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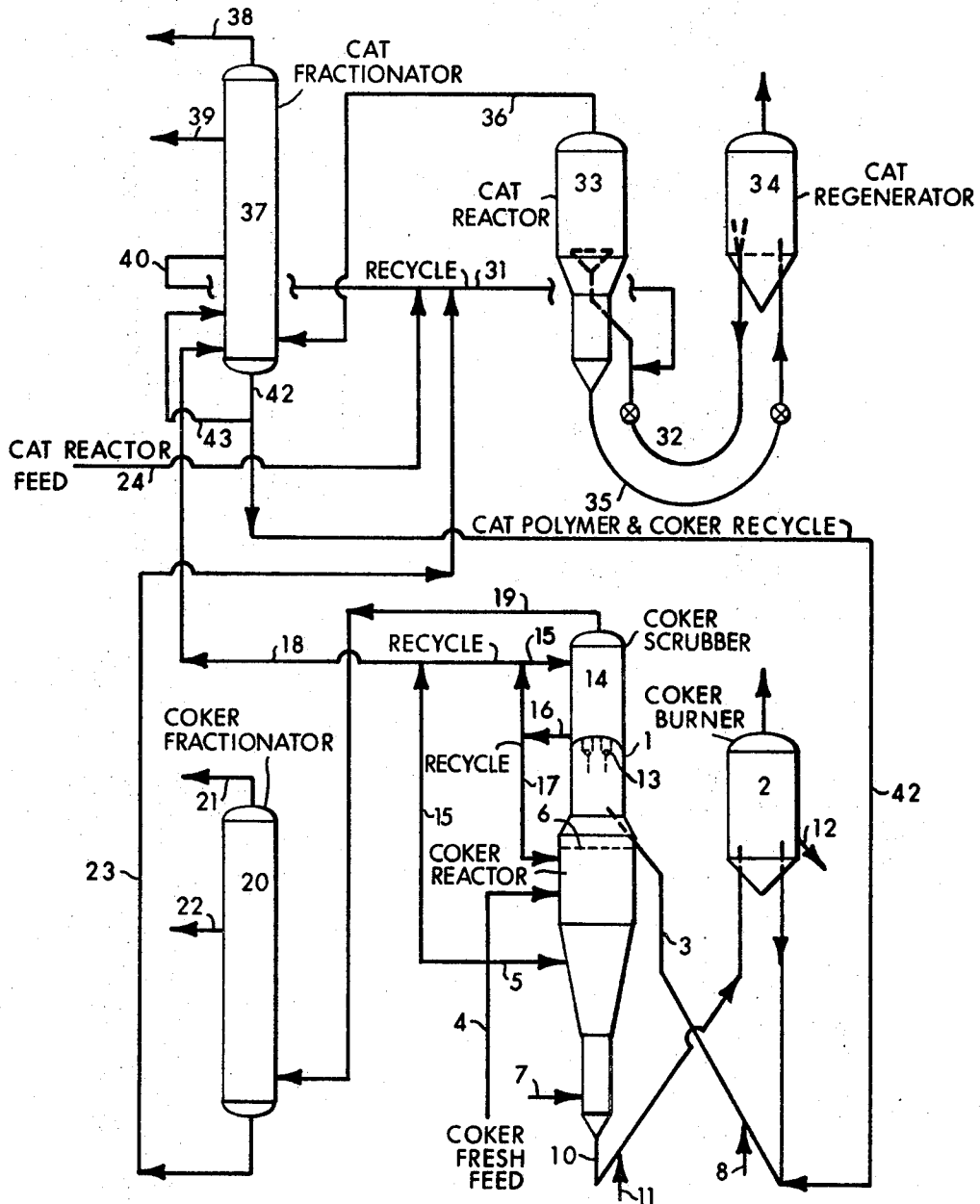
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FLUID COKING WITH CRACKING OF MORE REFRACTORY LESS
VOLATILE OIL IN THE TRANSFER LINE

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2 Sheets-Sheet 1

FIG. - 1



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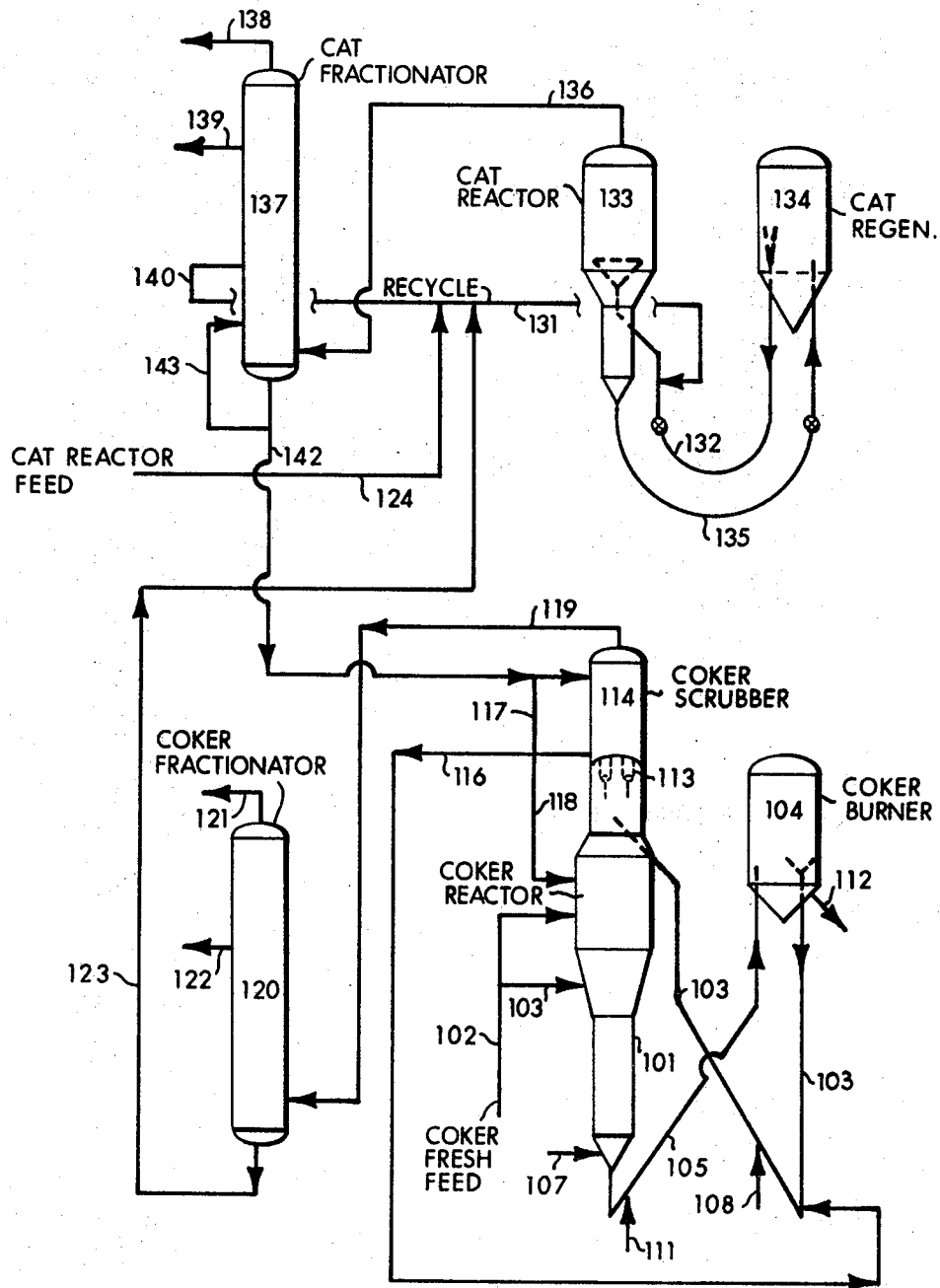
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2 Sheets-Sheet 2

FIG.- 2



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FLUID COKING WITH CRACKING OF MORE REFRACTORY LESS VOLATILE OIL IN THE TRANSFER LINE**Don E. Blaser, Dover, N.J., assignor to Esso Research and Engineering Company, a corporation of Delaware**

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9 Claims

ABSTRACT OF THE DISCLOSURE

A combined fluid coking and cracking process in which a heavy oil is injected into the bottom of the cracking unit fractionator in order to reduce the residence time of the polymer from the cracking process in the tower so that the cut point of the combined polymer-heavy gas oil can be increased to a point where the bottoms from the fractionator are as volatile or less volatile than the normal coker feed and can therefore be passed to the hot coke transfer line from the coke burner to the coker reactor and cracked therein at a higher temperature than exists in the coker. A similar result can be obtained by injecting any refractory oil which is more volatile than the coker feedstock into the coker scrubber to flash the more volatile portion of the feedstock overhead and leave only the portion of the refractory oil which is less volatile than the coker feedstock as feed to the coker transfer line.

BACKGROUND OF THE INVENTION

This invention relates to an improved petroleum refining process involving improvements in fluid coking for upgrading of heavy oils. More specific aspects of the invention relate to novel relationships between cracking and fluid coking.

As is well known in the art, the fluid coking process uses a fluid coking vessel or "reactor" and an external heating vessel, e.g. a fluid bed burner. A fluid bed of solids, preferably coke particles produced by the process having a size in the range of about 40 to 1000 microns, is maintained in the coking zone by the upward passage of a fluidizing gas, usually steam. The temperature of the bed is maintained at about 950° F.—1050° F. by circulating solids (coke) to the heating vessel (coke burner) and back. The heavy mineral oil to be converted is injected into the fluid bed and upon contact with the hot solids undergoes pyrolysis evolving lighter hydrocarbon vapors and depositing coke on the solids. The turbulence of the fluid bed normally results in substantially isothermal conditions and in through and rapid distribution of the heavy injected oil. Product vapors, after heavy entrained solids are removed, are withdrawn overhead from the coking vessel and sent to a scrubber and fractionator for cooling and separation. Generally, a stream of the coke particles is continuously withdrawn from the coking vessel or reactor and passed to the burner, where some of it is burned to heat the remainder, and heated coke is continuously recirculated to the reactor.

In the scrubber the heavier constituents of the effluent product vapor are condensed, usually with the aid of a quench oil, which may be at least a portion of the heavy

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oil fed to the coking reactor, in order to remove any coke particles and other undesirable heavy elements in the form of a slurry, this slurry being then fed to the coking reactor for further treatment. From the top of the scrubber, the cracked vapors pass to the fractionator, where they are separated into gas, gasoline and light and heavy gas oil. The light gas oil is normally used as charge stock for hydrocracking or hydrotreating. Heavy gas oil, boiling from about 600° F. to as 1050° F. is usually used as feed to catalytic cracking.

Another petroleum process which has achieved great importance is that of catalytic cracking, including the more recently developed hydrocracking. Catalytic cracking units require a charge stock much higher in grade than that of fluid coking units. In fact, fluid coking units are customarily added to refineries for the purpose of handling residuum which would give very poor results in other types of cracking units.

In the catalytic cracking unit most of the charge stock is upgraded to gasoline and other high grade products. The remainder is a heavy polymer normally boiling above 850°–950° F. with final vapor temperature of about 1300° F. Normally this material would be used as heavy fuel oil. However during high conversion operation of the catalytic cracking unit, the true boiling cut point of this polymer must be reduced to 800–900° F. in order to maintain 1.5 to 2.0% of this material in the catalytic cracking fractionating tower in order to operate the tower and prevent severe coking therein if the residence time goes too high.

SUMMARY

In accordance with the invention it has been found that a coking process and a cracking process can be integrated in a new way by using as part of the feedstock to the hot transfer line to the coker a material which is as volatile or less volatile than the normal coker feed such as bottoms from the cracking fractionator which have been stripped of all material boiling below 1000–1015° F. while at the same time injecting a heavy oil from the coker scrubber into the bottom of the cracking unit fractionator in order to reduce the residence time of the polymer in the tower so as to increase the allowable polymer-heavy gas oil cut point to 1000–1015° F. or above to make it suitable for cracking in the coker transfer line.

A second embodiment provides for this integration by injecting a refractory oil which is more volatile than the coker feedstock, namely the usual heavy gas oil bottoms (boiling 800–950° F.) from the fractionator into the fluid coker scrubber to flash the more volatile portion of the feedstock overhead and leave only the portion of the refractory oil (boiling above 1000–1015° F.) which is less volatile than the coker feedstock to be fed to the coker transfer line to be cracked therein.

A particular feature of the invention is the combination of fluid coking and fluid catalytic cracking.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a diagrammatic representation of processing steps incorporating one of the embodiments of this invention and illustrates diagrammatically both a fluid catalytic cracking unit and a fluid coking unit operating in conjunction with each other in which a small por-

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tion of the coker recycle stream or coker fresh feed is introduced into the bottom of the catalytic cracking fractionator and a bottoms fraction boiling at 1000–1015° F. and up is taken from the fractionator and introduced into the transfer stream of coke coming from the coke burner to the coking reactor.

FIG. 2 is a modification of FIG. 1 in which a catalytic cracking unit fractionator bottoms fraction, having a true boiling cut point of 800–950° F., is introduced into the top of the coker scrubber and a stream having a true boiling cut point of 1000–1015° F. is taken from the scrubber and recycled to the hot transfer line carrying the stream of coke from the coke burner to the coking reactor.

DETAILED DESCRIPTION

Referring now to FIG. 1, 1 represents a fluid coking reactor and 2 a coke burner. In the coke burner 2, coke is burned to provide heat for the coking reactor 1 and hot coke is returned to the coking reactor 1 through a hot transfer line 3, preferably and normally entering the upper part of reactor 1 as indicated in the drawing. The transfer line operates at a higher temperature than the coker reactor proper, namely 1050–1250° F. To the coking reactor 1, which is at a temperature of between 950° and 1050° F., a charge stock of residuum enter below the hot coke from lines 4 and 5 via a suitable manifold system. The injected oil contacts a bed 6 of fluidized coke and undergoes pyrolysis, evolving lighter hydrocarbon vapors and depositing additional coke on the coke particles.

Fluidization gas, e.g. steam, is injected at numerous points, indicated in the drawing by lines 7 and 8, to maintain fluidization of the coke particles and to effect transfer of coke from the burner 2 to the reactor 1 by line 3. Coke particles, after having been stripped of entrained hydrocarbons, are withdrawn from the base of the vessel 1 and sent to the coke burner 2 through line 10, to which steam or air is supplied as by a line 11. Coke in excess of that needed for burning and recirculation to the reactor 1, where it supplies heat for the endothermic coking reaction, is withdrawn from the burner 2 through a line 12.

From the reactor 1, the vaporous conversion products are withdrawn overhead through cyclone separators 13 which remove fine particles of entrained coke and return them to the reactor 1. From the cyclones 13, the effluent passes up into a scrubber 14, to which some or all of the fresh feed may be fed as quench oil through a line 15 and from which a slurry is withdrawn through a line 16 for recycle either to the quench line 15 or to the recycle line 17 or both.

In accordance with the present invention a small portion, equivalent to about 2% or more based on fresh feed to the catalytic cracking reactor unit, of the stream removed through line 16 and/or a similar portion of the fresh feed flowing in line 15 is passed by line 18 to the bottom of the catalytic cracking fractionator herein-after described in order to reduce the residence time of the catalytic polymer in the tower and increase the allowable polymer-heavy gas oil cut point to 1000–1015° F. From the scrubber 14, the uncondensed effluent passes overhead through a line 19 to a fractionator unit 20 where various fractions are taken off, such as gases and gasoline in line 21, light gas oil in line 22, and heavy gas oil that is passed via line 23 and mixed with fresh feed introduced by lines 24, and the mixture passed by lines 31 and 32 to a fluidized catalytic cracking reactor 33 along with other catalytic cracker charge stock. Catalyst from a regenerator 34 is fed in a fluidized condition through the line 32 to the reactor 33, and is returned through line 35 from the reactor 33 to the regenerator 34. The effluent from the reactor 33 passes through a line 36 to a fractionator 37, whence gas and gasoline are taken off through a line 38, light gas oil through line 39, and heavy recycle gas oil through line 40 which is returned to the catalytic reactor 33 through lines 31 and 32. A bottoms fraction boiling

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1000° F.–1015° F.+ is passed from the fractionator 37 by line 42 into the stream of coke coming from the burner to the coking reactor and flowing in transfer line 3 in which stream the temperature is higher than in the reactor bed being in the neighborhood of 1050° to 1250° F. where a considerable portion is converted to gasoline. A portion of this bottoms fraction may be returned to the fractionator by line 43.

FIG. 2 shows a slightly different arrangement in which a bottoms fraction having a slightly lower true boiling cut point (700–950° F.) is taken from the bottom of the catalytic cracking fractionator 137 and passed to scrubber 114 before being introduced to the transfer line 103 from the burner 104 to the coker 101. Briefly, feed is introduced to coker 101 through lines 102 and 103 and conveyed to burner 104 by line 105. Coke from the burner 104 is returned to the coking reactor 101 through a hot transfer line 103.

Fluidization gas, e.g. steam, is injected at numerous points, indicated in the drawing by lines 107 and 108, to maintain fluidization of the coke particles and to effect transfer of coke from the burner 104 to the reactor 101. Excess coke is withdrawn from the burner 104 through line 112.

From the reactor 101 the vaporous conversion products are withdrawn overhead through cyclone separators 113 which remove fine particles of entrained coke and return them to the reactor 101. From the cyclones 113, the effluent passes up into a scrubber 114, from which a slurry of refractory oil having a true boiling cut point of 1000–1015° F. is withdrawn through a line 116 and a portion of which is introduced to line 103. A majority of the stream withdrawn through line 116 is passed by line 117 to the top of the scrubber 114 or by line 118 to the bed in the coker.

The uncondensed effluent from the scrubber passes overhead through a line 119 to a fractionator 120 where gases and gasoline are removed by line 121, light gas oil by line 122, and a heavy gas oil that is passed via line 123 and mixed with fresh feed introduced by lines 124, and the mixture passed by lines 131 and 132 to a fluidized catalytic cracking reactor 133 along with other catalytic cracker charge stock. Catalyst from the regenerator 134 is fed in a fluidized condition through the line 132 to the reactor 133, and is returned through line 135 from the reactor 133 to the regenerator 134. The effluent from the reactor 133 passes through a line 136 to a fractionator 137, whence gas and gasoline are taken off through a line 138, light gas oil through line 139, and heavy recycle gas oil through line 140 which is returned to the catalytic reactor 133 through lines 131 and 132. A bottoms fraction having a true boiling cut point of 800–950° F. is passed by line 142 into the top of scrubber 114. The bottoms fraction true boiling cut point is adjusted to maintain at least 1.5 to 2.0% bottoms withdrawal. From the scrubber 114 a fraction boiling 1000–1015° F.+ mixed with coker recycle stock is withdrawn through line 116 and a portion thereof is introduced to line 103 where it is cracked at the high temperature therein (1050–1250° F.). The other portion is returned to the coker through line 118. A portion of the bottoms fraction from tower 137 may be returned to the fractionator by line 143.

By operating in the manner described in FIG. 1 or 2 a catalytic cracking unit and a fluid coking unit are so integrated that a higher initial cut point of the combined catalytic polymer and heavy gas oil can be maintained while at the same time the higher desirable bottoms rate from the catalytic cracking unit fractionator of 1.5 to 2% can also be maintained to enable the polymer gas oil bottoms to be passed to the hot coke in the transfer line from the fluid coker burner to the coker reactor which bottoms fraction is more refractory than and as volatile or less volatile than the normal charge stock to the coker reactor so that the more refractory stock can be subjected to the more severe cracking conditions existing in the hot

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transfer riser line and valuable gasoline fractions obtained therefrom.

While the invention has been described as a combined fluid coking-fluid catalytic cracking process, it is to be understood that the cracking process may be thermal as well as catalytic with equally good results stemming from the combination.

The nature of the present invention having thus been fully described and illustrated, what is claimed as new, useful and unobvious and desired to be secured by Letters Patent is:

1. In a combined coking and cracking process in which a heavy hydrocarbon charge oil is heated in a coking zone to produce coke and lower boiling hydrocarbons and in which the coking zone is maintained at coking temperature by circulation of coke particles from said coking zone to a burning zone wherein a portion thereof is burned to heat the remainder substantially above the temperature of the coke in the coking zone and the thus-heated coke is returned to said coking zone through an elongated hot transfer zone and in which a heavy hydrocarbon oil is simultaneously cracked in a cracking zone to lower boiling hydrocarbons which are fractionated in a fractionating zone into a plurality of light products and a heavy bottoms fraction,

the improvement which comprises scrubbing the cracked products from said coking zone in a scrubbing zone with a portion of the fresh feed to the coking zone, in which the major portion of the condensate in said scrubbing zone is passed to said coking zone as recycle thereto and in which a minor portion of said condensate, about 2% based on feed to said cracking zone, is introduced into the bottom of said fractionation zone to maintain a tower bottoms rate of 1.5 to 2% therein,

withdrawing from said fractionating zone a bottoms fraction having any desired true boiling cut point no lower than the final boiling point of the charge oil to the coking zone and introducing said withdrawn oil into said transfer zone to travel there-through in contact with heated coke particles therein for a distance sufficient that said refractory oil is cracked therein at a temperature substantially above that to which said charge oil is subjected.

2. In a combined coking and cracking process in which a heavy hydrocarbon charge oil is cracked to lower boiling hydrocarbons by contact with a dense fluidized bed of heated coke particles in a coking zone and the bed is maintained at coking temperature by circulation of coke particles from said bed to a burning zone wherein a portion thereof is burned to heat the remainder substantially above the temperature of said bed and the thus-heated coke particles are returned to said bed through an elongated hot transfer zone, and in which a heavy hydrocarbon oil is simultaneously cracked to lower boiling hydrocarbons by contact with a dense fluidized bed of heated particles and the cracked products thus obtained are fractionated in a fractionating zone into a plurality of light products and heavy bottoms fraction,

the improvement which comprises scrubbing the cracked products from said coking zone in a scrubbing zone with a portion of the fresh feed to the coking zone, in which the major portion of the condensate in said scrubbing zone is passed to said coking zone as recycle thereto and in which a minor portion of said condensate, about 2% based on feed to said cracking zone, is introduced into the bottom of said fractionation zone to maintain a tower bottoms rate of 1.5 to 2% therein,

withdrawing from said fractionating zone a bottoms fraction having any desired true boiling cut point no lower than the final boiling point of the charge oil to the coking zone and introducing said withdrawn oil into said transfer zone to travel there-through in contact with heated coke particles therein

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for a distance sufficient that said refractory oil is cracked at a temperature substantially above that to which said charge oil is subjected.

3. In a combined fluid coking and catalytic cracking process in which a heavy hydrocarbon charge oil is cracked to lower boiling hydrocarbons by contact with a dense fluidized bed of heated coke particles in the coking zone and the bed is maintained at coking temperature by circulation of coke particles from said bed to a burning zone wherein a portion thereof is burned to heat the remainder substantially above the temperature of said bed and the thus-heated coke particles are returned to said bed through an elongated hot transfer zone, and in which a heavy hydrocarbon oil is simultaneously cracked to lower boiling hydrocarbons by contact with a dense fluidized bed of heated catalyst particles and the cracked products thus obtained are fractionated in a fractionating zone into a plurality of light products and heavy bottoms fraction,

the improvement which comprises scrubbing the cracked products from said coking zone in a scrubbing zone with a portion of the fresh feed to the coking zone, in which the major portion of the condensate in said scrubbing zone is passed to said coking zone as recycle thereto and in which a minor portion of said condensate, about 2% based on feed to said cracking zone, is introduced into the bottom of said fractionation zone to maintain a tower bottoms rate of 1.5 to 2% therein,

withdrawing from said fractionating zone a bottoms fraction having any desired true boiling cut point no lower than the final boiling point of the charge oil to the coking zone and introducing said withdrawn oil into said transfer zone to reveal there-through in contact with heated coke particles therein for a distance sufficient that said refractory oil is cracked therein at a temperature substantially above that to which said charge oil is subjected.

4. The process of claim 3 in which the temperature in the coking zone is 950° F. to 1050° F. and in said transfer line is 1050° F. to 1250° F.

5. The process of claim 4 in which a small portion of the heavy hydrocarbon charge to the coking zone is introduced into the bottom of said fractionating zone along with the minor portion of said condensate.

6. The process of claim 6 in which the bottoms fraction has a true boiling cut point of 1000-1015° F.

7. In a combined fluid coking and catalytic cracking process in which a heavy hydrocarbon charge oil is cracked to lower boiling hydrocarbons by contact with a dense fluidized bed of heated coke particles in a coking zone and the bed is maintained at coking temperature by circulation of coke particles from said bed to a burning zone wherein a portion thereof is burned to heat the remainder substantially above the temperature of said bed and the thus-heated coke particles are returned to said bed through an elongated hot transfer zone, and in which a heavy hydrocarbon oil is simultaneously cracked to lower boiling hydrocarbons by contact with a dense fluidized bed of heated catalyst particles and the cracked products thus obtained are fractionated in a fractionating zone into a plurality of light products and a heavy bottoms fraction,

the method of simultaneously cracking in said transfer zone by contact with the hot coke therein a heavy oil more refractory and as or less volatile than said charge oil to said coking zone which comprises

scrubbing the cracked products from the said coking zone in a scrubbing zone with a bottoms fraction from said fractionating zone having a true boiling cut point of 800-950° F. and withdrawing a refractory fraction having any desired true boiling cut point no lower than the final boiling point of the charge oil to the coking zone from said scrubbing zone and introducing a minor portion thereof into

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said transfer zone to travel therethrough in contact with heated coke particles therein for a distance sufficient that said refractory oil is cracked therein at a temperature substantially above that to which said charge oil is subjected.

8. The process of claim 7 in which the temperature in the coking zone is 950° F. to 1050° F. and in said transfer line is 1050° F. to 1250° F.

9. The process of claim 8 in which refractory fraction has a true boiling cut point of 1000-1015° F.

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