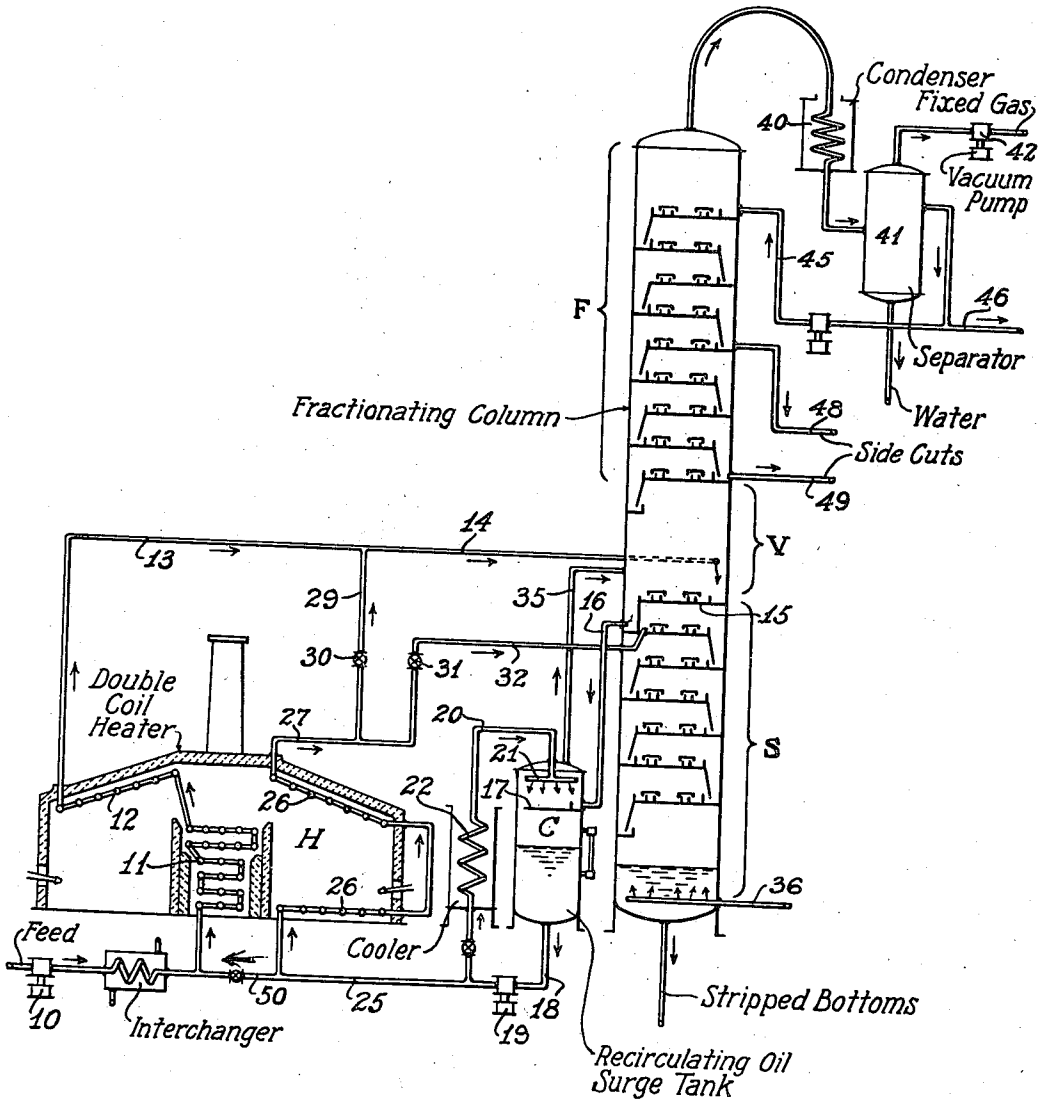
May 16, 1939. E. G. RAGATZ 2,158,425

VACUUM STEAM DISTILLATION OF HEAVY OILS

Filed Jan. 4, 1936



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Patented May 16, 1939

2,158,425

UNITED STATES PATENT OFFICE

2,158,425

VACUUM STEAM DISTILLATION OF HEAVY OILS

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Application January 4, 1936, Serial No. 57,560

12 Claims. (Cl. 196—73)

This invention relates to fractional distillation of oil, and particularly to the vacuum steam distillation of heavy hydrocarbon oils to produce lubricating oil distillates.

It is an object of this invention to provide an improved distillation system having increased distillation capacity for the extremely heavy or deep cut fractions but without employing the increased or excessive hydrocarbon oil feed temperatures usually associated with such increase in capacity of deep cut distillation and without the undesirable results attendant upon such excessive heating, such as decomposition of the oil resulting in coke deposit in the heater tubes, discoloration of the distillates, loss of the heavy hydrocarbon distillate yields, the production of asphalts of impaired quality and the production of excessive amounts of fixed gases. It is a further object of this invention to provide a heavy oil recirculatory system wherein the said recirculated oil may be more efficiently handled at high temperatures by the circulatory pumping equipment. It is a further object of this invention to maintain a higher level of heat throughout the stripping operations whereby a more complete distillation of the desirable heavy lubricating oil constituents is accomplished.

The invention resides in supplying the latent heat of vaporization to the vaporizable constituents of the feed material to be distilled in the vaporization zone of the fractionating system, by withdrawing, reheating and recirculating to the vaporizing zone a relatively large quantity of unvaporized oil, said oil containing and conveying from the heater to the vaporizing zone sufficient sensible heat to supply a substantial portion of the latent heat of vaporization of the vaporizable constituents of the feed material. The recirculated unvaporized oil is preferably hot residual equilibrium material withdrawn from the flash section of the vaporizing zone and is unvaporizable under the conditions prevailing therein.

The invention also resides in providing for coalescing and freeing the hot unvaporized oil of gas and foam withdrawn from the flash zone, prior to pumping through the reheater. This enables more efficient and effective handling of the oil at high tempreatures by the pumping equipment.

The accompanying drawing diagrammatically illustrates the preferred apparatus by which the process of this invention may be carried on, in which H is a double section heater provided with two separate sets of heating coils, one set for the fresh hydrocarbon feed to be distilled and the other set for the recirculated unvaporized oil; S is the stripping section; F the fractionating section; V the vaporizing section of the fractionating column; and C is the recirculating oil surge tank and coalescing chamber.

The typical operation of the distillation system may be as follows:

The cold hydrocarbon feed oil to be distilled is forced by means of pump 10 through the feed heater coil 11 and 12 and thence through lines 13 and 14 at a temperature of approximately 725° F.–750° F. into the flash section V of the fractionating column, where it flows across the flash tray 15. The heated feed thus introduced into the flash section of the fractionating column is intimately contacted as it flows across the tray 15 with rising steam and hydrocarbon vapors from the stripping sections S therebelow. Upon thus contacting the said steam and vapors, the heated oil feed is partially flashed into vapors, which in turn pass upward together with the steam and vapors from the stripping section through the fractionating section F of the fractionating column.

The unvaporized portion of the oil passing across the flash tray 15 is totally withdrawn therefrom through pipe 16 and introduced into the coalescing chamber C near the top where it first flows over the gas disengaging tray 17 and then drops in a coalesced body into the lower portion thereof. The unvaporized coalesced oil is withdrawn from the bottom of the coalescing chamber C through pipe 18 by means of pump 19. A portion of the unvaporized oil thus withdrawn from the bottom is recirculated through cooler 22 to the top of the coalescing chamber through pipe 20 and allowed to fall in the form of a spray from nozzles 21 upon the oil flowing over the disengaging tray 17. The effect of the cool recirculated oil spray impinging upon the oil passing over the disengaging tray 17 is to break the foam and cause its rapid coalescence. The oil collected in the lower portion of the coalescing chamber C is thus rendered relatively gas free, and even though still at a high temperature it can be efficiently handled by means of the pump 19 without the usual difficulties with gas lock and hammering.

The gas and vapor disengaged from the unvaporized oil in the coalescing chamber C is returned to the vaporizing section V of the fractionating column through line 35.

The balance of the oil withdrawn from the coalescing chamber C is forced by means of pump 19 through line 25 into the recirculating oil heating

tubes 26 in the heater H. From the heating tubes 26 the reheated oil, at a temperature of approximately 725° F.–750° F., flows through pipe 27 and a portion thereof is introduced through cross connection line 29 and valve 30 into the hot feed line 14. The commingled hot feed and the reheated unvaporized recirculated oil thus flow together through line 14 into the flash section of the fractionating column as described hereinbefore. Instead of recirculating all of the unvaporized oil withdrawn from the coalescing chamber C through the heater tubes 26, if desired all or a portion thereof may, by means of cross connection 50, be commingled with the cold feed material and heated together therewith in the feed heater tubes 11 and 12.

The remaining portion of the reheated recirculated unvaporized oil not commingled with the hot or cold feed is introduced by way of valve 31 and line 32 into the top of the stripping section S. The stripping section S is thus supplied with unvaporized unstripped oil from the flash section of the column which has been reheated and which is at a higher temperature than that which would result in the usual method of operation where the unvaporized material flows directly from the flash tray without being reheated into the top of the flash section.

The reheated oil introduced into the top of the stripping section S passes downward therein in countercurrent contact with steam introduced through line 36 wherein additional heavy lubricating oil fractions are vaporized. The stripped residual oil is withdrawn from the bottom of the stripping section through the bottoms draw-off line 37.

The combined vapors from the stripping section and the flash tray pass from the vaporizing section V up through the fractionating section F in countercurrent to descending reflux condensate derived from the condensation from the overhead vapors in condenser 40. Condensate and fixed gases are separated in the separating drum 41 and a vacuum may be maintained upon the system by means of a vacuum pump 42. The portion of the condensed overhead vapors not returned through line 45 as reflux to the top of the fractionating column is withdrawn through line 46 to production.

Side cuts of lubricating oil distillate may be withdrawn at a number of points in the fractionating section, as for example, through side cut withdrawals 48 and 49. Other connections may be provided so that side cuts may be taken from any of the trays in the column desired. The thus withdrawn side cuts may be stripped of their remnant light constituents in countercurrent contact with steam in any suitable apparatus.

It has been found advantageous to recirculate the heavy unvaporized oil from the flash tray through the heater with sufficient rapidity and in sufficient quantity so that that portion thereof which is commingled by means of valve 30 and cross connection 29 with the hot feed material flowing to the vaporizing section and flash tray will bear a ratio of from 2 to 5 volumes of recirculated oil to one volume of introduced feed. In recirculating the said unvaporized heavy oil through the heater and in commingling it with the feed material, it is advantageous to withdraw for such recirculation the unvaporized oil from the flash tray which in this case is the tray 15 in the vaporizing section V. This oil from the flash tray is preferred to column bottoms or other lower residual material for the reason that it approximates the equilibrium liquid of the flash section vapors, or in other words this withdrawn recirculated material is in approximate equilibrium with the vapors leaving the vaporizing section and entering the fractionating section of the column. When this condition obtains, the absorption oil effect of the oil recirculated and commingled with the feed stock is a minimum, permitting the distillation of the net overhead vapor cut at a lower temperature and at a greater efficiency than would be possible were column bottoms or other oil less nearly in equilibrium with the vapors employed.

The portion of the recirculated reheated oil introduced into the top of the stripping section S through line 32 constitutes in quality and quantity that remaining portion of the feed not vaporized in the vaporizing section of the fractionating column.

The advantages of the hereinabove described process are that since steam and reduced pressure is usually employed for effecting the vaporization of the heavy cuts at the distillation column, and since this vaporization heat must be supplied at the vaporizing zone by sensible heat imparted to the oil feed at the heater, and since the temperature plane to which the oil feed can be raised at the heater is definitely limited due to the cracking tendencies of the feed stock, it is highly desirable to increase the heat available for vaporization at the distillation column by conveying the said necessary heat thereto by recirculation through the heater of a relatively large proportion of equilibrium fractions which are comparatively unvaporizable under the conditions prevailing at the flash section of the column. Moreover the return of a portion of the separately reheated unvaporized oil from the flash section of the column directly to the top of the stripping section without remixture with the feed makes possible the operation of the said stripping section at the maximum temperatures permitted in the distillation unit heaters. Difficulties heretofore encountered in attempting to recirculate hot oil from a fractionating column where it was necessary to handle such recirculated material by means of pumps is overcome by employing means as illustrated herein to coalesce the oil and eliminate its gas lock tendencies prior to such pumping operations.

The invention, while particularly applicable to the distillation of heavy petroleum is, however, applicable to the distillation of other liquids.

I claim:

1. In a process for distillation of heavy oil, the steps comprising heating fresh feed oil to be distilled, introducing the said heated oil into a vaporizer and separating vapors and unvaporized oil, withdrawing unvaporized oil from the vaporizer, heating said withdrawn unvaporized oil and returning and commingling a portion thereof with the feed oil in the vaporizer, introducing another portion of said heated unvaporized oil into a stripper and passing the same in countercurrent contact with steam to effect additional vaporization, contacting the oil in the vaporizer with the steam and vapors from the stripper, commingling the vapors from the vaporizer and the stripper, and fractionating said commingled vapors in countercurrent contact with a previously condensed portion of said vapors.

2. In a process for vacuum steam distillation of heavy oil, the steps comprising heating fresh feed oil to be distilled, introducing the said heated oil into a vaporizer and separating vapors and

unvaporized oil, withdrawing unvaporized oil from the vaporizer, separately heating said withdrawn unvaporized oil and returning and commingling a portion thereof with the feed oil in the vaporizer, introducing another portion of said heated unvaporized oil into a stripper and passing the same in countercurrent contact with steam to effect additional vaporization, contacting the oil in the vaporizer with the steam and vapors from the stripper, commingling the vapors from the vaporizer and the stripper, and fractionating said commingled vapors in countercurrent contact with a previously condensed portion of said vapors.

3. In a process for vacuum steam distillation of heavy oil the steps comprising heating the fresh feed oil to be distilled, introducing the said heated oil into a vaporizer and separating vapors and unvaporized oil, withdrawing unvaporized oil from the vaporizer, separately heating said withdrawn unvaporized oil and returning and commingling a portion thereof with the feed oil in the vaporizer, introducing another portion of said heated unvaporized oil without commingling with the feed material into a stripper and passing the same in countercurrent contact with steam to effect additional vaporization, contacting the oil in the vaporizer with the steam and vapors from the stripper, commingling the vapors from the vaporizer and the stripper, and fractionating said commingled vapors in countercurrent contact with a previously condensed portion of said vapors.

4. In a process for vacuum steam distillation of heavy oil the steps comprising heating the fresh feed oil to be distilled, introducing the said heated oil onto a flash tray in a fractionating column and separating vapors and unvaporized oil, withdrawing unvaporized oil from the fractionating column at the said flash tray, heating said withdrawn unvaporized oil and returning and commingling a portion thereof with the feed oil on the flash tray, introducing another portion of said heated unvaporized oil without commingling with the feed oil into a stripping zone in said fractionating column to effect additional vaporization, contacting the oil on the flash tray with the vapors from the stripping zone, commingling the vapors from the stripping zone and the flash tray and fractionating said commingled vapors in countercurrent contact with a previously condensed portion of said vapors.

5. In a process for vacuum steam distillation of heavy oil the steps comprising heating the fresh feed oil to be distilled, introducing the said heated oil onto a flash tray in a fractionating column and separating vapors and unvaporized oil, withdrawing from the fractionating column at the said flash tray unvaporized oil which is in substantial equilibrium with the separated vapors, heating said withdrawn unvaporized oil and returning and commingling a portion thereof with the feed oil on the flash tray, introducing another portion of said heated unvaporized oil without commingling with the feed oil into a stripping zone in said fractionating column to effect additional vaporization, contacting the oil on the flash tray with the vapors from the stripping zone, commingling the vapors from the stripping zone and the flash tray and fractionating said commingled vapors in countercurrent contact with a previously condensed portion of said vapors.

6. In a process for vacuum steam distillation of heavy oil the steps comprising heating the fresh feed oil to be distilled, introducing the said heated oil onto a flash tray in a fractionating column and separating vapors and unvaporized oil, withdrawing all of the unvaporized oil from the fractionating column at the said flash tray, heating said withdrawn unvaporized oil and returning and commingling a portion thereof with the feed oil on the flash tray, introducing another portion of said heated unvaporized oil without commingling with the feed oil into a stripping zone in said fractionating column to effect additional vaporization, contacting the oil on the flash tray with the vapors from the stripping zone, commingling the vapors from the stripping zone and the flash tray and fractionating said commingled vapors in countercurrent contact with a previously condensed portion of said vapors.

7. In a process for vacuum steam distillation of heavy oil the steps comprising heating the fresh feed oil to be distilled, introducing the said heated oil onto a flash tray in a fractionating column and separating vapors and unvaporized oil, withdrawing all of the unvaporized oil from the fractionating column at the said flash tray, commingling a portion of said unvaporized oil with the fresh feed passing through the heater, separately heating a second portion of said withdrawn oil, introducing a portion of said separately heated oil into a stripping zone in said fractionating column in effect additional vaporization, contacting the oil on the flash tray with the vapors from the stripping zone, commingling the vapors from the stripping zone and the flash tray and fractionating said commingled vapors in countercurrent contact with a previously condensed portion of said vapors.

8. In a process for vacuum steam distillation of heavy oil the steps comprising heating the fresh feed oil to be distilled, introducing the said heated oil into a vaporizer, flashing the heated oil therein to substantial equilibrium with the vapors leaving said vaporizer and separating vapors and unvaporized oil, withdrawing unvaporized oil from the vaporizer, coalescing said withdrawn unvaporized oil in a coalescing chamber, returning gases from said coalescing chamber to the vaporizer, withdrawing coalesced oil from said chamber and reheating and returning said coalesced oil to the vaporizer.

9. In a process for vacuum steam distillation of heavy oil the steps comprising heating the fresh feed oil to be distilled, introducing the said heated oil into a vaporizer, withdrawing unvaporized oil from the vaporizer, coalescing said withdrawn unvaporized oil in contact with a spray of cool, previously coalesced oil in a coalescing chamber, withdrawing coalesced oil from said chamber and reheating and returning said coalesced oil to the vaporizer.

10. In a process for distillation of heavy oils, the steps comprising heating the fresh feed oil to be distilled, introducing the said heated oil into the flash section of a fractionating column and separating vapors and unvaporized oil, withdrawing unvaporized oil from the fractionating column at the flash section, said withdrawn unvaporized oil being in substantial equilibrium with the vapors leaving the said flash section, reheating said withdrawn unvaporized oil and returning said reheated oil separately to a point in the fractionating column lower than that from which it was withdrawn.

11. In a process for distillation of heavy oil

the steps comprising heating the fresh feed oil to be distilled, introducing said heated oil into a flashing zone and separating vapors and unvaporized oil, withdrawing unvaporized oil from the flashing zone, said withdrawn unvaporized oil being in substantial equilibrium with the vapors leaving the said flashing zone, reheating said withdrawn unvaporized oil and introducing said reheated oil separately into a stripping zone and passing the same in countercurrent contact with the stripping vapors to effect additional vaporization, contacting substantially all of the oil in the flashing zone with substantially all of the vapors from the stripping zone and thus commingling the vapors from the stripping zone and flashing zone, said commingled vapors constituting said first mentioned vapors leaving the flashing zone and condensing substantially all of said commingled vapors.

12. In a process for distillation of heavy oil the steps comprising heating the fresh feed oil to be distilled, introducing said heated oil into a flashing zone and separating vapors and unvaporized oil, withdrawing unvaporized oil from the flashing zone, said withdrawn unvaporized oil being in substantial equilibrium with the vapors leaving the said flashing zone, reheating said withdrawn unvaporized oil and introducing said reheated oil separately into a stripping zone and passing the same in countercurrent contact with the stripping vapors to effect additional vaporization, contacting substantially all of the oil in the flashing zone with substantially all of the vapors from the stripping zone, and thus commingling the vapors from the stripping zone and flashing zone, said commingled vapors constituting said first mentioned vapors leaving the flashing zone and fractionating said commingled vapors in countercurrent contact with a previously condensed portion of said vapors.

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