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DISTILLATION OF HYDROCARBON OILS FOR THE PRODUCTION OF LOWER BOILING HYDROCARBON OILS

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Fig. 1.

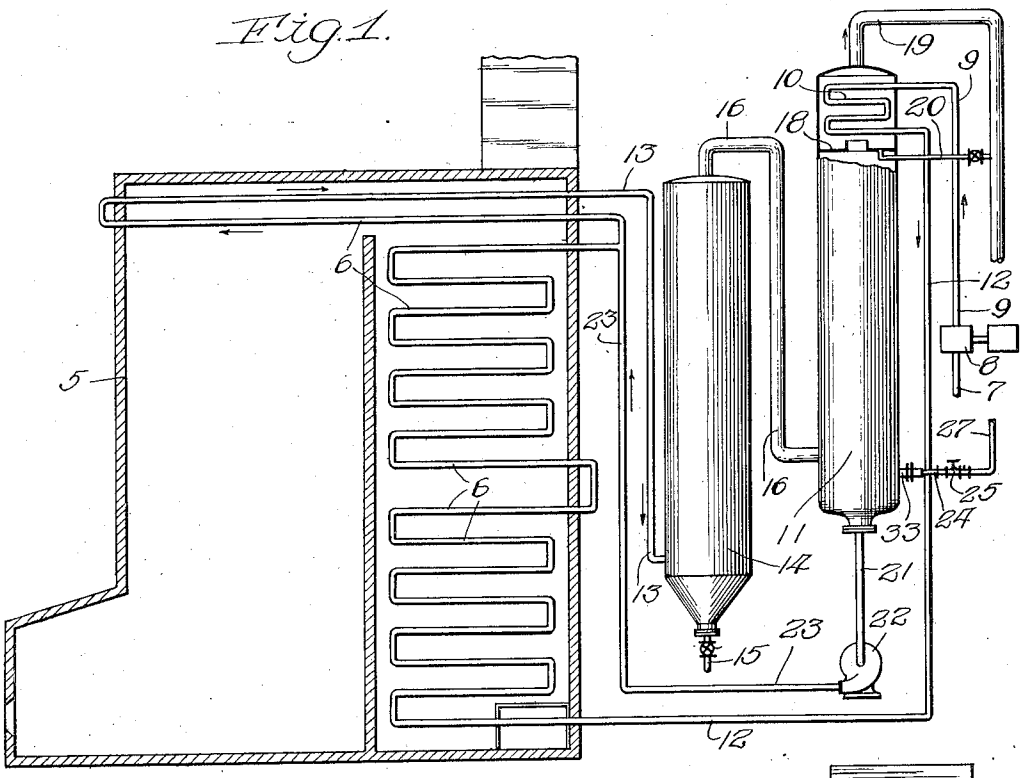
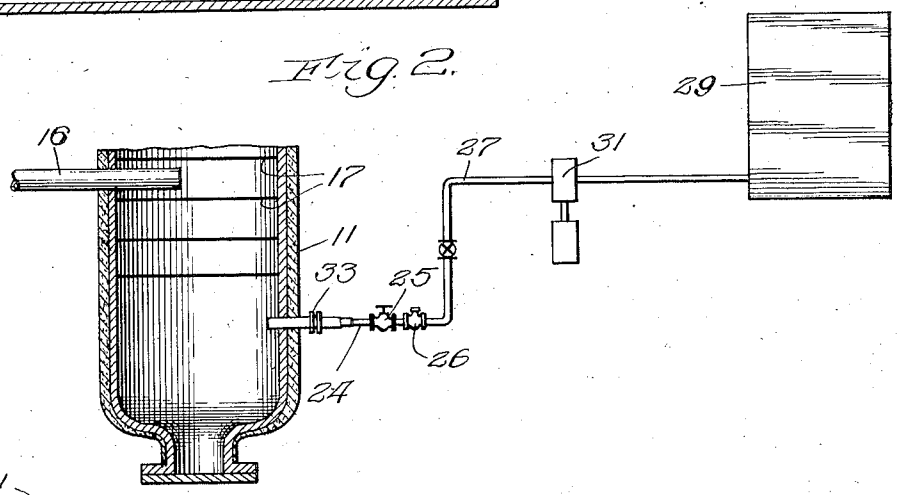


Fig. 2.



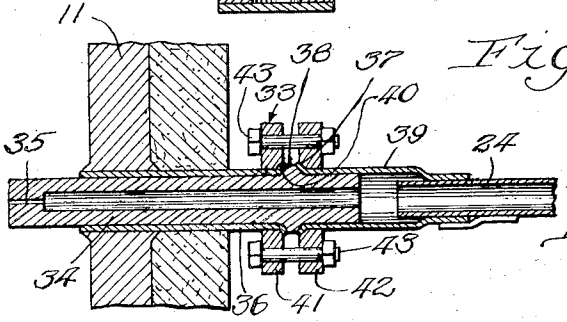


Fig. 3.

Inventors
William H. Bahlke,
Walter G. Whitman,
By Dyrenforth, Lee, Christie & Miles,
Attys.

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DISTILLATION OF HYDROCARBON OILS FOR THE PRODUCTION OF LOWER BOILING HYDROCARBON OILS

William H. Bahlke, Hammond, and Walter G. Whitman, Whiting, Ind., assignors to Standard Oil Company, Whiting, Ind., a corporation of Indiana

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7 Claims. (Cl. 196—48)

This invention relates to the distillation of hydrocarbon oils and refers more particularly to improvements in the distillation of such oils under pressure for the production of lower boiling oils, for example, those within the gasoline range of boiling points.

The invention will be fully understood from the following detailed description in conjunction with the accompanying drawing, in which,

Figure 1 is a side elevational view, diagrammatic in character, partly in section and partly broken away, of apparatus suitable for carrying out the present invention.

Figure 2 is an enlarged fragmentary vertical sectional view of the lower portion of the fractionating column showing suitable means for injecting liquid thereinto; and

Figure 3 is an enlarged longitudinal vertical section of suitable means for introducing liquid into the lower portion of the fractionating column.

Figure 1 illustrates, diagrammatically, apparatus for carrying out a well known type of pressure distillation or cracking process. In such processes the oil to be cracked is passed through an elongated restricted passageway, such as a pipe coil, wherein it is heated to cracking or conversion temperature. The heated oil is discharged into an enlarged chamber wherein it is maintained at cracking temperature for a substantial period of time. The vaporous products are withdrawn from the chamber and are passed to a fractionating column, such as a bubble tower, wherein certain of the higher boiling products undesired in the final distillate product are condensed and thereby separated from the vapors. The condensed heavier constituents are withdrawn from the fractionating column and are introduced into the restricted heated passageway or pipe coil and thus are admixed with the fresh charging stock, and subjected to cracking conditions of temperature along with the fresh stock. The fractionated vapors are condensed and subjected to the usual refining treatment.

We have observed that in the above type of processes, the heavier constituents condensed from the vaporous products and which are returned to the stream of fresh charging stock, normally, are responsible for certain inefficiencies in the process. For example, these heavy condensates contain certain portions which do not readily crack under the temperature and pressure conditions best adapted for the fresh stock and consequently tend to accumulate in the system and thus reduce the capacity of the same. Also these products are difficult to pump back into the fresh oil stream in that they tend to vaporize at the temperature at which they are maintained in the bottom of the fractionating tower, thus causing substantial vapor locking within the pump employed for forcing them into the stream of fresh stock.

We have found that the above mentioned disadvantages can be substantially minimized by introducing a liquid, for example, an aqueous fluid such as water into the heavy condensates before they are withdrawn from the lower portion of the vapor fractionating column. The liquid is heated by the hot condensates and is converted into vapor which bubbles up through the body of hot condensate and strips from them a substantial portion of the heavier constituents which are not adapted to be cracked with the fresh stock. These heavy portions are known in the art as "naphtha bottoms". The liquid when introduced in amounts sufficient to form the quantity of vapor necessary to effect the desired stripping, functions to cool the condensates to a point at which they do not form sufficient vapors to cause substantial vapor-locking of the pump which charges them into the cracking coil. The capacity of the cracking process is thus substantially increased since the fractions difficult to crack, in conjunction with the fresh stock, do not tend to accumulate in the system and are substantially removed from the heavy condensate or reflux before it is passed to the pipe coil and admixed with the fresh stock undergoing cracking.

It is to be understood that the present invention may be employed with any other type of cracking process wherein the heavier undesired constituents are condensed from the desired vaporous products and returned to the original cracking operation.

Referring more in detail to the drawing, the numeral 5 indicates a furnace setting in which is mounted a pipe coil 6 through which the oil to be converted or cracked is passed. The oil to be treated may be drawn from any suitable source through a line 7, by pump 8 from which it is discharged through a line 9, to a coil 10 disposed within the upper portion of a fractionating column 11 whereby the oil partially cools the vapors in the upper portion of the column. The partially heated oil is discharged from the coil 10 into a line 12 through which it is passed to the coil 6 mounted in the furnace 5. The oil is brought to cracking temperature within the coil

6 and is passed therethrough under a suitable pressure and at a velocity sufficient to avoid substantial cracking and deposition of coke within the coil 6.

The highly heated oil is discharged from the coil 6 through a line 13 into the lower portion of an enlarged reaction chamber 14 wherein it undergoes further cracking. The oil in chamber 14 may be maintained under substantially the same pressure at which it was discharged from coil 6, although it is to be understood a suitable pressure reducing valve (not shown) may be provided in line 13 for the purpose of maintaining a lower pressure in the chamber 14. The non-vaporous products are withdrawn from the lower portion of the chamber 14 and passed from the system through a valved line 15. The vaporous products are withdrawn from the upper portion of chamber 14 through a line 16 and are passed to the lower portion of the fractionating column 11.

The column 11 may contain any suitable fractionating means for example a spaced series of plates of the ring and disk type or of the bubble-cap type shown diagrammatically at 17 in Fig. 2. The vapors pass upwardly through the fractionating elements in column 11 and come into intimate contact with downflowing cooler liquid, whereby they are fractionated, the heavy constituents undesired in the final distillate product being condensed and thereby separated from the vapors. The fractionated vapors flow through a trap-out plate 18 and into the upper portion of the column 11 containing the coil 10 through which is passed the fresh oil to be cracked. The vapors give up a portion of their heat to the oil in the coil 10 and the heavier constituents thereof are condensed. The remaining vapors pass out of the column 11 through a line 19 leading to suitable condensing means, (not shown).

The portions of the vapors condensed by the cooling medium in coil 10 accumulate on the trap-out plate 18 from which any desired portion of such condensate may be withdrawn by line 20 and passed to the line 19 leading to the aforementioned condensing means. The remaining condensate overflows the trap-out plate 18 and thus provides a reflux cooling medium within the portion of the column therebelow.

The heavy condensed constituents undesired in the final distillate product are withdrawn from the bottom of column 11 through a line 21 and are passed therethrough to a pump 22. The hot condensates are forced from the pump 22 through a line 23 from which they are discharged into the pipe coil 6 at an intermediate point thereof. The heavy condensates become admixed with the fresh stock within the coil 6, flow through the remainder of the coil 6, being heated therein to cracking temperature and are passed on through the system along with the highly heated fresh stock. It is to be understood that these recycled heavy condensates may be returned to any point in the coil 6, and may, if desired, be introduced into the line 12 leading to the inlet of coil 6.

As previously stated, these heavy condensates withdrawn from the lower portion of column 11, contain certain portions which are difficult to crack under the conditions of operation most suitable for the fresh stock. These portions are ordinarily termed "naphtha bottoms" in the art, and since they are difficult to crack, they tend to accumulate in the system and thus reduce the capacity of the same. Also this body of condensate in the bottom of the column 11 is at a temperature at which its vapor pressure is sufficiently high that it forms vapor in the pump 22 in sufficient quantity to greatly reduce the efficiency of the pump.

In order to strip these undesired constituents from the hot condensate and at the same time cool the condensate to such a point that its vapor pressure will not be sufficiently high to form an undesired quantity of vapors in the pump 22, a quantity of liquid vaporizable at the temperature of the condensate, such as water, is admixed with the hot condensate in the bottom of the column 11. The liquid is heated by the condensate and converted into steam, which bubbles up through the condensate and strips therefrom a substantial portion of the constituents contained therein which are difficult to crack along with the fresh stock in coil 6, i. e. "naphtha bottoms". The liquid when introduced in quantities sufficient to effect the desired stripping action functions to cool the hot condensate to a temperature at which no undesired quantity of vapors will be formed in the pump 22.

This cooling and stripping liquid may be introduced into the bottom of column 11 through a line 24 provided with an adjustable valve 25 and a back-check valve 26. A valved line 27 leads from a suitable source 29 of water and communicates with the line 24. The line 27 is provided with a force pump 31.

It is preferred to provide the line 24 with a nozzle-like member 33 which discharges into the fractionating tower 11. This nozzle 33 preferably comprises a tubular portion 34 provided with a small outlet 35. The tubular member 34 is fitted into a cylindrical sleeve 36 carried by a wall of the fractionating tower 11 and provided with an outwardly flared end 37 adapted to engage an annular shoulder 38 formed upon the tubular portion 34 at a point spaced from the outer end thereof. The pipe 24 has secured to its end a cylindrical sleeve 39 adapted to surround the tubular member 34 and which is provided with an outwardly flared end 40 adapted to engage the other face of the annular shoulder 38. The sleeves 36 and 39 are maintained in contact with the shoulder 38 by means of a pair of annular rings 41 and 42 one of which engages the flared end 37 and the other of which engages the flared end 40. The rings 41 and 42 are forced toward each other by means of a plurality of bolts 43, whereby the entire assembly is secured together in a leak-proof manner.

In the operation of the process, 130 barrels of fresh stock to be cracked were passed through lines 7, 9, coil 10, line 12 and coil 6 wherein it was heated under superatmospheric pressure together with the hot condensate recycled from the bottom of column 11, to about 870 to 875° F. The vaporous products withdrawn from the top of chamber 14 were passed to column 11. The vapors withdrawn from the top of column 11 were at a temperature of about 550° F. and the hot condensates in the bottom of column 11 were at a temperature of about 785° F., and were formed at the rate of about 1.55 times the amount of fresh feed i. e. about 200 to 202 barrels per hour. The condensate on trap-out plate 18 was at 666° F. When water at atmospheric temperature was introduced through the line 24 into the column 11 at the rate of two gallons per minute it was found that the amount of back-trap or hot condensate withdrawn from the bottom of column 11 was about 1.05 times the amount of fresh feed i. e. 135 to 137 barrels per

hour, and was at a temperature of 705° F. The vapors withdrawn from the top of column 11 were at 543° F. and the condensate on trap-out plate 18 was at 672° F.

It was found that the capacity of the process was increased about 7% and the speed of the pump employed for recycling the condensate from column 11 to the coil 6 was reduced from 61 strokes per minute to 38 strokes per minute. The introduction of water caused the amount of "naphtha bottoms" in the reflux condensate in column 11 to be substantially reduced.

In processes of the above described type, a substantial superatmospheric pressure is maintained throughout the system. For example, in the above described specific operation, the column 11 was maintained under 310 lbs. pressure. In order to insure unvarying conditions of operation, it is desirable to force the aqueous fluid into column 11 under a pressure considerably greater than that employed in the column 11. For example, when a pressure of 310 lbs. is maintained upon the column 11, the water may be forced thereinto under a pressure of 600 lbs.

Although the present invention has been described in connection with the details of specific embodiments thereof, it is not intended that such details shall be regarded as limitations upon the scope of the invention, except in so far as included in the accompanying claims.

We claim:

1. In the conversion of hydrocarbon oils wherein such oil is heated to cracking temperature under substantial pressure, vaporous products being separated therefrom and subjected to fractional condensation, the uncondensed vapors being removed from the system and the condensate collected in a body at a temperature normally above 700° F. and while in heated condition being returned by applied mechanical force to the original body of oil undergoing cracking, the step of introducing an aqueous liquid directly into said body of condensate which would normally be at said temperature above 700° F. formed in the fractional condensation operation to strip and partially cool same and reduce the quantity of vapors therefrom before said condensate is returned to the body of oil undergoing cracking to substantially prevent vapor-locking of said applied mechanical force, said aqueous liquid being of such a boiling range that it will be substantially entirely vaporized by the hot condensate.

2. The method of converting hydrocarbon oils into lower boiling hydrocarbon oils which comprises, heating said oil to a cracking temperature, separately withdrawing vaporous products and subjecting them to fractional condensation whereby the insufficiently cracked constituents thereof are condensed and collected as a body of liquid oil at a temperature normally above 700° F., withdrawing the fractionated vapors from the system, returning by applied mechanical force the condensate while in heated condition to the oil undergoing cracking, and introducing a relatively cooler aqueous liquid in a stream of restricted cross-section directly into said body of condensate which would normally be at said temperature above 700° F. to cool same and reduce the quantity of vapors therefrom before passing the condensate to the oil undergoing cracking to substantially prevent vapor locking of said applied mechanical force, the aqueous liquid introduced being substantially entirely converted into steam and lighter constituents are stripped from said condensate thereby.

3. The method of converting hydrocarbon oils into lower boiling hydrocarbon oils which comprises, heating said oil under superatmospheric pressure to a cracking temperature, separately withdrawing vaporous products and subjecting them to fractional condensation whereby the insufficiently cracked constituents thereof are condensed and collected as a body of liquid oil at a temperature normally above 700° F., withdrawing the fractionated vapors from the system, returning by applied mechanical force the condensate while in heated condition to the oil undergoing cracking, and introducing a cooler and relatively lower boiling aqueous liquid to be completely vaporized directly into said body of hot condensate which would normally be at said temperature above 700° F. to reduce the quantity of vapors before the latter is subjected to said mechanically applied force wherein vapor locking thereof is substantially prevented in returning the condensate to the oil undergoing cracking.

4. The method of converting hydrocarbon oils into lower boiling hydrocarbon oils which comprises, passing said oil through a restricted elongated passageway wherein it is heated to cracking temperature, discharging the highly heated oil into an enlarged chamber wherein it is maintained at cracking temperature, withdrawing vaporous products from said chamber and passing them to a fractionating column wherein the insufficiently cracked constituents are condensed and collected in a pool in the lower portion of said column at a temperature normally above 700° F., withdrawing the fractionated vapors from said column, withdrawing the hot condensate from the lower portion of said column and returning the same by applied mechanical force to the oil flowing through said elongated passageway, and introducing a relatively cool lower boiling aqueous liquid to be substantially entirely vaporized directly into the pool of hot condensate which would normally be at said temperature above 700° F. before it is withdrawn from said column and passed to said passageway in the manner aforesaid to cool said condensate and reduce the quantity of vapors therefrom to substantially prevent vapor locking of said applied mechanical force.

5. The method of converting hydrocarbon oils into lower boiling hydrocarbon oils which comprises, passing said oil through a restricted elongated passageway wherein it is heated to cracking temperature, discharging the highly heated oil into an enlarged chamber wherein it is maintained at cracking temperature, withdrawing vaporous products from said chamber and passing them to a fractionating column wherein the insufficiently cracked constituents are condensed and collected in a pool in the lower portion of said column at a temperature normally above 700° F., withdrawing the fractionated vapors from said column, withdrawing the hot condensate from the lower portion of said column and returning the same by a pump to the oil flowing through said elongated passageway, and introducing a relatively cool lower boiling aqueous liquid to be substantially entirely vaporized directly into the pool of hot condensate which would normally be at said temperature above 700° F. before it is withdrawn from said column to reduce the quantities of vapors and passed to said passageway by said pump without vapor locking thereof.

6. The method of converting hydrocarbon oils into lower boiling hydrocarbon oils which com-

prises heating said oil to a cracking temperature under superatmospheric pressure, separately withdrawing vaporous products and subjecting them to fractional condensation whereby the insufficient cracked constituents thereof are condensed under superatmospheric pressure and collected in a pool at a temperature normally above 700° F., withdrawing the fractionated vapors from the system, returning by applied mechanical force the condensate while in a heated condition to the oil undergoing cracking, and supplying water free from extraneous treating materials in a stream of restricted cross-section and at a substantially higher pressure than existing during fractional condensation directly into the pool of condensate which would normally be at said temperature above 700° F. formed in the fractional condensation operation in a proportion that is completely vaporized to partially cool and strip the condensate before it is returned to the body of oil undergoing cracking and reduce the quantity of vapors therefrom to substantially prevent vapor locking of said applied mechanical force.

7. In the conversion of hydrocarbon oils wherein such oil is heated to cracking temperature while being maintained under superatmospheric pressure, vaporous products being separated therefrom and subjected to fractional condensation, the uncondensed vapors being removed from the system and the condensate collected in a body and while in heated condition being returned by applied mechanical force to the original body of oil undergoing cracking, the step of passing an aqueous liquid directly into said body of condensate formed in the fractional condensation operation to strip and materially cool same and reduce the quantity of vapors therefrom before said condensate is returned to the body of oil undergoing cracking to substantially prevent vapor locking of said applied mechanical force.

WILLIAM H. BAHLKE.
WALTER G. WHITMAN.