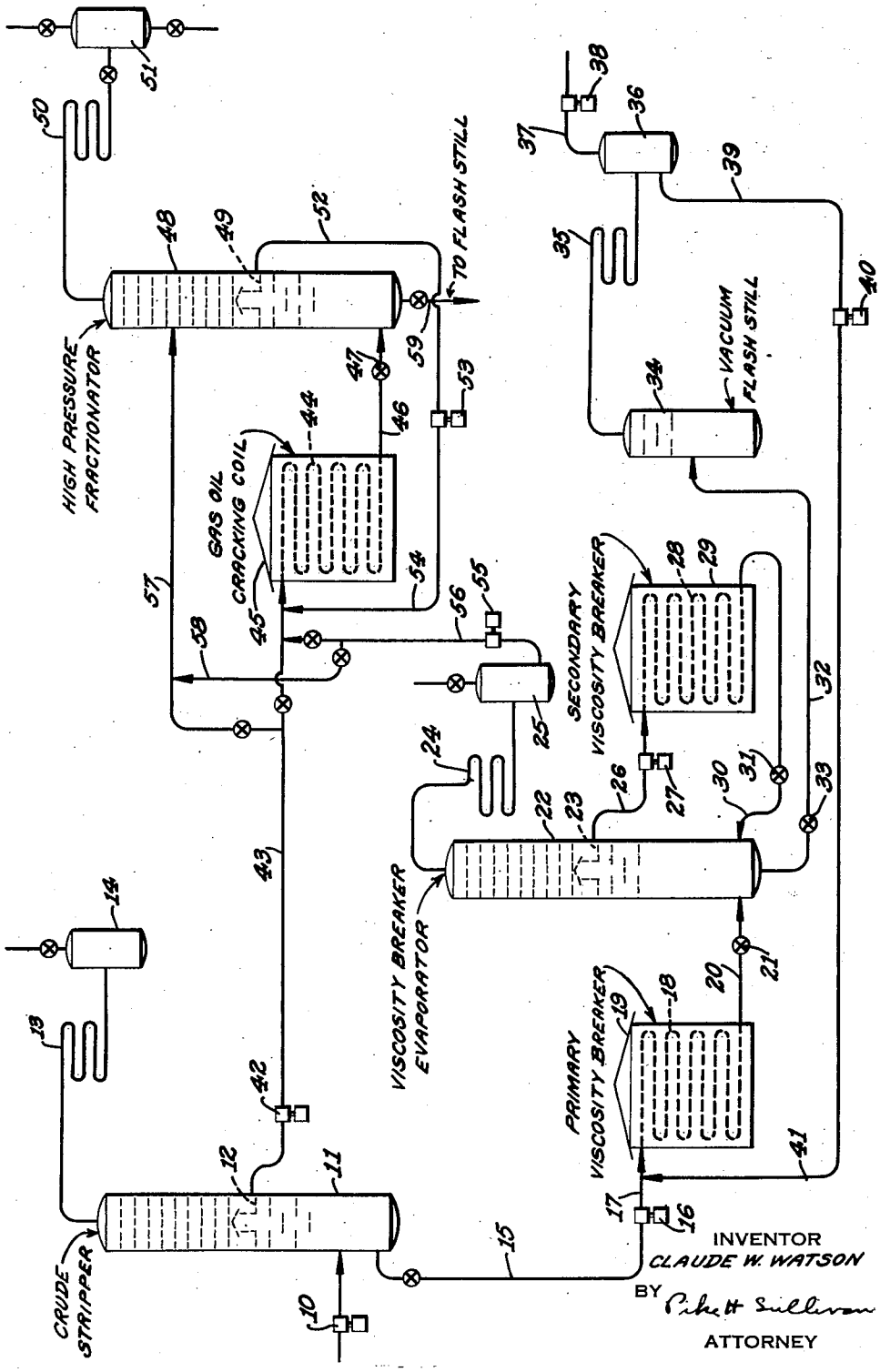
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TREATING HYDROCARBON OILS

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TREATING HYDROCARBON OILS

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4 Claims. (Cl. 196—49)

This invention relates to the conversion of higher boiling hydrocarbons into lower boiling hydrocarbons and has particular reference to certain improvements in combination cracking processes.

It is an object of the invention to provide a complete unitary process for processing crude petroleum so as to obtain a maximum yield of gasoline or motor fuel of superior anti-knock quality. The invention contemplates a process in which crude petroleum is distilled to separate it into a crude residuum and a condensate stock adapted for conversion into gasoline, in which the crude residuum is subjected to a primary cracking operation to effect viscosity-breaking, the resultant cracked products separated into vapors and residue and the vapors fractionated to separate out a relatively light condensate adapted for high cracking per pass cracking and a heavy viscous condensate which is subjected to a secondary viscosity-breaking operation and the resultant viscosity-broken products fractionated together with the products from the primary viscosity-breaking operation. By carrying on the viscosity-breaking operation in two stages, that is, by subjecting the crude residue to a primary viscosity-breaking operation and by subjecting the heavy viscous condensate separated out to a further viscosity-breaking operation, the yield of intermediate constituents adapted for high cracking per pass conditions for conversion into gasoline is greatly increased and these intermediate constituents and intermediate constituents from the crude stripping operation are subjected to high cracking per pass conditions for conversion into anti-knock gasoline.

The invention further contemplates the flashing of the residue from the viscosity-breaking operations in a vacuum flash zone wherein the residue is distilled under sub-atmospheric pressure and the distillate thus obtained directed to the primary viscosity-breaking zone for cracking together with the crude residue. In this way constituents are obtained from viscosity-broken residue which are of such high boiling point that they can not be separated by distillation at atmospheric pressure without decomposition and by subjecting these heavy constituents to further cracking in the primary viscosity-breaking zone a further yield of intermediate constituents adapted for high cracking per pass cracking is obtained.

In order to more fully disclose the invention, reference will now be had to the accompanying drawing which is a flow diagram illustrative of the invention.

In accordance with the invention, crude charging stock after being heated as by heat exchange with hot products in the process, is charged by pump 10 into a crude stripping and fractionating tower 11 in which vapors separate from residue and the vapors are fractionated to form a condensate at 12 adapted for high temperature cracking and an over-head vapor fraction which is condensed in a condenser coil 13 and collected in receiver 14. The residue is withdrawn from the tower 11 through line 15 by pump 16 and charged through line 17 to a primary cracking coil 18 positioned in furnace 19. The crude residue is subjected to a primary viscosity-breaking operation in the coil 18 and the resultant products discharged through transfer line 20, having a pressure reducing valve 21, thence into a viscosity-breaker evaporator and fractionating tower 22. In the tower 22 vapors separate from residue and the vapors are fractionated to form a heavy reflux condensate at 23 and a lighter vapor fraction which is condensed in condenser coil 24 and collected as a distillate in receiver 25. The heavy reflux condensate is withdrawn from trap-out tray 23 through line 26 by pump 27 and passed to a secondary cracking coil 28 positioned in furnace 29 in which the heavy reflux condensate is subjected to a further cracking to effect additional viscosity-breaking and the resultant products are passed through transfer line 30 having pressure reducing valve 31 thence into the evaporator 22.

Residue from the evaporator 22 is passed through line 32 having pressure-reducing valve 33 to a vacuum flash still 34 wherein the residue is subjected to distillation under sub-atmospheric pressure. Vapors from the vacuum still are condensed in condenser coil 35 and the distillate is collected in receiver 36. A sub-atmospheric pressure is maintained on the vacuum flash still by any suitable means, such as by means of a gas line 37 from the distillate receiver 36 and vacuum pump 38. Distillate from the receiver 36 is withdrawn through line 39 and pump 40 and directed through line 41 to the cracking coil 18. Thus the vacuum flashed distillate is subjected to cracking together with the crude residue introduced to the cracking coil 18 to effect additional conversion into lighter constituents adapted for cracking into gasoline.

The condensate from trap-out tray 12 of the crude stripper 11 is directed by pump 42 through charging line 43a to high temperature cracking

coil 44 positioned in furnace 45 wherein the condensate is subjected to conditions of high cracking per pass to effect conversion into gasoline constituents of high anti-knock value. The products from the cracking coil 44 are passed through transfer line 46, in which may be a pressure-reducing valve 47, thence to a separating and fractionating tower 48 wherein separation of vapors from residue takes place and wherein the separated vapors are fractionated to form a reflux condensate at 49 and an overhead vapor fraction which is condensed in condenser coil 50 and collected as a distillate in receiving drum or gas separator 51. Condensate from trap-out tray 49 is withdrawn through line 52 and directed by pump 53 through line 54 to the cracking coil 44. Distillate from the receiver 25 of the viscosity-breaker evaporator is directed by pump 55 and line 56 to the cracking coil 44. If desired, a portion or all of the distillate from the crude stripper being charged by the pump 42, may be directed through branch line 57 to the fractionating section of the tower 48 and similarly a portion or all of the distillate from the viscosity-breaker being introduced by pump 55 may be directed through a branch line 58 to the fractionating section of the tower 48 and the condensate thus introduced to the tower 48 which remains unvaporized is thus combined with the other reflux condensate therein to be withdrawn from the trap-out tray 49 and cycled to the cracking coil 44. Thus the straight-run condensate from the crude stripper and the condensate from the viscosity-breaker is subjected to conditions of high cracking per pass in the coil 44 for conversion into high anti-knock gasoline constituents. Cracked residue is withdrawn from tower 48 through line 59 and may be directed to a flash still wherein the residue is distilled at lower pressures than obtains in the tower 48 to thus recover distillate products from the residue. The distillate from the flash still may advantageously be used as reflux in the fractionating section of the viscosity-breaker evaporator 22 or the vapors from the flash still may be conducted to the tower 22 being preferably introduced below the trap-out tray 23, so that the constituents vaporized in the flash still may thus be combined with constituents from the viscosity-broken products and subjected to further cracking.

In practicing the invention crude petroleum is fractionated in the tower 11 and straight-run distillate such as gasoline may be collected in the receiver 14 while gas oil condensate adapted for high temperature or vapor phase cracking and having for example an end-point of about 650° F. to 700° F., is withdrawn from the tray 12 and directed to the high temperature cracking coil 44. The reduced crude, preferably containing heavy gas oil constituents, is passed through the primary cracking or viscosity-breaking coil 18 wherein the residue, together with the vacuum flashed distillate introduced through line 41, is subjected to cracking temperatures of, for example, 850° F. to 880° F., under a superatmospheric pressure of 150 to 300 lbs. with a time of reaction adequate to effect about 8% to 12% cracking per pass (based on conversion into gasoline of 400° F. end-point). Under these conditions the viscosity of the residue is reduced and there is an extensive conversion into intermediate constituents of the nature of kerosene and gas oil, adapted for cracking under high cracking per pass conditions, and also a conversion into gasoline constituents. The cracked products are discharged into the evaporator 22 wherein the pressure is reduced to a pressure approaching atmospheric, such for example, as about 10 lbs. Fractionation is so conducted in the tower 22 as to obtain an over-head distillate collected in receiver 25 having an end-point of about 600° F. to 700° F. The heavy reflux condensate collecting on tray 23 consists essentially of higher boiling constituents and this heavy condensate is directed to the recycling heavy gas oil cracking coil 28 wherein the oil is subjected to a cracking temperature of, for example, 900° F.–975° F. under pressures of 200–600 lbs. with a cracking per pass of about 10% to 15% and the cracked products are discharged into the evaporator 22. By maintaining low pressure conditions in this evaporator, such as about 10 lbs. pressure, there will be only a minimum of constituents boiling under 700° F. in the residue which is withdrawn and directed to the vacuum flash still 34. The distillation in the still 34 is carried on under conditions of high vacuum, such for example as 70 mm. to 90 mm. of mercury absolute pressure. In this way constituents are vaporized and collected as a distillate in receiver 36 which cannot be vaporized at atmospheric pressure without decomposition and, since the more volatile products of the residue have been removed in the low pressure tower 22, the vacuum flashed distillate collected in receiver 36 consists essentially of constituents boiling above 700° F. This distillate will ordinarily contain not more than 10% to 15% of constituents boiling under 700° F. By subjecting the reduced crude, together with the vacuum flashed distillate to cracking in coil 18 and the heavy gas oil to recycling cracking in the coil 28 and distilling the combined cracked products in the evaporator 22, a large production of intermediate constituents of the nature of light gas oil and kerosene is accumulated in the tank 25 for passage to the high cracking per pass cracking zone 44. The distillate in tank 25 will also contain gasoline constituents produced in the cracking coils 18 and 28 and the entire distillate may be passed to the cracking coil 44 so as to effect not only conversion of higher boiling constituents into gasoline constituents but also effect reforming of the gasoline constituents into higher anti-knock products. If desired, instead of passing the distillate from receiver 25 directly to the cracking coil 44, this distillate or a portion thereof may, as has been stated, be by-passed through line 58 and refluxed on the tower 48 in which case gasoline constituents will be separated from the heavier constituents which are combined with the cycle stock being cycled to the cracking coil 44. The condensate thus subjected to cracking in the cracking coil 44 consists of straight-run distillate and the viscosity-breaker distillate as well as the recycle condensate and this condensate is subjected to cracking under high temperature or vapor phase conditions at temperatures of, for example, 950° F.–1020° F. under pressure of 400–800 lbs. with a time of reaction to effect a conversion of about 18% to 25% cracking per pass. The cracked products are fractionated in the tower 48 under super-atmospheric pressures of for example 200 to 400 lbs. and a light distillate such as gasoline of the desired end-point is taken off overhead and collected in the receiver 51.

In a modification of the invention, the straight-run distillate, as withdrawn from tray 12 of the crude stripper, and the viscosity-breaker distillate as withdrawn from receiver 25, are passed through a single-pass cracking coil and discharged into

the tower 48 while only the cycle condensate as withdrawn from tray 49 is directed to the recycling cracking coil 44. In this operation temperature-pressure conditions similar to those given for the cracking coil 44 may be maintained in both the single-pass and the recycling cracking coils but with preferably higher rates of cracking per pass in the single-pass coil. Thus the single-pass coil may be operated with a time of reaction to effect a cracking per pass of 30%–40%, while the recycling coil is operated with a time of reaction to sustain a cracking per pass of about 18%–25%.

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 cracking of hydrocarbon oils, the process that comprises subjecting crude petroleum in a primary fractionating zone to fractionation to form a residue and a condensate fraction, passing said residue to a primary viscosity-breaking zone wherein the residue is subjected to cracking temperature under conditions to effcet the formation of a high yield of intermediate constituents adapted for conversion into gasoline, directing resultant viscosity-broken products into a viscosity-breaker separating zone, separate from said primary fractionating zone, wherein separation of vapors from residue takes place, passing the separated vapors into a fractionating zone, separate from said primary fractionating zone, and subjecting the vapors therein to fractionation to form a heavy reflux condensate and a lighter fraction comprising said intermediate constituents, passing said heavy reflux condensate to a second cracking zone wherein the heavy condensate is subjected to cracking temperature under conditions to effect the formation of a high yield of intermediate constituents adapted for conversion into gasoline, directing resultant cracked products from the second cracking zone into said viscosity-breaker separating zone so that intermediate constituents separating as vapor therein enter into, and constitute a part of, the aforesaid lighter fraction comprising intermediate constituents, withdrawing liquid residue from said viscosity-breaker separating zone and subjecting it to vacuum distillation in a flashing zone maintained under sub-atmospheric pressure to form a heavy vacuum flash distillate and directing it to said primary viscosity-breaking zone for conversion into intermediate constituents, combining said lighter fraction obtained from the viscosity-broken products with said condensate fraction obtained from the crude petroleum and subjecting the mixture to cracking in a third cracking zone under such conditions of temperature and time of reaction as to sustain a high rate of cracking per pass and effect conversion into gasoline of high anti-knock quality and directing resultant cracked products from the third cracking zone to a final separating zone, separate from the aforesaid separating and fractionating zones, to recover the desired gasoline product.

2. In the cracking of hydrocarbon oils, the process that comprises subjecting crude petroleum in a primary fractionating zone to fractionation to form a residue and a condensate fraction, passing said residue to a primary viscosity-breaking zone wherein the residue is subjected to cracking temperature under conditions to effect the formation of a high yield of intermediate constituents adapted for conversion into gasoline, directing resultant viscosity-broken products into a viscosity-breaker separating zone, separate from said primary fractionating zone, wherein separation of vapors from residue takes place, passing the separated vapors into a fractionating zone, separate from said primary fractionating zone, and subjecting the vapors therein to fractionation to form a heavy reflux condensate and a lighter fraction comprising said intermediate constituents, passing said heavy reflux condensate to a second cracking zone wherein the heavy condensate is subjected to cracking temperature under conditions to effect the formation of a high yield of intermediate constituents adapted for conversion into gasoline, directing resultant cracked products from the second cracking zone into said viscosity-breaker separating zone so that intermediate constituents separating as vapor therein enter into, and constitute a part of, the aforesaid lighter fraction comprising intermediate constituents, withdrawing liquid residue from said viscosity-breaker separating zone and subjecting it to vacuum distillation in a flashing zone maintained under subatmospheric pressure to form a heavy vacuum flash distillate and directing it to said primary viscosity-breaking zone for conversion into intermediate constituents, combining said lighter fraction obtained from the viscosity-broken products with said condensate fraction obtained from the crude petroleum and subjecting the mixture to cracking in a third cracking zone under such conditions of temperature and time of reaction as to sustain a high rate of cracking per pass and effect conversion into gasoline of high anti-knock quality and subjecting the resultant cracked products from the third cracking zone to fractionation, in a fractionating zone separate from the aforesaid separating and fractionating zones, to form a reflux condensate and a desired light distillate, subjecting said reflux condensate to cracking to effect conversion into gasoline constituents and fractionating the resultant cracked products, separately from the crude petroleum and viscosity-breaker separating and fractionating zones, to recover desired light distillate.

3. In the cracking of hydrocarbon oils, the process that comprises subjecting crude petroleum in a primary fractionating zone to fractionation to form a residue and a condensate fraction, passing said residue to a primary viscosity-breaking zone wherein the residue is subjected to cracking temperature under superatmospheric pressure under conditions to effect the formation of a high yield of intermediate constituents adapted for conversion into gasoline, directing resultant viscosity-broken products into a viscosity-breaker separating zone, separate from said primary fractionating zone, wherein separation of vapors from residue takes place, maintaining a relatively low pressure approximating atmospheric pressure in the viscosity-breaker separating zone, passing the separated vapors into a fractionating zone, separate from said primary fractionating zone, and subjecting the vapors therein to fractionation to form a heavy reflux condensate and a lighter fraction comprising said intermediate constituents, passing said heavy reflux condensate to a second cracking zone wherein the heavy condensate is subjected to cracking temperature under conditions to effect the formation of a high yield of

intermediate constituents adapted for conversion into gasoline, directing resultant cracked products from the second cracking zone into said viscosity-breaker separating zone so that intermediate constituents separating as vapor therein enter into, and constitute a part of, the aforesaid lighter fraction comprising intermediate constituents, withdrawing liquid residue from said viscosity-breaker separating zone and subjecting it to vacuum distillation in a flashing zone maintained under sub-atmospheric pressure to form a heavy vacuum flash distillate and directing it to said primary viscosity-breaking zone for conversion into intermediate constituents, combining said lighter fraction obtained from the viscosity-broken products with said condensate fraction obtained from the crude petroleum and subjecting the mixture to cracking in a third cracking zone under such conditions of temperature and time of reaction as to sustain a high rate of cracking per pass and effect conversion into gasoline of high anti-knock quality and directing resultant cracked products from the third cracking zone to a final separating zone, separate from the aforesaid separating and fractionating zones, to recover the desired gasoline product.

4. In the cracking of hydrocarbon oils, the process that comprises subjecting reduced crude petroleum in a primary viscosity-breaking zone to cracking temperature under superatmospheric pressure under conditions to effect the formation of a high yield of intermediate constituents adapted for conversion into gasoline, directing resultant viscosity-broken products into a viscosity-breaker separating zone wherein separation of vapors from residue takes place, maintaining a relatively low pressure approximating atmospheric pressure in the viscosity-breaker separating zone, passing the separated vapors into a fractionating zone and subjecting the vapors therein to fractionation to form a heavy reflux condensate and a lighter fraction comprising said intermediate constituents, passing said heavy reflux condensate to a second cracking zone wherein the heavy condensate is subjected to cracking temperature under conditions to effect the formation of a high yield of intermediate constituents adapted for conversion into gasoline, directing resultant cracked products from the second cracking zone into said viscosity-breaker separating zone so that intermediate constituents separating as vapor therein enter into, and constitute a part of, the aforesaid lighter fraction comprising intermediate constituents, withdrawing liquid residue from said viscosity-breaker separating zone and subjecting it to vacuum distillation in a flashing zone maintained under sub-atmospheric pressure to form a heavy vacuum flash distillate and directing it to said primary viscosity-breaking zone for conversion into intermediate constituents, directing aforesaid lighter fraction comprising intermediate constituents to a third cracking zone wherein it is subjected to cracking under such conditions of temperature and time of reaction as to sustain a high rate of cracking per pass and effect conversion into gasoline of high anti-knock quality and directing resultant cracked products from the third cracking zone to a final separating zone, separate from the aforesaid separating and fractionating zones, to recover the desired gasoline product.

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