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SEPARATING APPARATUS FOR SEPARATION OF SALT IN ONCE-THROUGH BOILERS

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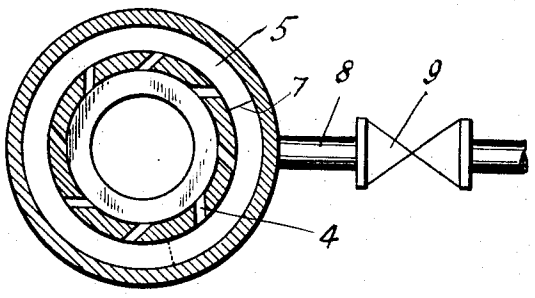

FIG. 2

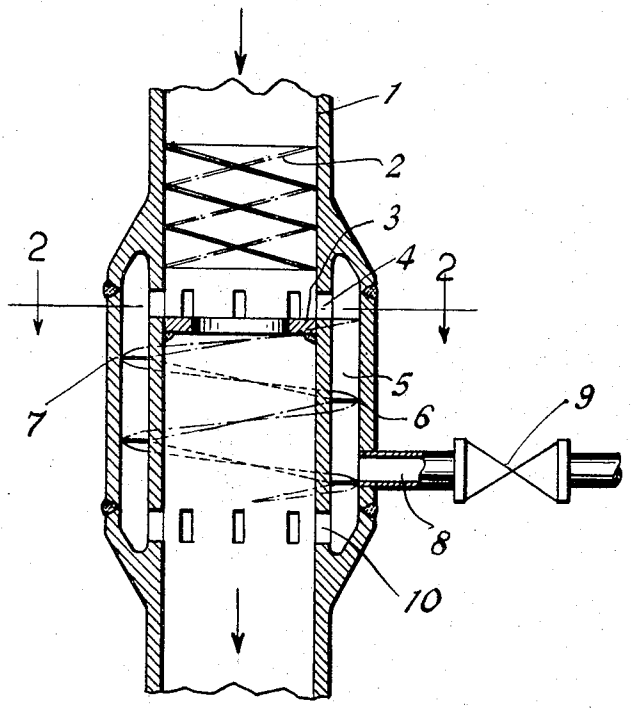

FIG. 1

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SEPARATING APPARATUS FOR SEPARATION OF SALT IN ONCE-THROUGH BOILERS

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7 Claims. (Cl. 183—34)

This invention relates in general to improvements in vapor generators of the once-through type and more particularly, to apparatus for controlling the quantity of the liquid carried solid deposition within once-through type vapor generators.

Characteristically, the once-through type vapor generator is a heated single conduit in which a vaporizable liquid is pumped into one end of the tube and superheated vapor emerges from the opposite end thereof. At an intermediate position within the length of the tube the final evaporation from liquid to vapor occurs. It is during the final evaporation that deposition of solids from the liquid occurs. This normally is the range where the vapor-liquid mixture has about 80 percent or more of vapor by volume. The position of the final evaporation within the tube is called the transition zone. In the final evaporation the impurities or solids which are dissolved in the liquid are deposited on the walls of the tube. These deposits create an internal thermal resistance and elevate the tube wall temperature which results in loss of the tube or accelerated corrosion rates. Many attempts have been made to solve or at least mitigate the effects of deposited solids in the transition zone.

It has been proposed in the prior art to locate the transition zone in a low heat input zone, so as to prolong the operating life of the tube and reduce the temperature to which the tube wall may be elevated. This, however, has the disadvantage that the deposited solids must be removed by frequent washing during which time the boiler is shut down.

It has also been suggested to remove the deposits by washing and flushing individual tubes while the remaining tubes of the vapor generator are operating normally. This arrangment usually utilizes an individual vapor-liquid separator for each tube circuit outside the boiler setting and the efficiency of the separation is low. This results in large quantities of the liquid carried impurities being left in the superheated vapor and carried into the turbine, thus causing a reduction of turbine operating effectiveness.

In other forced flow boilers the solid deposits problem has been solved by using a vapor-liquid separating drum and having a fixed superheater connected thereto and receiving the separated vapor, with the separated liquid being either blown down or recirculated. This arrangement does not have the desirable feature of a flexible superheater which is the principal characteristic of a once-through type vapor generator.

The subject invention retains the flexible superheater characteristic of the once-through vapor generator while providing for the removal of liquids in which the solids are highly concentrated. Accordingly, the invention provides a once-through type vapor generator having a setting and a heated conduit located within the setting, in which there flows a vapor-liquid mixture constituted largely of vapor. A portion of the conduit is arranged as a vapor-liquid separator of a generally tubular shape having an inlet at one end and an outlet at the opposite end thereof. An annular chamber is arranged about the conduit at a

position between the inlet and outlet thereof and includes a plurality of axially spaced liquid inlet and outlet openings communicating with the conduit. The fluid mixture entering the separator receives a whirling action by a whirling means. The whirling motion causes centrifugal separation of the mixture. Means are provided for restricting the flow area of the conduit so that the higher density liquid is directed through the liquid inlet openings into the annular chamber. A blow down line or conduit controllably removes a portion of the higher density liquid from the annular chamber. The liquid outlet openings from the annular chamber are arranged to return the remaining portion of liquid to the conduit. The liquid being returned to the conduit mixes intimately with the vapor flowing within the conduit and is subsequently vaporized therein.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which are illustrated and described the preferred embodiments of the invention.

In the drawings:

Fig. 1 is a vertical section through a conduit of a once-through vapor generator showing a preferred embodiment of apparatus for performing the invention.

Fig. 2 is a transverse section along the lines 2—2 of Fig. 1.

In Fig. 1 is illustrated a portion of a tube of a once-through type vapor generator, with a conduit 1 within which a vapor-liquid mixture is flowing in a single direction. A double pitched spiral vane 2 is located within said conduit 1 and in contact with the interior walls thereof. The vapor-liquid mixture is flowing in the direction of the arrows and upon contact with the spiral vane 2 receives a whirling motion. The resulting centrifugal force set up by the whirling motion causes a separation of the vapor from the liquid which contains dissolved solid materials, the greater density liquid being forced toward the walls of the conduit 1 while the lower density vapor continues to flow in the direction of the arrows.

An impact ring 3 shaped to form an orifice is provided downstream of the spiral vane 2 transversely of and in contact with the wall of the conduit 1. The opening or orifice in the impact ring 3, as illustrated in Fig. 2, is substantially less than the transverse section of the conduit 1 and permits passage therethrough of the lower density vapor. At the same time the impact ring 3 impedes the flow of greater density liquid along the wall of the conduit 1 and directs the liquid through a plurality of openings 4 in the wall of the conduit 1 to an exterior annular chamber 5 which encloses the conduit 1, the wall of conduit 1 and the wall 6 combining to form the exterior annular chamber.

The openings 4 in the conduit wall are angularly arranged, as illustrated in Fig. 2, in the direction of the liquid whirl to decrease flow resistance. The liquid, bearing dissolved solid materials, passes into the exterior annular chamber 5 and is continued in rotational motion by a continuous helically shaped spin plate 7. The continued rotational motion within the exterior annular chamber 5 provides for the final separation of vapor and liquid. The centrifugal action also permits the liquid to be partially classified, with the greater density solid-bearing liquid being forced to the outer wall of the exterior annular chamber 5.

A blowdown conduit 8 is connected to the downstream end and at the periphery of the exterior annular chamber 5 and the discharge therefrom is controlled by a valve 9. The desired controlled quantity of the greater density

solid bearing liquid is discharged through the blowdown connection 8.

A plurality of openings 10 communicating between the downstream end of the exterior annular chamber 5 and the conduit 1 are provided to reintroduce that portion of the liquid not blown down plus any vapor remaining in the chamber into the conduit 1.

The liquid and vapor introduced back into the conduit through the openings 10 mixes intimately with the separated vapor flowing from the ring 3 and subsequently evaporates. The fluid continues to flow in the direction indicated by the arrows.

The apparatus of this invention allows for the removal of liquid with high solid concentrations from the vapor generator, while allowing the more or less pure liquid to be carried along with the vapor-liquid mixture while the vapor generator is being controlled to produce the final desired vapor temperature. Thus the superheater may be of any size necessary to do the superheating and the transition zone only accumulates solids, if at all, at a slow rate. This will allow the maximum length of operation between scheduled cleanings, as required by all standard boilers. Additionally, the apparatus of the invention has the advantage that it permits the continuous removal of the liquid-carried solids by a blow-down system. Thus, there is a constant control of the feed liquid quality.

It is unimportant whether there be 10 or 20 percent of the liquid in the vapor-liquid mixture when it reaches the position of separation as the quantity of liquid blown down may be regulated so that only the highly concentrated liquid is removed and so that the temperature control of the vapor generator is not disturbed.

While in accordance with the provisions of the statutes there is illustrated and described herein a specific embodiment of the invention, those skilled in the art will understand that changes may be made in the form of the invention covered by the claims, and that certain features of the invention may sometimes be used to advantage without a corresponding use of the other features.

What is claimed is:

1. In a once-through type vapor generator, a conduit arranged therein to flow a vaporizable fluid therethrough, a portion of said conduit containing a vapor-liquid mixture largely constituted of vapor and arranged as a vapor-liquid separator of a generally tubular shape having an inlet at one end and an outlet at the opposite end thereof, an annular chamber about said conduit disposed between the inlet and outlet thereof and having a plurality of axially spaced liquid inlet and outlet openings communicating therewith, means for imparting a whirling action to the fluid mixture entering said separator, means restricting the flow area of said conduit disposed adjacent but downstream of said inlet openings and cooperating with said whirling means to direct the high density liquid through said liquid inlet openings into said annular chamber, means for controllably blowing down some of the high density liquid from said annular chamber, said liquid outlet openings from said annular chamber being arranged to return the remaining portion of the liquid to said conduit for intimate mixing and subsequent evaporation within the flowing separated vapor.

2. In a once-through type vapor generator, a heated conduit arranged therein to flow a vaporizable fluid therethrough, a portion of said conduit containing a vapor-liquid mixture largely constituted of vapor and arranged as a vapor-liquid separator of a generally tubular shape having an inlet at one end and an outlet at the opposite end thereof, an annular chamber about said conduit disposed between the inlet and outlet thereof, means forming spaced liquid inlet and outlet openings through said conduit to said chamber, means for imparting a whirling action to the fluid mixture entering said separator, means restricting the flow area of said conduit disposed adjacent but downstream of said inlet openings and cooperating with said whirling means to direct the high density liquid through said liquid inlet openings into said annular chamber, means for controllably blowing down some of the high density liquid from said annular chamber, said liquid outlet openings from said annular chamber being arranged to return with a whirling motion the remaining portion of the liquid to said conduit for intimate mixing and subsequent evaporization within the flowing separated vapor.

3. In a once-through type vapor generator, a heated conduit arranged therein to flow a vaporizable fluid therethrough, a portion of said conduit containing a vapor-liquid mixture largely constituted of vapor and arranged as a vapor-liquid separator of a generally tubular shape having an inlet at one end and an outlet at the opposite end thereof, an annular chamber about said conduit disposed between the inlet and outlet thereof and having a plurality of axially spaced liquid inlet and outlet openings communicating therewith, means for imparting a whirling action to the fluid mixture entering said separator, means restricting the flow area of said conduit disposed adjacent but downstream of said inlet openings and cooperating with said whirling means to direct the high density liquid through said liquid inlet openings into said annular chamber, means in said annular chamber for continuing the whirling action of the high density liquid flowing therein, means for controllably blowing-down some of the high density liquid from the outer periphery of said annular chamber, said liquid outlet openings from said annular chamber being arranged to return with a whirling motion the remaining portion of the liquid to said conduit for intimate mixing and subsequent evaporization within the flowing separated vapor.

4. In a once-through vapor generator providing a mixture of vapor and liquid flowing within a conduit, said mixture predominating in vapor and the liquid containing dissolved solids, means located in the conduit for whirling said mixture therein to create a centrifugal force and thereby concentrate the heavier solids-laden liquid at the periphery of the whirling mixture in the conduit, means for removing a greatly predominant portion of said liquid from the periphery of the whirling mixture in the conduit, means for discharging the more concentrated portion of said separated liquid, and means for returning the remaining liquid into the whirling mixture in the conduit downstream from the means for removing said liquid from the periphery of the whirling mixture.

5. In a once-through vapor generator providing a mixture of vapor and liquid flowing within a conduit, said mixture predominating in vapor and the liquid containing dissolved solids, means located in the conduit for whirling said mixture therein to create a centrifugal force and thereby concentrate the heavier solids-laden liquid at the periphery of the whirling mixture in the conduit, means for removing a greatly predominant portion of said liquid from the periphery of the whirling mixture in the conduit, means for continuing to whirl the separated liquid to concentrate the solids in the liquid at the periphery of the whirling liquid stream, means for controllably discharging a portion of said whirling liquid stream from the periphery thereof, and means for returning the remaining liquid into the whirling mixture in the conduit downstream from the means for removing said liquid from the periphery of the whirling mixture.

6. A vapor-liquid separator comprising a conduit to flow a vaporizable fluid therethrough, a portion of said conduit containing a vapor-liquid mixture largely constituted of vapor and arranged as a vapor-liquid separator of generally tubular shape having an inlet at one end and an outlet at the opposite end thereof, an annular chamber about said conduit disposed between the inlet and outlet thereof and having a plurality of axially spaced

liquid inlet and outlet openings communicating therewith, means for imparting a whirling action to the fluid mixture entering said separator, means restricting the flow area of said conduit disposed adjacent but downstream of said inlet openings and cooperating with said whirling means to direct the liquid through said liquid inlet openings into said annular chamber, and means for controllably blowing down some of the liquid from said annular chamber, said liquid outlet openings from said annular chamber being arranged to return the remaining portion of the liquid to said conduit for mixing with the vapor flowing therein.

7. A vapor-liquid separator comprising a mixture of vapor and liquid flowing within a conduit, means located in the conduit for whirling said mixture therein to create a centrifugal force and thereby concentrate the liquid at the periphery of the whirling mixture in the conduit,

means for removing a greatly predominant portion of said liquid from the periphery of the whirling mixture in the conduit, means for discharging the more concentrated portion of said separated liquid, and means for returning the remaining liquid into the whirling mixture in the conduit downstream from the means for removing said liquid from the periphery of the whirling mixture.

References Cited in the file of this patent

UNITED STATES PATENTS

1,523,916	Tomkins	Jan. 20, 1925
1,682,285	Kieth	Aug. 28, 1928
2,413,324	Holzwarth	Dec. 31, 1946

FOREIGN PATENTS

123,934	Austria	July 25, 1931