

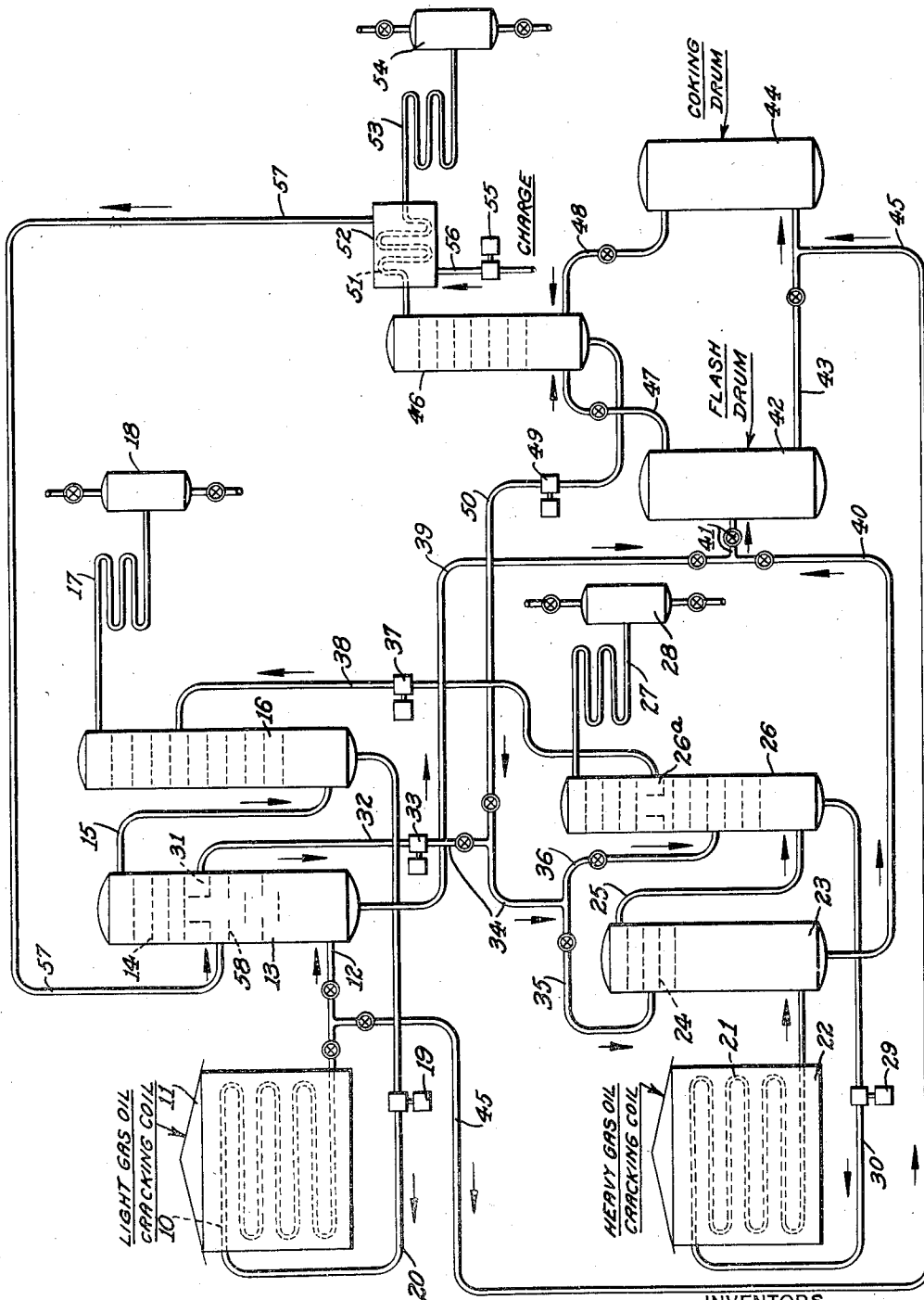
April 23, 1940.

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2,198,557

CRACKING HYDROCARBON OILS

Filed Sept. 13, 1936



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2,198,557

CRACKING HYDROCARBON OILS

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Application September 13, 1938, Serial No. 229,662

4 Claims. (Cl. 196—49)

This invention relates to a method of treating hydrocarbon oils for the production of low boiling products, such as gasoline or motor fuel, and contemplates a process in which a lighter condensate is subjected to cracking in a cracking zone and a portion of the resultant cracked products directed into a separating zone for separation into vapors and liquid residue, in which the separated vapors are fractionated to separate the desired gasoline or motor fuel distillate from higher boiling constituents, with the cycling of a lighter fraction of such constituents to the cracking zone mentioned and the passage of a heavier fraction thereof to a separate cracking zone, in which the products from the second cracking zone are separated into vapors and liquid residue in a second separating zone, in which the liquid residue from both separating zones is subjected to auto-distillation under reduced pressure to separate volatilizable products and in which the resultant flashed residue is subjected to coking by being passed into a coking zone and reduced to coke by means of a portion of the hot cracked products produced in the cracking of the lighter condensate.

The invention further contemplates a process in which lighter and heavier stocks are subjected to cracking in separate cracking zones and resultant cracked products separately distilled and in which heavier reflux condensate obtained in fractionating the vapors from the light oil cracking operation is directed into the fractionating zone of the vapors from the heavy oil cracking operation while a lighter fraction obtained in the fractionation of the vapors from the heavy oil cracking operation is directed into the fractionating zone of the vapors from the light oil cracking operation. Thus the vapors separated from the light oil cracking operation may be fractionated to form a heavy condensate, an intermediate condensate and a gasoline or motor fuel distillate product, the intermediate condensate cycled to the light oil cracking zone, the heavy condensate directed into the fractionating zone for the vapors of the heavy oil cracking zone for vaporization and fractionation therein, the vapors fractionated in the second fractionating zone to form a heavy condensate which is cycled to the second or heavy oil cracking zone and a lighter fraction, which may include intermediate constituents adapted for cracking as well as gasoline constituents, and this lighter fraction is directed to the first fractionating zone for fractionation therein so that constituents thereof may be cycled to the first cracking zone and gasoline

constituents may enter into the gasoline distillate taken off the first fractionating zone. The invention further contemplates that the vapors in the second fractionating zone may be fractionated to form a heavy or primary condensate which is cycled to the second cracking zone, an intermediate fraction which is directed into the first fractionating zone for vaporization and fractionation therein and a lighter product comprising the desired gasoline or motor fuel distillate which is separately collected.

An important feature of the invention involves the introduction of a heavy charging stock, such as crude petroleum or topped or reduced crude, into the separator which receives cracked products of the light oil or higher temperature cracking zone so that constituents adapted for cracking may be vaporized from the crude or residue and the crude residual stock combined with residual material formed in the cracking, the flashing of the combined crude residuum stock and cracked residue to remove such portion of volatilizable materials as may be removed by the auto-distillation and the coking of the resultant flashed residue which is accomplished by diverting into the coking zone a portion of the cracked products from the light oil fraction cracking coil. By introducing the crude oil stock initially into a high temperature evaporator a large portion of vaporizable constituents may be removed therefrom by the heat of the cracked products and passed over into the fractionating zone in which fractions are collected for cracking and the resultant crude residuum produced may be removed before the residual constituents have been subjected to extensive cracking. The effect of the operation is to dilute the cracked residue in the evaporator with an uncracked residual stock, or with one which has been cracked to only a comparatively slight extent. The cracked residue produced from extensive cracking operations, such as high cracking per pass cracking operations on cycle stocks, yields on coking relatively large proportions of gas as compared to gasoline and crackable stock, while a virgin residual stock gives on coking a much lower yield of gas per volume of gasoline and crackable stock produced and furthermore the gas oil produced in coking virgin stocks is much less refractory than that produced in the coking of highly cracked tars. The invention thus provides an advantageous method of obtaining maximum yields of good crackable stock from an original crude petroleum or crude residuum charging stock in an operation in which the

cracked residual constituents are also ultimately reduced to coke.

In accordance with the invention the mixture of crude residuum and cracked residue from the first separating zone and the cracked residue from the second separating zone are flashed by contained heat to remove crackable stock as distillate and the resulting residue is then subjected to coking by the introduction into the coking drum of a portion of the hot stream of products from the light oil cracking coil. The crackable fractions obtained in the flashing and coking operations are combined with the other stocks being cracked so that the original charge of crude oil or crude residuum may be processed to ultimate yields.

For the purpose of more fully disclosing the invention, reference will now be had to the accompanying drawing which is a flow diagram representing a typical operation contemplated by the invention.

Referring to the drawing, the lighter stock is subjected to cracking in the cracking coil 10 mounted in a furnace 11 adapted for supplying the necessary heat. A transfer line 12 serves to conduct cracked products to a separator 13 provided with a fractionating section 14 from which uncondensed vapors pass through vapor line 15 to a fractionating tower 16 provided with suitable bubble trays or the like for efficient fractionation. The overhead vapors from tower 16 pass to a condenser 17 and the distillate is collected in a receiving drum or gas separator 18. Reflux condensate from tower 16 is directed by pump 19 through discharge line 20 to the cracking coil 10.

The heavier stock is subjected to cracking in a heating coil 21 mounted in a furnace 22 adapted for supplying the necessary heat and the cracked products are discharged into a separator 23 for separation into vapors and liquid residue. The separator tower 23 is preferably provided with a section 24 having baffles or trays to provide for liquid-vapor contact. The overhead vapors from tower 23 pass through vapor line 25 to a fractionating tower 26 provided with suitable bubble trays or the like for efficient fractionation and formed with a trapout tray 26a for the collection of an intermediate condensate. The overhead vapors from tower 26 pass to a condenser coil 27 which discharges into a distillate receiver or gas separator 28. Reflux condensate from the bottom of tower 26 is conducted by pump 29 through line 30 to the cracking coil 21.

Primary or heavy condensate produced in fractionating section 14 of tower 13 which collects on a trapout tray 31, is withdrawn through line 32 and directed by pump 33 through line 34 having branches 35 and 36 by which the condensate may be directed to either or both of the towers 23 and 26, respectively. The lighter or intermediate condensate collected on trapout tray 26a of tower 26 is directed by the pump 37 through line 38 to the tower 16.

Residue from separator 13 is conducted through line 39 and residue from separator 23 is conducted through line 40. The lines 39 and 40 extend to a common tar line 41 by which the residues are discharged into a flash drum 42 wherein the residues are flashed under reduced pressure into vapors and liquid residue.

The resultant flashed residue passes through line 43 to a coking drum 44. A line 45 extends from the transfer line 12 to the coke drum 44, or to the transfer line 43, for introducing a portion of the hot stream from the cracking coil 10 into

the coking drum 44 to accomplish the coking of the flashed residue introduced thereinto.

A common fractionating tower 46 receives vapors through vapor line 47 from the flash drum and vapors through vapor line 48 from the coking drum. Reflux condensate is drawn from tower 46 by pump 49 and directed through line 50 to line 34 for passage through either or both of lines 35 and 36 into towers 23 and 26, respectively. The overhead vapors from tower 46 pass through a cooling coil 51 in heat exchange with a heat exchange element 52 thence to a second cooling and condensing coil 53 discharging into a distillate receiver or gas separator 54.

Charging stock for the process is introduced by a pump 55 through a line 56 to heat exchange element 52 and thence through line 57 into separator tower 13. The charging stock is introduced into the tower below trapout tray 31 and preferably flows over baffles or trays 58 counter-current to the separated vapors rising therein.

In practicing the invention with the apparatus illustrated, a charging stock, such as crude petroleum or topped or reduced crude, is introduced by pump 55 and after being preheated in the exchanger 52, and additionally preheated if desired, is directed into the evaporator 13 in which it is subjected to extensive vaporization by being contacted with hot products of cracking from the heating coil 10. Moderate superatmospheric pressures of the order of 100 to 200 pounds are maintained in the evaporator 13. The separated vapors including vaporized constituents of the charging stock and of the cracked products from cracking coil 10 are subjected to fractionation to form a primary or heavy condensate at 31, an intermediate condensate in tower 16 and a final distillate collected in receiver 18. The intermediate condensate from tower 16 is cycled to the coil 10 for cracking therein. This intermediate condensate should be a substantially vaporizable stock having an endpoint of the order of 650° F. so that it may be well adapted for vapor phase cracking at relatively high cracking temperatures and with high rates of cracking per pass in the coil 10 so as to not only effect conversion into gasoline constituents of high anti-knock quality but also to provide a high degree of heat which is utilized both for the initial distilling of the charging stock in evaporator 13 and also to accomplish the coking in the final coking step of the process. The heavier or primary condensate from trapout tray 31 and the reflux condensate condensed in tower 46 from the vapors of the flashing and coking operations, are preferably directed through line 35 into the evaporator 23 so that the heavy reflux condensate condensed from the vapors and collected at the bottom of tower 26 will be a re-distilled product and, although of a heavy nature, essentially clean in character and adapted for extensive cracking in coil 21. The oil in coil 21 is ordinarily subjected to somewhat lower cracking temperatures and less drastic cracking conditions than obtain in the coil 10. It sometimes happens that in the flashing operation and more especially in the coking operation, heavy constituents of a tarry or coke-like nature may be carried over with the vapors and consequently it is advisable to re-distill the stock in the evaporator 23. If desired, the heavy condensate from tray 31 may be refluxed in the tower 26 while the condensate from the tower 46 may be directed to the evaporator 23.

The composite residuum formed in the evaporator 13 consisting of unvaporized constituents

of the charging stock and residual constituents from the cracked products introduced from coil 10 may, in accordance with the invention, be withdrawn from the evaporator at such a rate as to prevent the accumulation of liquid residue therein or so as to maintain only a low level of liquid therein, to thereby prevent the residual constituents of the charging stock from extensive cracking. This composite residue and the cracked residue from tower 23 are introduced into the flash drum 42 wherein the pressure is reduced to a degree approaching or approximating atmospheric pressure and the residue flash distilled, with the aid of steam or other carrier gas if desired. The resultant flashed residue is directed through line 43 into the coking drum 44 wherein the pressure may be further reduced, if desired. A portion of the cracked stream from the light oil or high temperature cracking coil 10 is diverted through line 45 into the flashed residue from the flashing drum to thereby raise the temperature of the flashed residue and effect conversion of the coke. Usually about 20%-40% of the stream from the cracking coil is adequate to accomplish the coking of the flashed residue.

In a typical example of the invention, a fuel oil (crude residuum) of 20 A. P. I. gravity is charged at the rate of 100 barrels per hour through heat exchanger 52 thence into the evaporator 13 which is maintained at 110 pounds pressure with a bottom temperature of 800° F., with a temperature of 725° F. adjacent the tray 31 and with a temperature of 700° F. at the top of the tower. The tower 16 is maintained at 100 pounds pressure with a temperature of 600° F. at the bottom. Cycle condensate at the rate of 200 barrels per hour from tower 16 is directed to heating coil 10 which is maintained under 500 pounds pressure with 1000° F. outlet temperature. The cracked stream from the cracking coil is split with 130 barrels per hour going to the evaporator 13 and 70 barrels per hour going to the coking drum 44. Cycle condensate at the rate of 100 barrels per hour is drawn from tower 26 and subjected to cracking in heating coil 21 under 500 pounds pressure with an outlet temperature of 900° F. The tower 23 is held at 110 pounds pressure with a bottom temperature of 800° F. and a top temperature of 725° F. The tower 26 is maintained at 100 pounds pressure with a bottom temperature of 650° F. Reflux condensate from tower 46 and reflux condensate from tray 31 of tower 13 is refluxed in the fractionating section 24 of tower 23. The flash drum has a bottom temperature of 700° F. under 30 pounds pressure. The flashed residue is passed from the flash drum to the coking drum into which, as stated, cracked products from coil 10 are delivered at the rate of 70 barrels per hour which operate to raise the flashed residue to a temperature approximating 900° F. and effect the coking thereof. The distillate collecting in receiving drum 54 is refluxed in the tower 16. Gasoline distillates are collected in receiving drums 18 and 28 amounting to a total yield of 59 barrels per hour.

While we have described a particular embodiment of our invention for the purpose of illustration, it should be understood that various modifications and adaptations thereof, occurring to one skilled in the art, may be made within the spirit of the invention as set forth in the appended claims.

We claim:

1. In a process for cracking hydrocarbon oil,

the method that comprises subjecting cycle condensate to cracking conditions of temperature and pressure in a cracking zone to effect conversion into lower boiling hydrocarbons, removing the resultant cracked products from the cracking zone in a stream, splitting the stream and delivering a portion thereof into a separating zone maintained under superatmospheric pressure wherein separation of vapors from liquid residue takes place, fractionating the separated vapors in a fractionating zone to form heavy reflux condensate, an intermediate reflux condensate and a lighter condensate, directing resultant intermediate condensate to said cracking zone as the cycle condensate subjected to cracking therein, directing resultant heavy reflux condensate into a second fractionating zone wherein it is subjected to vaporization and fractionation, subjecting the vapors in said second fractionating zone to fractionation to form a heavy reflux condensate and a lighter reflux condensate, cycling resultant heavy reflux condensate to a second cracking zone wherein it is subjected to cracking conditions of temperature and pressure to effect conversion into lower boiling hydrocarbons, passing the resultant cracked products into a second separating zone maintained under superatmospheric pressure wherein separation of vapors from liquid residue takes place, passing resultant separated vapors to the second fractionating zone, directing lighter reflux condensate from the second fractionating zone into the first fractionating zone for vaporization and fractionation therein, withdrawing residue from the first and second separating zones and subjecting the residue to flash distillation under reduced pressure to form a flashed residue, passing resultant flashed residue into a coking zone, and introducing the other portion of the stream of cracked products from the first cracking zone into said coking zone to raise the temperature of the flashed residue introduced thereinto and effect a reduction of the flashed residue to coke.

2. The process of cracking hydrocarbon oil that comprises subjecting cycle condensate to cracking conditions of temperature and pressure in a cracking zone to effect conversion into lower boiling hydrocarbons, removing the resultant cracked products from the cracking zone in a stream, splitting the stream and delivering a portion thereof into a separating zone maintained under superatmospheric pressure wherein separation of vapors from liquid residue takes place, introducing charging stock into said separating zone wherein it is subjected to vaporization to separate it into vapors and residue, passing the separated vapors from said separating zone to a fractionating zone wherein the vapors are fractionated to form a heavy reflux condensate, an intermediate reflux condensate and a lighter condensate, directing resultant intermediate condensate to said cracking zone as the cycle condensate subjected to cracking therein, directing resultant heavy reflux condensate into a second fractionating zone wherein it is subjected to vaporization and fractionation, subjecting the vapors in said second fractionating zone to fractionation to form a heavy reflux condensate and a lighter reflux condensate, cycling resultant heavy reflux condensate to a second cracking zone wherein it is subjected to cracking conditions of temperature and pressure to effect conversion into lower boiling hydrocarbons, passing the resultant cracked products into a second separating zone maintained under superatmospheric pressure

wherein separation of vapors from liquid residue takes place, passing resultant separated vapors to the second fractionating zone, directing lighter reflux condensate from the second fractionating zone into the first fractionating zone for vaporization and fractionation therein, withdrawing residue from the first separating zone comprising residual constituents of the charging stock and cracked products and withdrawing residue from the second separating zone, subjecting the residues thus withdrawn to flash distillation under reduced pressure to form a flashed residue, passing resultant flashed residue into a coking zone, and introducing the other portion of the stream of cracked products from the first cracking zone into said coking zone to raise the temperature of the flashed residue introduced therinto and effect a reduction of the flashed residue to coke.

3. The process of cracking hydrocarbon oil that comprises subjecting cycle condensate to cracking conditions of temperature and pressure in a cracking zone to effect conversion into lower boiling hydrocarbons, removing the resultant cracked products from the cracking zone in a stream, splitting the stream and delivering a portion thereof into a separating zone maintained under superatmospheric pressure wherein separation of vapors from liquid residue takes place, introducing charging stock into said separating zone wherein it is subjected to vaporization to separate it into vapors and residue, passing the separated vapors from said separating zone to a fractionating zone wherein the vapors are fractionated to form a heavy reflux condensate, an intermediate reflux condensate and a lighter condensate, directing resultant intermediate condensate to said cracking zone as the cycle condensate subjected to cracking therein, directing resultant heavy reflux condensate into a second fractionating zone wherein it is subjected to vaporization and fractionation, subjecting the vapors in said second fractionating zone to fractionation to form a heavy reflux condensate and a lighter reflux condensate, cycling resultant heavy reflux condensate to a second cracking zone wherein it is subjected to cracking conditions of temperature and pressure to effect conversion into lower boiling hydrocarbons, passing the resultant cracked products into a second separating zone maintained under superatmospheric pressure wherein separation of vapors from liquid residue takes place, passing resultant separated vapors to the second fractionating zone, directing lighter reflux condensate from the second fractionating zone into the first fractionating zone for vaporization and fractionation therein, withdrawing residue from the first separating zone comprising residual constituents of the charging stock and cracked products and withdrawing residue from the second separating zone, subjecting the residues thus withdrawn to flashing under reduced pressure to form flashed residue and separated vapors, passing resultant flashed residue into a coking zone, introducing the other portion of the stream of cracked products from the first cracking zone into said coking zone to raise the temperature of the flashed residue introduced therinto and effect a reduction of the flashed residue to coke, passing the evolved vapors from the coking and flashing zones into a third fractionating zone, subjecting the vapors to fractionation therein to form a reflux condensate and a lighter distillate and directing said reflux condensate into said second fractionating zone wherein it is subjected to vaporization and fractionation.

introduced therinto and effect a reduction of the flashed residue to coke, subjecting the resultant vapors from the flashing and coking steps to condensation to form a condensate and introducing said condensate into said second fractionating zone.

4. The process of cracking hydrocarbon oil that comprises subjecting cycle condensate to cracking conditions of temperature and pressure in a cracking zone to effect conversion into lower boiling hydrocarbons, removing the resultant cracked products from the cracking zone in a stream, splitting the stream and delivering a portion thereof into a separating zone maintained under superatmospheric pressure wherein separation of vapors from liquid residue takes place, introducing charging stock into said separating zone wherein it is subjected to vaporization to separate it into vapors and residue, passing the separated vapors from said separating zone to a fractionating zone wherein the vapors are fractionated to form a heavy reflux condensate, an intermediate reflux condensate and a lighter condensate, directing resultant intermediate condensate to said cracking zone as the cycle condensate subjected to cracking therein, directing resultant heavy reflux condensate into a second fractionating zone wherein it is subjected to vaporization and fractionation, subjecting the vapors in said second fractionating zone to fractionation to form a heavy reflux condensate and a lighter reflux condensate, cycling resultant heavy reflux condensate to a second cracking zone wherein it is subjected to cracking conditions of temperature and pressure to effect conversion into lower boiling hydrocarbons, passing the resultant cracked products into a second separating zone maintained under superatmospheric pressure wherein separation of vapors from liquid residue takes place, passing resultant separated vapors to the second fractionating zone, directing lighter reflux condensate from the second fractionating zone into the first fractionating zone for vaporization and fractionation therein, withdrawing residue from the first separating zone comprising residual constituents of the charging stock and cracked products and withdrawing residue from the second separating zone, subjecting the residues thus withdrawn to flashing under reduced pressure to form flashed residue and separated vapors, passing resultant flashed residue into a coking zone, introducing the other portion of the stream of cracked products from the first cracking zone into said coking zone to raise the temperature of the flashed residue introduced therinto and effect a reduction of the flashed residue to coke, passing the evolved vapors from the coking and flashing zones into a third fractionating zone, subjecting the vapors to fractionation therein to form a reflux condensate and a lighter distillate and directing said reflux condensate into said second fractionating zone wherein it is subjected to vaporization and fractionation.

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