

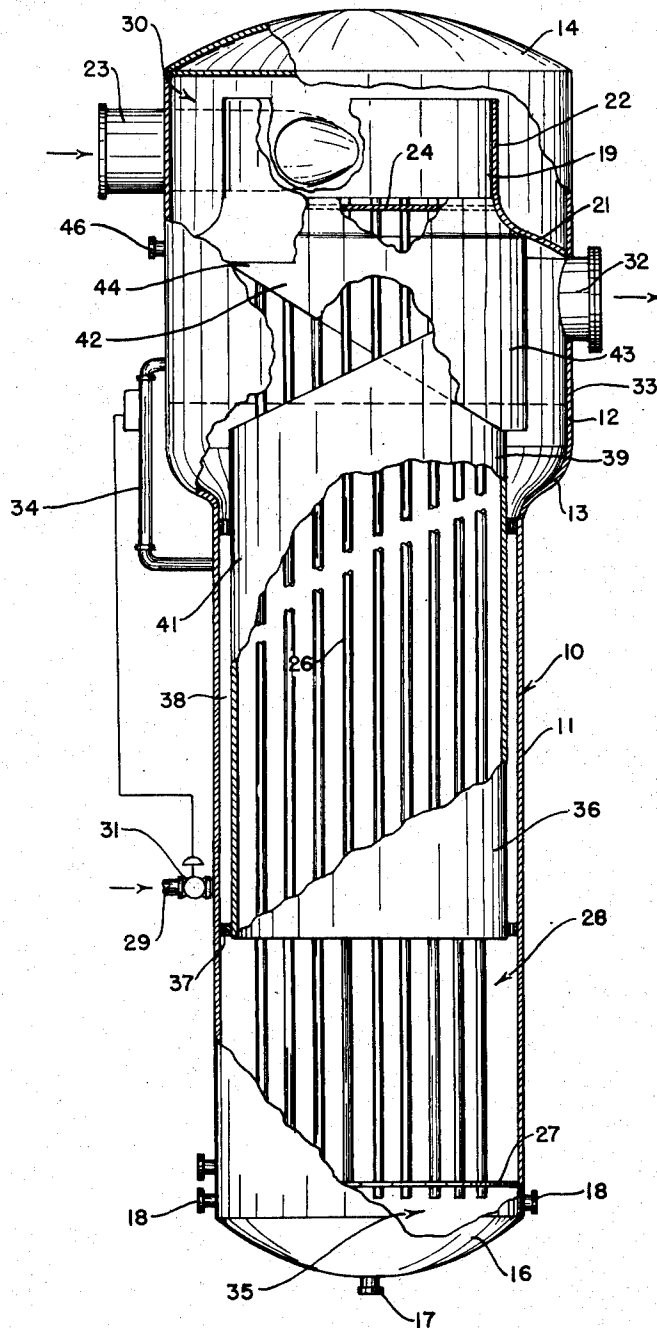
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HEAT EXCHANGER

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HEAT EXCHANGER

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My invention relates generally to heat exchangers, and particularly to the type of heat exchanger adapted for the generation of clean dry steam from contaminated, relatively wet steam.

In various fields of industry, and particularly in the chemical process industries, it is frequently necessary to convert wet or contaminated steam or other vapor into clean dry steam before the heat content of the vapor can be effectively utilized. This may be accomplished by condensing the dirty steam in a heat exchanger, which transfers the heat in the vapor to a body of water, the latter being thus vaporized to yield clean steam at a somewhat lower pressure.

To accomplish this conversion economically, care must be observed in the construction of the apparatus to avoid fouling or stoppage of the heat exchange passages by foreign particles carried into the apparatus by the incoming dirty steam, as well as to avoid the discharge of unvaporized water with the steam generated in the ebullition chamber.

An important object of my invention is to provide heat exchange apparatus particularly adapted for the generation of clean dry steam from wet or dirty steam, which is highly resistant to fouling or stoppage of the heat exchange passage, which provides an improved path of circulation for the liquid being heated, which incorporates novel baffle arrangements effective in decreasing the water content of the generated steam, as well as providing for the efficient disposition of foreign particles introduced by the dirty steam, which is efficient in operation, and which may be operated for extended periods of time without maintenance.

Other objects of my invention, which refer generally to various novel combinations and sub-combinations of the component parts of my apparatus, will be disclosed in the course of the following detailed description and in the appended drawing in which is shown a partially sectioned elevation of a preferred form of my apparatus.

In brief, my heat exchanger includes a tube bundle extending through tube or end plates which are sealed within an elongated upright shell, thereby defining an ebullition chamber above a condensate chamber and surmounted by a steam inlet chamber. A generally cylindrical upright baffle, open at its upper end, encompasses the open upper ends of the tubes in the steam inlet chamber. Steam or other vapor is introduced tangentially into the steam inlet chamber below the level of the top of the baffle, thus separating by centrifugal force the foreign particles and a majority of the water droplets carried into the steam inlet chamber by the contaminated or wet steam. The tubes are surrounded by water

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or other vaporisable liquid introduced through a suitable inlet into the ebullition chamber which condenses the steam in the tubes and is in turn heated above its boiling point.

A lower cylindrical baffle extends around the tube bundle in the ebullition chamber and is spaced both from the shell and from the end plates. Preferably, one wall of this baffle is longer than the other, the longer wall extending upwardly past the water level towards the steam outlet, which is formed in the upper portion of the ebullition chamber. An upper cylindrical baffle, also having a long wall portion and a short wall portion, extends downwardly from the upper end plate between the steam outlet and the upper extremity of the lower baffle preferably to below the water level, it being understood that the long wall portion is spaced from both the lower baffle and the shell. The short wall portion of the upper baffle is disposed diametrically opposite the long wall portion and the steam outlet and is above both the water level and the lower baffle.

Thus, a majority of the water and foreign material is eliminated from the incoming dirty steam by cyclonic action in the steam inlet chamber, the relatively clean vapors passing downwardly into the tubes and transferring their heat to water or other liquid in the ebullition chamber, thereby vaporizing this liquid.

The application of heat to the liquid sets up relatively strong and well defined thermal currents, which pass upwardly within the lower baffle and downwardly between the shell and the outer wall of the baffle. Violent boiling occurs at the water surface around the tubes, and under ordinary conditions results in the entrainment of a considerable number of water particles with the vapor. The upper and lower baffles, however, act to prevent the entrainment of water particles in the steam passing to the steam outlet, since they force the vapor to travel around the upper internal surface of the shell and around the long wall portions of both baffles before reaching the steam outlet. This permits the water particles to settle, and in addition, brings the particles in contact with the walls of the equipment, which aids in a separation.

Referring to the drawing, the preferred form of my apparatus includes an elongated upright shell 10 of generally cylindrical cross section having a lower portion 11 and an upper portion 12 connected by a throat 13. The upper portion 12 is somewhat greater in diameter than the lower portion 11, and is closed by a cap 14, while the bottom portion 11 is closed by a cap 16, having a discharge opening 17 and gas elimination openings 18.

A baffle 19 is disposed within the upper portion of the shell 12 and includes lower side walls

21 secured to the shell 10 and extending upwardly and inwardly to an upright cylindrical wall portion 22, which defines an opening communicating with the interior of the shell 10 below the cap 14. A tangential steam inlet 23 is formed in the shell between the upper and lower extremities of the baffle 19.

An upper tube, or end plate 24, is sealed across the baffle 19 approximately at the junction of the wall portions 21 and 22 and is provided with a multiplicity of openings through which a plurality of tubes 25 are sealed. The lower ends of the tubes 25 are sealed through a lower tube or end plate 27, which is peripherally secured to the shell 10 near the bottom cap 16. Thus, the plates 24 and 27 define an ebullition chamber, designated 28, a steam inlet chamber 30, and a condensate chamber 35. A water inlet 29, preferably having a solenoid valve 31, extends through the shell 10 and serves to introduce water into the ebullition chamber 28. A steam outlet 32 extends through the upper portion 12 of the shell 10 near the junction of the baffle 19 with the shell.

Since it is highly desirable in operation to maintain the level of water in the ebullition chamber 28 substantially constant and preferably at or near the level indicated at 33, I prefer to utilize automatic control equipment, generally designated 34, which may be connected with the solenoid valve to open and close the water inlet 29, as required. The control apparatus 34 may be of any conventional construction and is not therefore herein described in detail.

A cylindrical baffle 35 is telescoped over the tubes 26 within the ebullition chamber 28 and is supported in spaced relation to the plates 24 and 27 and to the shell 10 by suitable means, such as arms 37 secured to the shell 10 and to the baffle 35. Thus, the baffle 36 and shell 10 define a peripheral water passage 38 around the baffle 36. Preferably, although not necessarily, the upper end of the baffle 36 is cut along a plane disposed at an acute angle to the axis, thereby forming a long side 39 and a short side 41. The long side 39 extends upwardly past the water level 33 towards the steam outlet 32 in such manner as to intercept vapor escaping from within the baffle 36 and traveling towards the outlet 32. The upper extremity of the short side 41 is preferably located slightly below the water level 33. If the baffle 36 is constructed in the form of a right cylinder, the upper extremity should be disposed above the water level 33, and preferably slightly below the level of the steam outlet 32.

A second cylindrical baffle 42 having a long side 43 and a short side 44 is secured to the baffle 19 or to the plate 24 and extends downwardly into the ebullition chamber 28 around the tubes 26. Preferably the diameter of the baffle 42 is somewhat greater than the diameter of the baffle 36 and is arranged in such manner that the long side 43 is disposed between the steam outlet 32 and the upper extremity of the baffle 36. The lower extremity of the short side 44 of the baffle 42 is disposed well above the water level 33 and above the upper extremity of the baffle 36. Although not always essential, it is desirable that the long side 43 extend downwardly to a level below the water level 33.

In operation, contaminated or wet steam is introduced in my heat exchanger through the inlet 23, entering the steam inlet chamber 30 at a relatively high velocity in a tangential di-

rection. Centrifugal force throws the water and foreign particles outwardly against the inner walls of the chamber 30 from which they fall by gravity and may be discharged through a suitable outlet 46 extended through the shell near the level of the lower portion of the baffle 19. The vapor, now substantially freed of its foreign material and water droplets, passes over the top of the baffle 19 and into the tubes 26, which are surrounded with water. The steam is thus condensed, the condensate passing downwardly in the tubes into the condensate chamber 35, from which it may be discharged through the outlet 17. Non-condensable gas is discharged from the openings 18. Foreign particles lodging within the tubes 26 may be periodically removed by conventional methods, although it will be found that in most instances this operation is only infrequently necessary.

The latent heat of the condensing steam, as well as some of its sensible heat is transferred to the water surrounding the tubes 25 in the ebullition chamber 28, thus establishing thermal currents which cause the water to rise through the baffle 36, overflow the upper extremity of the short wall 41 into the passageway 38, and re-enter the baffle 36 below its lower extremity.

A portion of the heated water, upon reaching the water surface 33, is converted into vapor and will entrain a certain number of water droplets. Since steam is continuously discharged through the steam outlet 32, the vapor passes to the left, through the opening defined by the lower extremity of the short wall 44 and the upper extremity of the short wall 41, traveling around the inner wall of the shell 10 to the steam outlet 32. The vapor can not pass directly from the water surface 33 immediately around the tubes 26 to the outlet 32 because of the long walls of the baffles 36 and 42, which block direct passage. Thus, the vapor travels to the outlet 32 at relatively low velocity, permitting the water particles to settle and is also continuously impinged upon the shell 10, as well as against the baffles 36 and 42, which aids the settling out of the water droplets. As a result, steam issuing from the outlet 32 is not only clean, but is substantially free of water droplets.

Continuous circulation of the water by thermal currents within the baffle 36 aids considerably in increasing the efficiency of heat transfer to the water and to some extent avoids the formation of deposits on the tubes 26. This, however, can not be completely avoided and descaling treatment will be periodically required, depending upon the hardness of the water and quantity of steam generated.

I claim:

1. A heat exchanger for generating vapor including a hollow shell, spaced end members in the shell defining an ebullition chamber, a plurality of tubes extending through the end members and the ebullition chamber, a vapor outlet for the ebullition chamber and a liquid inlet for maintaining a liquid level below said vapor outlet in said chamber, means for passing vapor into the tubes, a first baffle around the tubes spaced from the shell and end members including a long wall portion facing the vapor outlet and terminating above the liquid level and a second baffle around the tubes supported above the first baffle, said second baffle including a long wall portion disposed in spaced relation between the portion of the shell incorporating the vapor outlet and the upper extremity of the first baffle and extending

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to the liquid level, and a short wall portion opposite said long wall portion being spaced axially from the first baffle and having its lower extremity above said liquid level.

2. A heat exchanger for generating steam comprising a hollow upright shell, a pair of spaced generally horizontal tube plates in the shell defining an ebullition chamber, a plurality of tubes in the chamber sealed through the plates, means including an inlet in the shell for passing steam into the tubes, a steam outlet in the shell below the upper of said plates, a water inlet in the shell between the plates for maintaining a water level in the ebullition chamber below the steam outlet, a lower baffle in the chamber around the tubes spaced from the shell and from said plates, and an upper baffle around the tubes including a long wall portion disposed in spaced relation between the upper extremity of the lower baffle and the portion of the shell incorporating the steam outlet and extending downwardly from the upper of said plates past the level of the steam outlet and a short wall portion having its lower extremity disposed above the upper extremity of the lower baffle, the portions of each of the baffles nearest the steam outlet extending past the water level.

3. A heat exchanger for generating steam comprising a hollow upright shell, a pair of spaced generally horizontal tube plates in the shell defining an ebullition chamber, a plurality of tubes in the chamber sealed through the plates, means including an inlet in the shell for passing steam into the tubes, a steam outlet in the shell below the upper of said plates, a water inlet in the shell between the plates for maintaining a water level in the ebullition chamber below the steam outlet, a lower baffle in the chamber around the tubes spaced from the shell and from said plates, the upper extremity of said lower baffle being above said water level, and an upper baffle around the tubes including a long wall portion disposed in spaced relation between the upper extremity of the lower baffle and the portion of the shell incorporating the steam outlet and extending downwardly past the level of the steam outlet to water level and a short wall portion having its lower extremity disposed above the upper extremity of the lower baffle.

4. A heat exchanger of the type adapted for steam generation comprising a closed shell, spaced transverse plate members in the shell defining a closed ebullition chamber having a water inlet and a steam outlet, a plurality of tubes extending through the chamber and plate members, means for maintaining a water level in the chamber below the steam outlet, an upright generally cylindrical first baffle in the chamber around the tubes, said first baffle being spaced from the shell and plate members and having an upper extremity projecting beyond the water level towards the steam outlet, a second generally cylindrical upright baffle around the tubes sealed to the upper of the plate members and having a long wall portion projecting downwardly to water level in spaced relation between said steam outlet and the upper extremity of said first baffle, said second baffle having a short wall portion opposite the long wall portion, the lower end of said short wall portion being above the water level and spaced axially from the upper extremity of the first baffle.

5. A heat exchanger of the type adapted for steam generation comprising an elongated upright closed shell, transverse members in the

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shell defining a steam inlet chamber, a condensate chamber, and an ebullition chamber, said steam inlet chamber being above the ebullition chamber and having a tangential steam inlet and a drain, a plurality of tubes extending through the ebullition chamber and said members, a first cylindrical baffle in the steam inlet chamber open at its upper end and encompassing the upper ends of the tubes, said first baffle extending upwardly from the upper of said members in spaced relation to the shell to a level below the top of the shell, but above the level of the steam inlet, a water inlet and a steam outlet for the ebullition chamber, means for maintaining a water level in the ebullition chamber below the steam outlet, a second baffle around the tubes in the ebullition chamber spaced from the shell and from the transverse members including an upper wall portion extending upwardly past the water level towards the steam outlet, and a third baffle around the tubes above the second baffle, the third baffle including a long wall portion disposed in spaced relation between the steam outlet and the upper extremity of said second baffle, and extending downwardly past the steam outlet to water level, the third baffle also having a short wall portion opposite said long wall portion, the short wall portion having its lower extremity spaced axially from the upper extremity of the second baffle and above said water level.

6. A heat exchanger of the type adapted for steam generation comprising an elongated upright closed shell, transverse members in the shell defining a steam inlet chamber, a condensate chamber, and an ebullition chamber, said steam inlet chamber being above the ebullition chamber and having a tangential steam inlet and a drain, a plurality of tubes extending through the ebullition chamber and said members, a first cylindrical baffle in the steam inlet chamber open at its upper end and encompassing the upper ends of the tubes, said first baffle extending upwardly from the upper of said members in spaced relation to the shell to a level below the top of the shell, but above the level of the steam inlet, a water inlet and a steam outlet for the ebullition chamber, means for maintaining a water level in the chamber below the steam outlet, a generally cylindrical second baffle in the ebullition chamber around the tubes spaced from the shell and said members, the upper extremity of said baffle projecting beyond the water level towards the steam outlet, and a third generally cylindrical baffle sealed to the upper of said members and having a long wall portion projecting downwardly approximately to the water level in spaced relation between the steam outlet and the upper extremity of the second baffle, said third baffle also having a short wall portion opposite said long wall portion, the lower end of the short wall portion being above water level and spaced above the upper extremity of the second baffle.

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