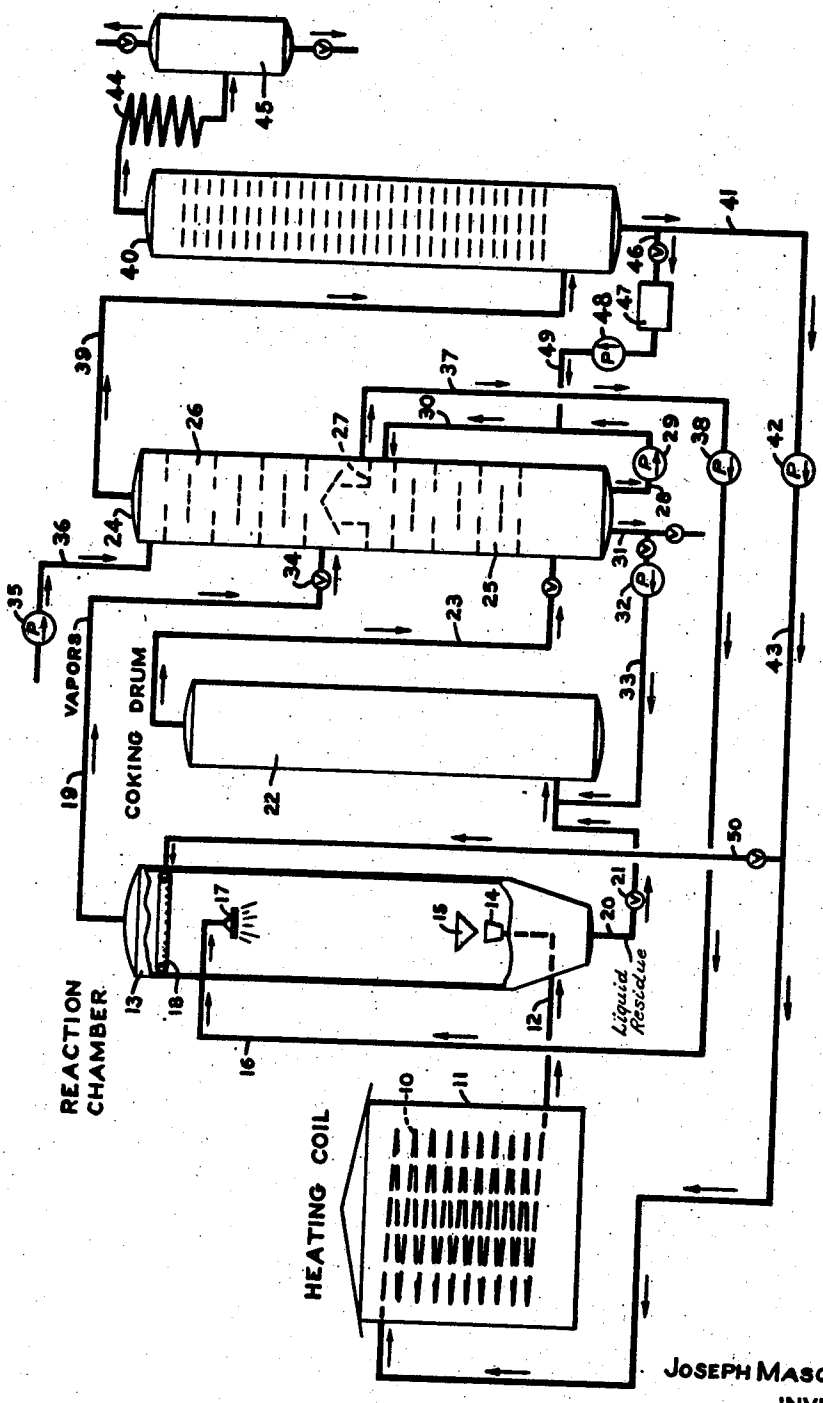
Aug. 27, 1946. J. M. BARRON 2,406,313

CRACKING AND COKING HYDROCARBON OILS

Filed Nov. 28, 1942



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Patented Aug. 27, 1946

2,406,313

UNITED STATES PATENT OFFICE

2,406,313

CRACKING AND COKING HYDROCARBON OILS

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Application November 28, 1942, Serial No. 467,177

2 Claims. (Cl. 196—49)

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This invention relates to certain improvements in the cracking and coking of hydrocarbon oils.

The invention is concerned with the coking of residual constituents from a pressure cracking operation and contemplates a combination cracking and coking process in which a condensate stock is subjected to a cracking temperature in a heating zone and the heated effluent therefrom subjected to countercurrent contact with a heavy or residual stock in a reaction chamber wherein separation of vapors from liquid residue occurs and in which the residue is flashed to coke by means of its contained heat.

The invention is based upon the discovery that by having the heated condensate stock and the heavy or residual oil in countercurrent contact in the reaction chamber a sufficiently high temperature may be maintained therein that the residue may be flashed to coke solely by its contained heat.

In accordance with the invention a condensate stock is passed through a heating zone and delivered to the lower portion of a reaction chamber into the upper portion of which a heavy oil or residual stock is introduced for cracking in countercurrent contact with the rising vapors therein. Separation of vapors from liquid residue occurs in the reaction chamber and the vapors and residue are separately withdrawn. The reaction chamber is maintained at a high cracking temperature sufficient that upon the flashing of the residue a conversion to coke will occur. Liquid is prevented from accumulating in the reaction chamber by rapidly withdrawing it and delivering it to the coking zone wherein the pressure is lowered and the residue flashed to coke.

In the prior art practice coking has been accomplished with the aid of considerable quantities of hot vapors and gases and one of the principal difficulties encountered has been that occasioned by the priming of the coking drum. In this priming, potential coke-forming constituents are carried with the effluent vapors from the coking drum and create coking difficulties in the vapor line and in the dephlegmating or fractionating portion of the system. In order to avoid this difficulty it has been necessary in the past to operate with relatively low charging rates to the coking drum and to maintain relatively high outage gauges therein, the outage gauge being the height of the space in the drum above the coke level. In accordance with the present invention, since the material directed to the coking chamber is essentially a liquid, the quantity of vapors and gases evolved from the

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coking chamber is greatly reduced with a consequent material diminution in priming tendencies. The practice of the invention thus makes possible the maintenance of high charging rates to the coking drum and high levels therein while avoiding priming, with the result that a maximum amount of coke is produced per coke drum cycle.

Additional advantages of the high temperature in the reaction chamber made possible by the countercurrent operation therein are the resultant higher conversion per pass on the material delivered to the reaction chamber and the improvement in the efficiency of the operation by reason of the fact that the reaction chamber vapors pass directly to the dephlegmating or fractionating portion of the system at maximum temperatures.

In a preferred embodiment of the invention the vapors from the coking operation are subjected to a separate primary dephlegmation to produce a heavy tarry condensate which is of a highly aromatic character well adapted for fuel oil blending. This heavy condensate may be withdrawn as a fuel oil product of the process. However, due to the heat made available by the countercurrent contact in the reaction chamber it is advantageous to combine the heavy tarry condensate with the cracked residue being delivered to the coking drum. The primary dephlegmation of the coke still vapors is carried on at relatively high temperatures within the cracking temperature range and coking tendencies may be reduced to a negligible quantity within the dephlegmator by maintaining therein a constant circulation of the condensate formed. This circulation together with the return of the primary condensate to the coking drum insures that this heavy material will be coked in the coke drum and not in the dephlegmator, or that the condensate may be withdrawn as a liquid product in cases wherein it is desired to obtain such fuel product.

The dephlegmated coke still vapors from the primary dephlegmating operation are combined with the vapors separately withdrawn from the reaction chamber and subjected to dephlegmation with charging stock such as topped or reduced crude and the resultant mixture of reflux condensate and unvaporized charging stock is directed to the upper portion of the reaction chamber. The uncondensed vapors are subjected to further fractionation to separate a higher boiling reflux condensate from lower boiling products and this reflux condensate is cycled through

a heating coil wherein it is subjected to a cracking temperature and the heated effluent is discharged into the lower portion of the reaction chamber for countercurrent contact with the heavier stock.

For the purpose of more fully explaining the invention reference is now had to the accompanying drawing which is a diagrammatic elevation of an apparatus adapted for the practice of the invention.

In the apparatus illustrated a heating coil 10 is disposed in a furnace 11 adapted to heat the oil to a cracking temperature. The heated effluent passes through a transfer line 12 to a reaction chamber 13 which is vertically disposed and heat insulated. As illustrated, the transfer line extends within the lower portion of the reaction chamber and terminates in an enlarged pipe or section 14 through which the heated products are discharged in an upward direction against a baffle 15. In practice with a three-inch transfer line the element 14 may be composed of a six-inch pipe. The products passing from the coil 10 to the reaction chamber will consist largely of vapors and gases and upon being discharged through the enlarged pipe 14 against the baffle 15 an efficient diffusion of the vapors and gases is accomplished. A black oil or residual stock is introduced to an upper portion of the reaction chamber 13 through a line 16 which extends within the reaction chamber and terminates in a distributor or spray nozzle 17. The spray 17 is arranged to spray the liquid oil in a downward direction through the chamber so as to bring the liquid oil into intimate contact with the rising vapors. It is desirable to have an unobstructed space between the distributor 15 and spray nozzle 17, free from baffles or any other contact elements, since it is contemplated to maintain such elevated temperatures therein that injurious coking would take place if surfaces were presented upon which coke deposition could take place. At the top of the chamber a ring spray pipe 18 may be disposed for spraying oil against the wall of the chamber so as to produce a downflowing liquid film which is conducive to the prevention of coke deposits on the wall of the chamber.

Separation of vapors from liquid residue takes place in the reaction chamber 13. The separated vapors are withdrawn from the upper portion of the chamber through a vapor line 19. Liquid is prevented from accumulating in the chamber by the rapid withdrawal of liquid residue therefrom. In practice a very slight amount of vapor may be withdrawn with the liquid, an amount merely sufficient to insure that no liquid level is maintained in the reaction chamber. The residue is withdrawn through a line 20 and pressure reducing valve 21 to a coking drum 22 wherein it is converted to coke by means of its contained heat. In practice a plurality of coking drums are employed so that while one is on stream the other or others may be down for coke removal and cleaning and thus continuity in the complete process is maintained. The coking drums are suitably heat insulated.

The vapors from the coking drum pass through a vapor line 23 to a primary dephlegmating zone. As illustrated, a tower 24 is provided having a lower section 25 and an upper section 26 separated by a trapout tray 27. The vapor line 23 communicates with the lower section 25 wherein the vapors from the coking operation are subjected to a separate dephlegmation. A limited

amount of cooling is supplied to the dephlegmating zone 25 so as not to unduly reduce the temperature and so as to obtain a condensate consisting of extremely high boiling constituents collected as a tarry condensate at the bottom of the dephlegmator. A portion of this heavy condensate is continuously withdrawn through a line 28 and directed by a pump 29 through a line 30 to the upper portion of the dephlegmating zone 25. The function of this circulation is not to accomplish any cooling but merely to establish and maintain a flow of liquid through the dephlegmating zone which will prevent coking.

Heavy dephlegmate or condensate is withdrawn from the dephlegmator 25 through a line 31 and discharged from the system as a fuel oil product or is directed by a pump 32 through a line 33 to the coking drum 22 or to the transfer line 20, so as to combine the heavy tarry material with the mixture of vapors and liquid which is passed from the reaction chamber 13 to the coking drum 22.

The dephlegmated coke still vapors pass upwardly from the primary dephlegmating zone 25 to the dephlegmating zone 26 wherein they are combined with the vapors which are separately withdrawn from the reaction chamber 13 and which are introduced through the vapor line 19 and a pressure reducing valve 34. In the dephlegmating zone 26 the combined vapors are dephlegmated with charging stock, such as crude petroleum or topped or reduced crude, introduced by a pump 35 through line 36. The resultant mixture of reflux condensate and unvaporized charging stock is withdrawn from the tray 27 through a line 37 and directed by a pump 38 through the line 16 to the reaction chamber 13. Uncondensed vapors pass from the dephlegmating zone 26 through a vapor line 39 to a fractionating tower 40. This tower is equipped with bubble trays or other suitable vapor-liquid contact elements and is supplied with conventional cooling or refluxing means (not shown). The vapors are subjected to fractionation therein to separate a lighter product of desired boiling point from higher boiling reflux condensate. The reflux condensate is withdrawn through a line 41 and directed by a pump 42 and line 43 to the heating coil 10. The overhead vapors pass to a condenser 44 thence to a distillate receiver or gas separator 45 wherein the desired gasoline or naphtha distillate is collected.

A convenient method of supplying the limited amount of cooling required in the dephlegmating zone 25 is to withdraw a small portion of the reflux condensate from line 41 through a branch line 46 thence through a cooler 47, and direct the cooled condensate by a pump 48 and line 49 to the dephlegmating section 25 or conveniently to the line 30. The line 43 may be provided with a branch line 50 by which a relatively small portion of the hot condensate may be directed to the ring spray 18 for supplying the downflowing film to the reaction chamber 13. If desired, this hot condensate spray may be eliminated and only the black oil, conducted through line 16, admitted to the upper portion of the reaction chamber, in which case the black oil is preferably introduced at the top of the chamber and sprayed in such a way that a portion thereof will be directed against the wall of the chamber to produce a downflowing film.

In practicing the invention typical operating conditions involve temperatures of 1015° F.–1030° F. in the outlet of the heating coil 10, tempera-

tures of 920° F.–925° F. in the bottom of the reaction chamber 13 under a pressure of 350 p. s. i., coke drum temperatures of 850° F.–855° F. under a pressure of 160 pounds, temperatures of 900° F.–910° F. in vapor line 19, temperatures of 920° F.–925° F. in the effluent passing from the reaction chamber to the transfer line 20, a pressure of 150 pounds in the tower 24 with temperatures of 790° F.–810° F. at the bottom of dephlegmating zone 25 and temperatures of 800° F.–810° F. in the trapout tray 27 and with a pressure of 135 pounds in the tower 40 with temperatures of 680° F.–700° F. at the bottom of the tower.

It is not necessary to apply any heat to the coking drum other than that of the entering oil. By avoiding the accumulation of liquid in the reaction chamber and by withdrawing the liquid residue from the reaction chamber at temperatures upwards of about 920° F. and delivering it to the coking chamber autogenous conversion to produce a marketable coke is readily accomplished.

The improved results made possible by the invention are shown by a comparison with the prior practice. Thus, for example, when using coke drums 40 feet by 10 feet in size it was necessary in the prior practice to maintain the coke drum outage gauge at about 23–24 feet, that is coke depths of 16–17 feet, in order to prevent priming and consequent coking the primary dephlegmator. The present invention has made it possible to reduce the outage gauge to 20 feet, that is to increase the coke depth to 20 feet, without any indication of priming and without having reached a capacity limitation and, in fact, runs have been successfully made with outage gauges as low as 15–17 feet, that is with coke depths of 23–25 feet, with a consequent increase in fresh charge capacity of 30%–50%.

While the practice of the invention does not preclude the passage of the mixture of reflux condensate and unvaporized charging stock through a heating coil prior to introduction to the reaction chamber, such procedure is ordinarily unnecessary, and, in fact, one of the advantages of the invention resides in the adequate cracking which can be applied to this stock in the reaction chamber.

While I have described a particular embodiment of my invention for purposes of illustration, it should be understood that various modifications and adaptations thereof, which will be obvious to one skilled in the art, may be made within the spirit of the invention as set forth in the appended claims.

I claim:

1. In the combination cracking and coking of hydrocarbon oils the process that comprises passing condensate oil formed as hereinafter specified through a heating coil wherein it is subjected to a high cracking temperature, delivering the heated stream into the lower portion of a vertically disposed reaction chamber maintained under superatmospheric pressure and wherein separation of vapors from liquid residue takes place, introducing a stream of high boiling oil formed as hereinafter specified into the upper portion of the reaction chamber, subjecting resultant downflowing liquid and upwardly rising vapors to countercurrent contact in an unobstructed zone within the reaction chamber while maintained at temperatures of the order of upwards of 900° F. by reason of the heated entering streams, maintaining a temperature approximating 920–925° F. in the lower portion of the reaction chamber, withdrawing the separated vapors from the upper portion of the reaction chamber, withdrawing the liquid residue therefrom at a temperature approximating 920–925° F. and at a rate adequate to prevent the accumulation of liquid residue therein, delivering the withdrawn residue to a coking zone wherein the pressure is reduced and wherein coking is effected solely by the contained heat of the residue, subjecting the evolved vapors from the coking zone to a separate primary dephlegmation in a primary dephlegmating zone maintained at temperatures of about 790–810° F. to form a heavy tarry condensate constituting a synthetic fuel oil, combining the resultant dephlegmated vapors with the vapors separately withdrawn from the reaction chamber and subjecting the combined vapors to dephlegmation with a residual charging stock to form a resultant mixture of reflux condensate and unvaporized charging stock collected at a temperature approximating 800–810° F., subjecting the latter dephlegmated vapors to further dephlegmation to separate reflux condensate from lower boiling products, directing said reflux condensate to the aforesaid heating coil, and utilizing said mixture of reflux condensate and unvaporized charging stock as said high boiling oil being introduced into the upper portion of the reaction chamber.

2. The process according to claim 1 wherein the said heavy tarry condensate is combined with liquid residue being delivered to the coking zone for coking.

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