse partitions through which said fluid flows.

6. An evaporator as claimed in claim 4, wherein said shell is cylindrical, said openings being arranged in the upper part of said shell, a further upstanding plate being arranged in each shell so as to form with said upstanding plate a pair of plates extending upwards from the bottom of each stage and being inclined towards each other at an angle of 14 to 50 degrees, each of said pair of plates extending between two of said transverse partitions, said top plate having a further lip extending downwards therefrom opposite to said first mentioned lip, said further lip being inclined to said further plate at an angle of 7 to 30 degrees, said top plate being disposed a distance above the upper edges of said pair of plates substantially equal to one half the distance between the upper edges of said pair of plates, each of said further lips, further plates and top plates forming a further evaginated venturi, said venturi and said further venturi being continuous so as to form a double evaginated venturi, draining means being provided for draining unvaporized fluid from the bottom of each of said stages.

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