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OF VAPORS FROM LIQUIDS

2,760,918

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2 Sheets-Sheet 1

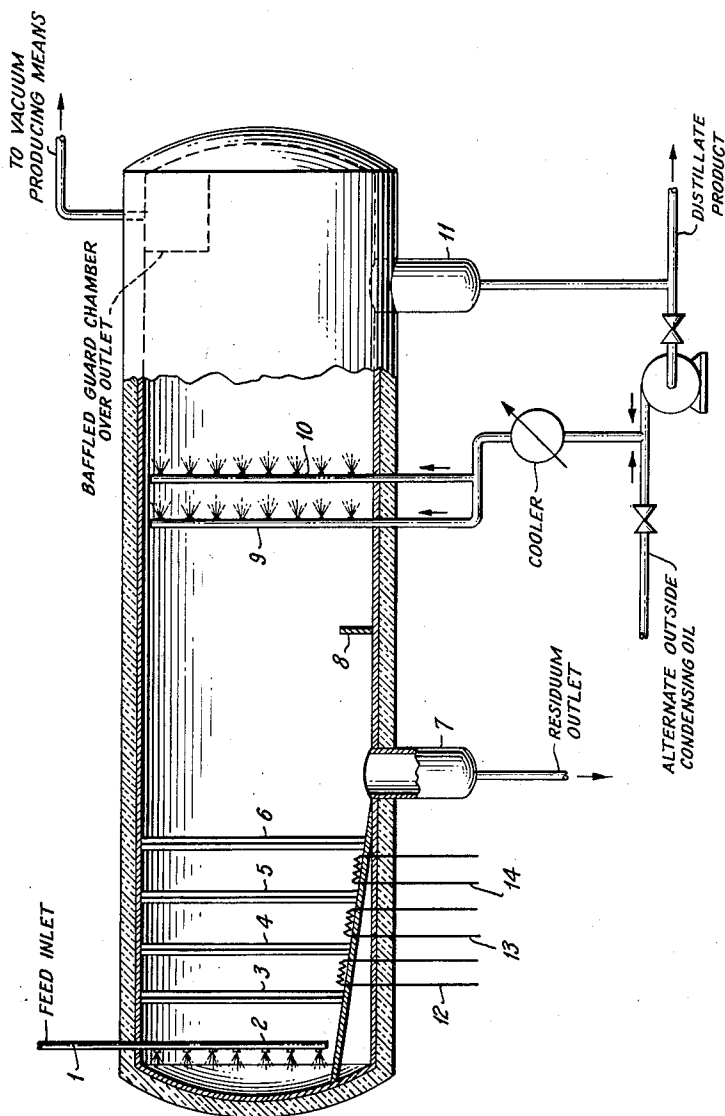


Fig. 1.

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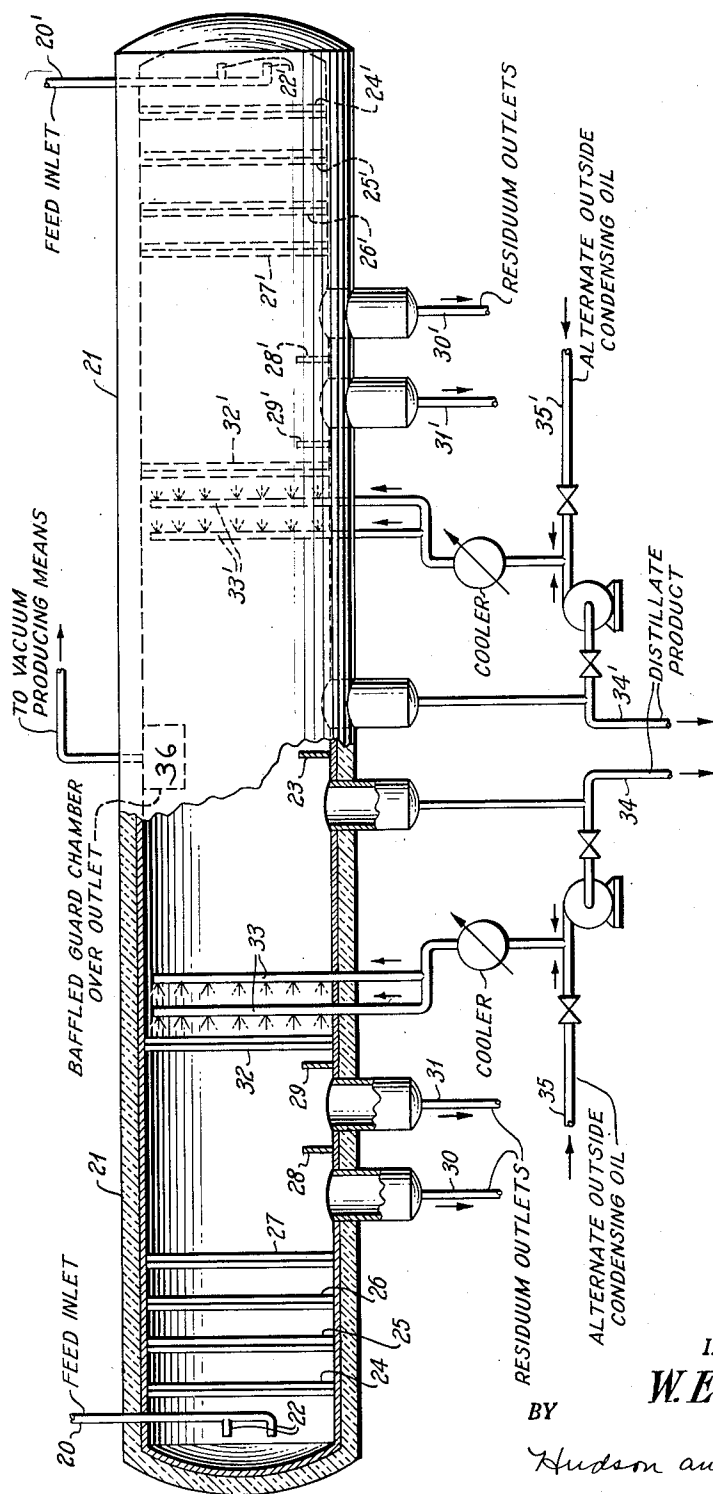


Fig. 2.

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METHOD AND APPARATUS FOR FLASH VAPORIZATION OF VAPORS FROM LIQUIDS

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8 Claims. (Cl. 196—77)

This invention relates to the art of distillation, especially to the art of distillation of hydrocarbon oils. In one of its aspects, this invention relates to a method for the increase of the depth of flash obtainable with an oil while minimizing or eliminating the carry-over or entrainment of the residuum in the vapor. In another aspect, this invention provides apparatus with which entrainment, while obtaining increased depth of flash, of residuum of an oil being subjected to flash vaporization, can be minimized.

The ordinary method of separating a vapor from its liquid residuum in flash vaporization systems is frequently accompanied by considerable carry-over of the residual product in the vapor. The feed material is usually introduced into a flash compartment through sprays or nozzles where the vapor is flashed out of the feed. A number of devices are normally used to clean up the overhead product, such as bubble trays, mist extractor mats, cascade trays, and various types of baffle separators. The common objection to all of these devices is that the pressure drop across them does not permit the residual liquid to be flashed at the lowest pressure possible.

According to this invention, there are provided a method and apparatus for the separation of a vapor from its residual liquid by flash vaporization which comprises the steps of subjecting the residual liquid resulting from the flash vaporization of a liquid to successively lower flashing pressures in successive flash zones which are maintained at successively lower pressures, thus reducing the quantity of vaporization or flashing which occurs at any given time, the apparatus, in one embodiment of the invention, comprising a flash zone separated into several flashing sections separated by baffle separators or other devices for entrainment separation which are so constructed and arranged as to allow the residuum from the initial and each successive flashing section to flow to the next flashing section and to be therein subjected to a more reduced flashing pressure. In a preferred embodiment of the invention, the flashing is accomplished in a substantially horizontally disposed vessel in which the flashing zone is subdivided into several flashing sections through the major portions of which there is a vapor flow, the said sections being determined by baffle separators or other devices acting as the permeable walls thereof and permitting passage along the bottom portion of said vessel and through said separators of the liquid which remains unvaporized at any given time.

Figure 1 is a side view, partly in vertical cross-section, of an apparatus according to the invention in which the feed is introduced at one end (left-hand) of the device and the distillate product is removed therefrom at the other end thereof. Figure 2 shows a sideview of an arrangement or device according to the invention, partly in vertical cross-section, in which the feed is introduced at both ends and from which product is removed at points intermediate the ends of the vessel.

In order to more fully describe the method and the ap-

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paratus of this invention, reference is now made to Figure 1 of the drawing in which 1 is an inlet conduit for preheated feed, for example, a hydrocarbon oil to be separated into a vaporous and non-vaporous fraction. As noted, the purpose of the invention is to increase the depth of flash obtainable but at the same time to avoid the entrainment of residuum in the vapors. Therefore, in the embodiment illustrated in the drawing schematically, the preheated oil is sprayed by means of spray arrangement 2 against the left-hand end of the substantially horizontally disposed vessel. In this first section of the flashing zone which is determined by the substantially horizontally disposed vessel and baffle means 3, the oil is flashed generating vapors which will pass through baffle means 3 and leaving an unvaporized residual liquid which will flow along the bottom of the vessel successively through baffles 3, 4, 5, and 6. In the flashing section determined by baffle means 3 and 4, additional vapor is generated from the residuum flowing along the bottom of the vessel. Likewise, in the section determined by baffles 4 and 5 and in the section determined by baffles 5 and 6, additional vapor will be flashed from the liquid. As the vapor passes through the baffles, the entrained residuum will be separated or knocked down. If desired, the baffles can be controlled to be at a certain predetermined temperature by means not shown. As the oil flows along the bottom of the vessel, as it emerges through baffle 3, it will be subjected to a flashing pressure which is lower than that maintained or obtained in the first flashing section which is determined by the end of the vessel and baffle 3. Likewise, as the oil passes through baffle 4, it will be subjected to a still further reduced pressure, etc. Finally residual liquid is collected at 7 and removed from the vessel. In order to prevent flow of residuum toward the product removal end of the vessel, a dam 8 is provided. The right end of the vessel is a vapor-condensing section and can be suitably equipped with vapor-condensing sprays 9 and 10, condensate collecting at the bottom of the vessel being withdrawn at 11. This condensate or another oil can be the condensing oil. The condensing oil is cooled before it is used in the sprays as by passing it through the cooler, as shown.

It will be obvious to one skilled in the art that at each flashing section, an amount of vapor is released corresponding to the equilibrium temperature and pressure in that section. Since each flash is only a fraction of the total, the amount of carry-over is reduced, and, in addition, the vapors from each flash must pass through all of the following baffles where it is freed of entrained residuum. Therefore, residuum entrained in the first or major flashing section of the vessel would have to pass through baffles 3, 4, 5, and 6 before it could enter the vapor condensing section. An additional baffle can be advantageously placed between dam 8 and sprays 9 and 10, as later described herein. The final flash is accomplished at substantially the pressure prevailing in the vapor condensing section of the vessel and this is the lowest possible pressure. This final flash being but a very small fraction of the total flashing which has been accomplished, little or no entrainment can now occur. Thus, the amount of carryover residual liquid in the overhead vapor is reduced to an absolute minimum.

In one of the embodiments of the invention, and as an important feature thereof as shown in the drawing, there are provided heaters in one or more of the sections defined by the baffles. Thus, heaters 12, 13 and 14 are provided respectively in the second, third, and fourth flash sections of the flashing zone. Additional heaters, not shown, can be provided in the first flashing zone or, for that matter, immediately following the last baffle. In this manner, according to the invention, the depth of flash is further increased by providing internally of the flashing sections

at least that quantity of heat which is lost due to the heat of vaporization of the material undergoing vaporization in each of said sections.

Although the bottom of the flashing zone has been shown as inclined, to favor the flow of residuum through the baffle separators and to the residuum outlet, it will be within the skill of the art to incline the entire flash vessel, if desired. Obviously, the invention is not limited to the use of an inclined bottom for the flash zone or to inclining of the entire vessel. In the event that the vessel is inclined, it is preferable to maintain substantially vertically disposed the several baffles and spray arrangements which have been shown.

While a spray arrangement for introducing the feed has been shown, it is clear that other arrangements such as an open-end pipe can be employed. Also single or multiple sprays may be used, spraying in either direction.

While the drawing shows only one dam, that is, dam 8, it is within the skill of the art to provide additional dams at various points along the bottom of the vessel, for example, between the residuum outlet at 7 and dam 8. In such an event, a draw-off conduit can be provided between such an extra dam and dam 8. Material withdrawn between such dams would consist largely of any settled entrained particles and some condensate.

While only one set of condensing sprays, that is, sprays 9 and 10, has been shown, it is within the skill of the art to provide additional sprays. Thus, sprays intermediate dam 8 and spray 9 can be provided to provide for a partial condensation of vapors. In such event, an additional dam can be provided intermediate the partial condensing sprays and final condensing sprays and through a suitable draw-off there can thus be withdrawn a light condensate.

The method and apparatus of this invention are particularly suited for application in methods and apparatus as described and claimed in Serial No. 188,604, filed October 5, 1950, by V. C. Cavin et al., and now abandoned, and Serial No. 241,183, filed August 10, 1951, by Paul M. Waddill, now abandoned.

In accordance with process and apparatus disclosed in application, Serial No. 188,604, a heavy oil is vacuum distilled by first flashing it so as to effect partial vaporization; removing entrained liquid droplets from vapors thus formed, by passing the said vapors against an impinging oil spray maintained at a temperature and under momentum conditions so as to cause settling of the entrainment with substantially no condensation of the vapors; thereafter condensing resulting liquid-free vapor in contact with one or more cooler impinging oil sprays maintained under momentum conditions to cause settling of condensate formed, or by contacting such liquid-free vapors first with a cooler condensing surface and then with an impinging oil spray to settle the condensate formed. In another embodiment, residuum recovered from the flashing step is further reduced in a second stage, in a separate vessel employing entrainment removal and condensation steps similar to those of the first stage.

In accordance with process and apparatus disclosed in application, Serial No. 241,183, a heavy oil is vacuum distilled by flashing, removal of entrainment, and subsequent condensation, in accordance with the process and apparatus of Serial No. 188,604 except that a second stage distillation of first stage residuum product is effected in the same vessel in which the first stage reduction is effected, or in a separate vessel, in either case utilizing only one source of vacuum, this latter feature being possible by taking advantage of the inherent pressure drop across the first stage distillation zone. Supplemental heating of residuum charged to the second stage distillation can be dispensed with. Distillation temperatures lower than employed heretofore are provided, while maintaining the pressure substantially unchanged, by dispersing the oil feed in a highly finely divided state.

One modification of the apparatus described in con-

nection with the figure, which is often desirable when operating at very high rates of throughput and/or reduced pressures with concomitant high vapor velocities, is to place another entrainment removing baffle between outlet 7 and dam 8 or coincident with dam 8 or between dam 8 and spray 9. When such a dam is used the direction of sprays 9 and 10 can be reversed, if desired.

It is within the scope of this invention to employ an arrangement or operation as here described in an arrangement such as shown in Serial No. 241,183, filed August 10, 1951, by Paul M. Waddill, in which arrangement feed is introduced at both ends of a vessel and distillate product is removed from a point intermediate said ends. In said arrangement the vacuum producing means is applied at a point intermediate the said ends of the said vessel. Furthermore, while it is within the scope of this invention to construct in identical fashion the apparatus parts in both portions of the said vessel receiving two feed streams it is also within the scope of the invention to employ dissimilar construction in the respective portions and indeed to omit one or more of the following features in one or both portions of said vessel namely the sprays 2 which can be replaced by one or more open end pipes which can be arranged to direct a body of oil against the end of the vessel which can have applied to its inner surface a porous mat or equivalent device adapted to retain a vaporizing body of oil thereon or therein; the inclined bottom in which event the bottom of the vessel will support the oil flowing toward residuum outlet 7; and one or more of the heating means 12, 13 and 14 which can be dispensed with or substituted for by other heating means.

In the event that a vessel which receives two or more feed streams is employed one or more of said feed streams can originate within said vessel or from a suitable external source.

Figure 2 of the drawing, as noted, is one such arrangement. Referring now to Figure 2, feed inlets 20 and 20' are provided at each end of vessel 21 and are equipped with open-end pipe portions 22 and 22' to introduce feed into vessel 21. The feed introduced into the vessel at 20 can be of a character different from that introduced at 20' and to this end, vessel 21 is divided at its bottom by a dam 23. Baffles 24, 25, 26 and 27 and 24', 25', 26', and 27' are provided and can be similar in construction to baffles 3, 4, 5, and 6 of Figure 1. Provision of dams 28, 29, 28' and 29' permits withdrawal of two residuum streams 30, 31 and 30', 31' at each end of vessel 21. Provision of a series of dams, as shown, in operation will permit withdrawal at 30 and 30' of residuum formed within or near and collected at the bases of the baffles and at 31 and 31' of substantially all of any entrained material which owing to surges might not have been caused to be at the bottom of the vessel 21 before passing beyond dams 26 and 26'. Baffles 32 and 32' are provided in combination with sprays 33 and 33' which are employed to condense distillate product which is removed at 34 and 34'. As shown, some of this distillate product can be pumped through a suitable cooler and employed as the condensing spray fluid or part or all of the said fluid can be obtained from an outside source and introduced at 35 and/or 35'. A guard chamber 36 leading to a vacuum-producing means completes the apparatus of Figure 2 in respect of its essential parts or components which, as in Figure 1, are diagrammatically illustrated.

Reasonable variation and modification are possible within the scope of the foregoing disclosure, drawing, and appended claims to the invention, the essence of which is that there have been provided a method and apparatus for gradually flashing, to a desirable depth of flash, a liquid, for example, a hydrocarbon oil, by passing the same successively through flashing sections in a flash zone of a vessel and in each flashing section subjecting the said liquid to increasingly reduced pressures and that said

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apparatus in one form thereof comprises a horizontally elongated shell into at least one end of which the liquid to be flashed is fed, the same end thereof having a flashing zone determined by a series of spaced baffle separators through which vapor will pass and which act to knock down entrained residual liquid and also through which will pass along the bottom of the vessel unvaporized liquid, substantially as set forth and described herein.

I claim:

1. A method for the flash vaporization of a liquid which comprises introducing said liquid into one end of a substantially horizontal vapor-liquid separation compartment comprising several flashing sections maintained at successively and increasingly reduced flashing pressures, separately passing in the same direction from each flashing section to a succeeding flashing section vapors and liquid and removing separately from said compartment said vapors and said flashed liquid.

2. A method for the separation of a vapor from its residual liquid by flash vaporization which comprises the steps of successively subjecting to step-wise lowered flashing pressures the said liquid by passing the said liquid separately into zones of increasingly lower flash pressures while separately passing in the same direction as the liquid vapors as generated through said zones of increasingly lowered flash pressures.

3. A method for the flash vaporization of a liquid which comprises preheating the said liquid and introducing the same into one end of a vapor-liquid separation zone comprising several flashing sections maintained at successively and increasingly reduced flashing pressures, separately passing vapors as generated through said sections, in each of said sections removing any entrained unvaporized liquid, also separately passing in the same direction as the vapors unvaporized liquid through each of said sections and therein vaporizing at said successively increasingly lower flashing pressures additional portions of the said liquid.

4. An apparatus especially adapted for the separation of vapors from liquids which comprises a substantially horizontally disposed elongated shell, at one end of said shell a feed inlet conduit, a plurality of spaced baffle separators arranged across the cross-sectional area of said shell intermediate said inlet conduit and the other end of said shell, each of said baffle separators being so constructed and arranged as to allow vapor flow through the upper portions thereof and to allow liquid flow through the bottom portions thereof, a liquid damming means along the bottom of said shell intermediate said plurality of baffle separators and said other end of said shell, a

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vapor condensing section intermediate said damming means and said other end of said shell, a liquid withdrawal means intermediate said baffle separators and said damming means, and a liquid withdrawal means intermediate said damming means and said other end of said shell.

5. An apparatus according to claim 4 in which a plurality of spaced damming means is placed along the bottom of said shell at a locus intermediate said plurality of baffle separators and said vapor condensing section; a baffle means is placed across the cross section of said vessel beyond the first of said damming means and before said vapor condensing section; and in which there is provided a liquid withdrawal means between two of said plurality of damming means.

6. An apparatus according to claim 4 wherein in said vapor condensing section condensing spray means are provided.

7. In an apparatus for the distillation of a hydrocarbon oil in which a preheated hydrocarbon is flash vaporized, in a substantially horizontal elongated vaporization section, means for introducing said preheated hydrocarbon into one end of said section, a plurality of vertically disposed baffle separators, each extending throughout the available cross section of the vaporization section at the locus of its disposition therein and being so constructed and arranged as to allow vapor flow through an upper portion thereof and to allow liquid flow through a bottom portion thereof, and so as to cause stepwise pressure drop of vapors and liquid passing therethrough in operation of the apparatus, and means for recovering separately vapors and liquid from after the last of said plurality of baffle separators at the other end of said section.

8. An apparatus according to claim 6 in which there is provided at least one heating means within said plurality of vertically disposed baffle separators.

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