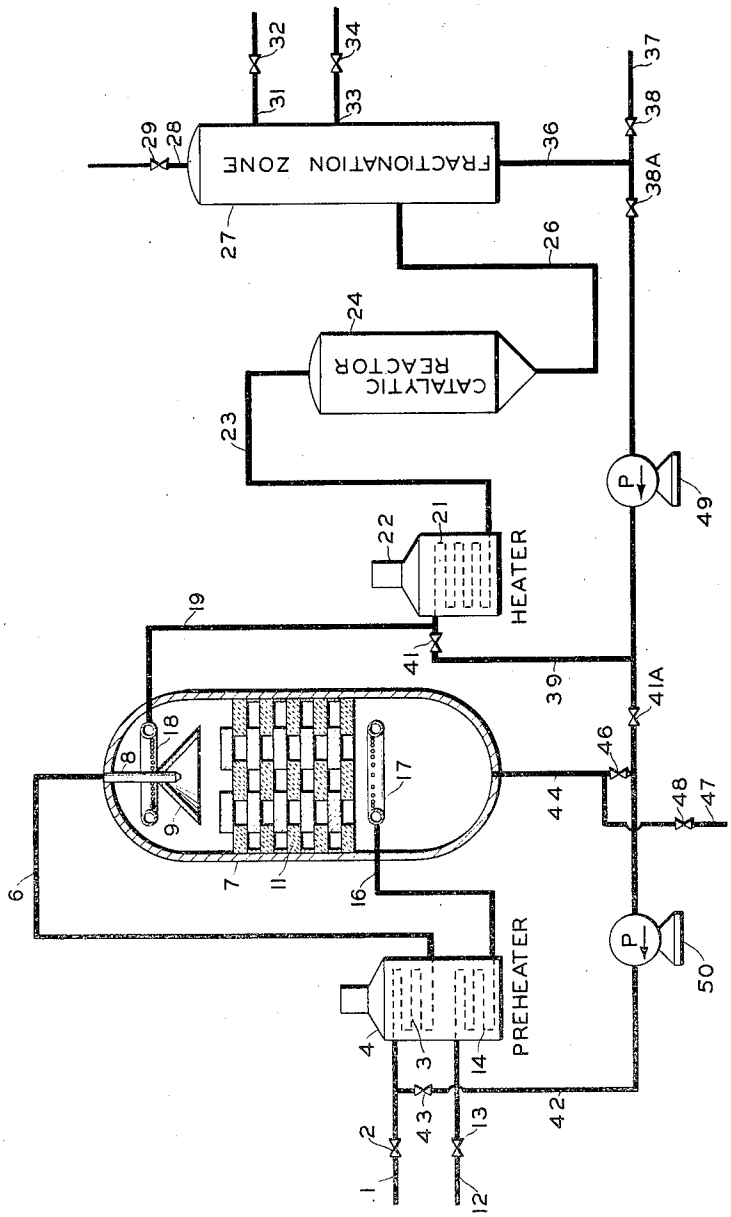
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CATALYTIC HYDROCARBON CONVERSION PROCESS AND APPARATUS

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CATALYTIC HYDROCARBON CONVERSION PROCESS AND APPARATUS

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This invention relates to a hydrocarbon conversion process. In a more specific aspect it relates to a catalytic cracking process for the production of motor fuels. In another specific aspect it relates to a method of preparing a cracking feed stock from high boiling point hydrocarbon oils.

It is recognized in the art that catalytic cracking processes are more efficient for the production of high grade motor fuels than thermal cracking processes. It is also known that high boiling point hydrocarbon oils will yield high grade motor fuels by cracking processes. However, the catalytic processes are limited by the fact that oils boiling above about 800° F. cannot be efficiently cracked catalytically because of the excessive carbon deposition on the catalyst. The use of high boiling point hydrocarbons in a catalytic cracking system is further limited by the fact that they give excessive carbon deposition in the preheater tubes, which results in shutting off the flow of oil through the preheater after a short period of use.

I have discovered a method whereby high boiling oils can be converted into a suitable feed stock for a catalytic cracking process and wherein the disadvantages caused by excessive carbon deposition are eliminated.

It is therefore an object of this invention to provide an improved hydrocarbon conversion process.

It is another object of this invention to provide an improved method of preparing feed stocks for catalytic cracking processes.

It is still another object of this invention to provide a process for utilizing high boiling point hydrocarbons in the production of motor fuels wherein the disadvantages of excessive coke deposition are minimized.

Further objects and advantages of this invention will be apparent to those skilled in the art upon reading the accompanying specification, drawing and claims.

The single drawing is an elevational view, partly in section, of a system embodying my invention.

In the drawing, heavy hydrocarbon feed is introduced through linel controlled by valve 2 and flows into coil 3 of heater 4. The effluent from said coil flows through line 6 to a chamber 7 into which it is emptied through a special distributing nozzle 8 surrounded by baffle 9 and flows downward over a refractory checkerwork 11. A mixture of steam and air flows through line 12, controlled by valve 13, into coil 14 of heater

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4 and, from thence, through line 16 into chamber 7 through a distributing ring 17 in a lower portion of said chamber. Collecting ring 18 is provided in an upper portion of said chamber for collecting gases formed within said chamber, from which said gases flow through line 19 to coil 21 of preheater 22. The heated gases flow from said preheater through line 23 into catalytic reactor 24 and the reactants flow from said reactor through line 26 into fractionation zone 27, which may be any suitable separation system, such as a series of fractional distillation columns. Line 28 controlled by valve 29, line 31 controlled by valve 32, and line 33 controlled by valve 34 are provided for removal of various fractions from said fractionation zone 27. The bottoms from said fractionation zone may be removed through line 36 and sent to storage through line 37 controlled by valve 38 or to preheater 22 through line 39 controlled by valve 41 or they may be passed through line 42 controlled by valve 43 into line 1 for mixing with the heavy hydrocarbon feed stock flowing into heater 4. Line 44 controlled by valve 46 is provided for removal of bottoms from chamber 7, which bottoms may be drawn off to external storage through line 47 controlled by valve 48 or may be returned to preheater 4 through said line 42. Valves 38A and 41A in line 42 are provided for regulating and proportioning of the recycle streams. Pumps 49 and 50 are provided in line 42 for pumping the material into the desired chamber.

Operation

In practicing our invention, a high boiling point oil such as a topped crude may be used in a catalytic cracking process without running the risk of excessive carbon deposition either on the catalyst or in the preheater tubes. The crude stock is run through coil 3 of preheater 4 at a rate of 50–300 barrels per hour and it is heated to a temperature in the range of 500 to 700° F. at a pressure of preferably 50 to 100 p. s. i. g. At this temperature there is substantially no cracking in the preheater tubes and consequently no carbon deposition. The heated stock is conducted to chamber 7 into which it is emptied through a distributor 8 and flows downward through said chamber over a checkerwork of refractory material 11. A mixture of air and steam which has been superheated to a temperature of about 900 to 1200° F. in coil 14 of heater 4, is introduced into a lower portion of chamber 7 through a distributing ring 17 disposed below the refractory checkerwork and flows upward

through said checkerwork in counter-current contact with the downward flowing oil.

We prefer to maintain a pressure of 0 to 50 p. s. i. g. within said chamber. The preferred ratio of air to steam to oil is about 100 pounds of steam per 150 cubic feet of air per 42 gallons of oil. It will be readily understood by those skilled in the art that this ratio may vary considerably in accordance with the vaporization and coking characteristics of the specific oil feed being vaporized. In general, a steam-to-oil ratio from 20 to about 200 pounds of steam per barrel of oil is satisfactory. The ratio of air (or oxygen) to oil will depend on the carbonization characteristics of the oil. The amount of air is regulated so that at least a substantial part of the carbon deposited on checkerwork 11 is burned off.

A fraction of the charge stock is vaporized immediately by flashing and is removed through collecting ring 18 without undergoing any thermal decomposition. Materials not vaporizable at the temperatures existing at the point of influx flow downward over the hot refractory checkerwork where they are mildly cracked to produce vaporizable material. The heat for maintaining the temperature inside this chamber is supplied partly from the preheated gases, and partly by the oxidation of a portion of the liquid hydrocarbons as they flow downward over the hot refractory material and are contacted by the hot, oxygen-containing gases. One of the principal advantages of a vaporizer such as this is that the spaces between the refractory material are large and there is almost no danger of their being blocked by coke deposition. The rising oxidizing gases will keep the coke burned off. Another advantage is that the vaporizable materials are removed from the chamber substantially immediately and there is little thermal cracking above that required to produce vaporizable hydrocarbons. Moreover, the more difficultly vaporizable constituents of the oil are subjected to higher and higher temperatures as they flow downward over checkerwork 11. Any tarry fraction that is not cracked sufficiently to make it vaporizable during the single pass through said chamber 7 may be removed through line 44 and recycled through preheater 4 back to the top of said chamber 7.

The vapors are collected in the upper portion of said chamber 7 by a collecting ring 18 and are then sent through coil 21 of heater 22 where they are heated to the desired temperature and then run into catalytic reactor 24. Baffle 9 shields inlet nozzle 8 and prevents entrainment of liquid, carbon-depositing constituents by upward-flowing vapors and thus minimizes consequent carbon deposition in coil 21 and reactor 24. The reaction products are drawn off to a fractionator 27 for separation into the desired fractions. The amount of carbon deposition in the tubes of preheater 22 and on the catalyst is no greater, and is frequently less, than it would be if the original charge stock were of boiling range suitable for charging into a catalytic reactor without preliminary treatment. Handling the heavy oil in this manner results in a maximum amount of charge stock for the catalytic unit with a minimum amount of low grade thermal gasoline, which, however, is further catalytically cracked and thereby improved.

Catalytic reactor 24 may be of any of the conventional designs known in the art. It may embody the fixed-bed, moving-bed, fluid-bed, or other known principle of catalytic contacting. The catalyst may be any of the numerous suitable cracking catalyst known in the art; for example, it may be granular calcined bauxite, silica-alumina, silica-zirconia, activated clay, etc.

Example:

A topped crude boiling above 650° F. is charged at a rate of 100 barrels per hour into heater 4 where it is heated to give a coil outlet temperature of 700° F. at a pressure of 100 p. s. i. g., and the stream is flashed into chamber 7 at a pressure of 50 p. s. i. g. A mixture of 10,000 pounds per hour of steam and 15,000 cubic feet per hour of air is charged to superheater coil 14 where it is heated to a temperature of 1150° F. This heated air and steam mixture is conducted to the section below the refractory checkerwork and flows upward through said checkerwork countercurrent to the liquid oil. The temperature in the zone adjacent the entry point of said mixture is 950° F. and the temperature of the gases leaving this chamber is approximately 800° F. By this method of treatment approximately 85 per cent of the original charge oil is vaporized and the remainder is drawn off as tar bottoms. The total mixed vapors are then heated to 1000° F. and passed through a bauxite catalyst at a space velocity of 1.0 liquid volume of oil per volume of catalyst per hour and at a pressure of 20 p. s. i. g. for a process period of 4 hours. The effluent from the catalyst case shows the following composition based on the 85 per cent of the original oil charge vaporized.

Dry Gas, weight per cent	13.5
Total C_4, volume per cent	8.9
Debutanized 400 F. E. P. gasoline, volume per cent	37.2
Total Conversion, volume per cent	57.2
Carbon, weight per cent	3.6
ASTM Octane rating:	
0 ml. TEL	78.0
1 ml. TEL	81.0
Research Octane rating:	
0 ml. TEL	88.5
1 ml. TEL	93.4

When the same topped crude is charged to a conventional cracking system comprising a preheater operated at 1000° F. followed by a catalyst chamber, carbon deposition in the preheater coil and on the catalyst is so great that onstream periods longer than 1 hour are impossible.

The above description and example are merely illustrative embodiments of the invention, and are not limitations to the invention, the true scope of which is set forth and defined by the following claims.

Having described our invention, we claim:

1. In a process for the production of motor fuel from a high boiling hydrocarbon oil by a catalytic cracking process in which the oil is first vaporized and then catalytically cracked the steps as follow: heating said oil to a temperature in the range of 500 to 700° F. under a pressure sufficient to maintain it substantially in the liquid phase; flashing said oil into the top of a vaporizing zone maintained at a temperature in the range 700 to 1,000° F. to form vapors and an unvaporized portion; immediately withdrawing from said zone and passing said vapors to a catalytic cracking zone and therein cracking said vapors to form said motor fuel; allowing said unvaporized portion of the oil flashed into said vaporizing zone to pass downwardly therethrough over a checkerwork of refractory material in contact with a rising current of air and steam at a temperature in the range of 900 to 1,000° F. and in a quantity sufficient to oxidize

a sufficient portion of said downwardly passing oil to provide just sufficient heat at successive points during its downward travel to just sufficiently heat and crack said oil on said checkerwork to cause it to become vaporous, allowing said vaporous oil to rise freely through said checkerwork and to join said vapors resulting from the flashing of the oil in said vaporizing zone there to be removed immediately with said vapors from said zone and to be catalytically cracked therewith in said catalytic cracking zone, controlling the said oxidation and the other conditions of operation of said vaporizing zone containing said checkerwork to allow any tarry material which is formed to accumulate and to be withdrawn from the bottom thereof without any substantial vaporization or cracking thereof and withdrawing said tarry material from the bottom of said zone.

2. An apparatus for the preparation of a catalytic cracking stock from a mixture of high boiling point hydrocarbons which comprises a preheater having a first coil adapted to heat a hydrocarbon feed stock and a second coil adapted to heat steam-air mixture and a vaporizing chamber having an internal checkerwork of refractory material, a gas distributing ring positioned below said checkerwork in a lower portion of said vaporizing chamber, conduit means between said gas distributing ring and said second heater coil, a liquid distributor in an upper portion of said vaporizing chamber above said checkerwork, a conical shield coaxially disposed on and around said liquid distributor, conduit means between said liquid distributor and said first heater coil, a gas collecting ring disposed above said liquid distributing nozzle in an upper portion of said chamber and having a conduit connection leading to a catalytic cracking zone, and a drain outlet in a lower portion of said chamber.

3. A hydrocarbon vaporizer for preparing a catalytic cracking feed stock from high boiling point hydrocarbons which comprises a single chamber having an internal checkerwork of refractory material, a gas distributing means disposed below said refractory checkerwork in a lower portion of said chamber and having a conduit connection with an external source of steam-air mixture, a liquid distributing means disposed above said checkerwork in an upper portion of said chamber and having a conduit connection with an external source of liquid hydrocarbons, a conical shield disposed coaxially on and around said liquid distributing means, a gas collecting means disposed above said liquid distributing means in an upper portion of said chamber and having a conduit connection with an external catalytic cracking zone.

4. In an apparatus for the catalytic production of motor fuel from a charge stock of high boiling point hydrocarbons, an improved feed stock vaporizer which comprises in combination a preheater and a hydrocarbon vaporizer, said preheater being adapted to simultaneously heat a stream of heavy hydrocarbon feed stock and a stream of vaporizing gas, said vaporizer comprising a single chamber having an internal refractory checkerwork, a gas distributing means disposed below said checkerwork in a lower portion of said vaporizer, conduit means connecting said distributing means with the vaporizing gas outlet of said preheater, a liquid distributing nozzle above said refractory checkerwork in an upper portion of said vaporizer, a conical shield coaxially disposed on said liquid distributing nozzle, conduit means connecting said liquid distributing nozzle with the hydrocarbon outlet of said preheater, a gas collecting means in an upper portion of said vaporizer, conduit means leading from said collecting means to the cracking zone.

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