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CONVERSION OF HYDROCARBON OIL

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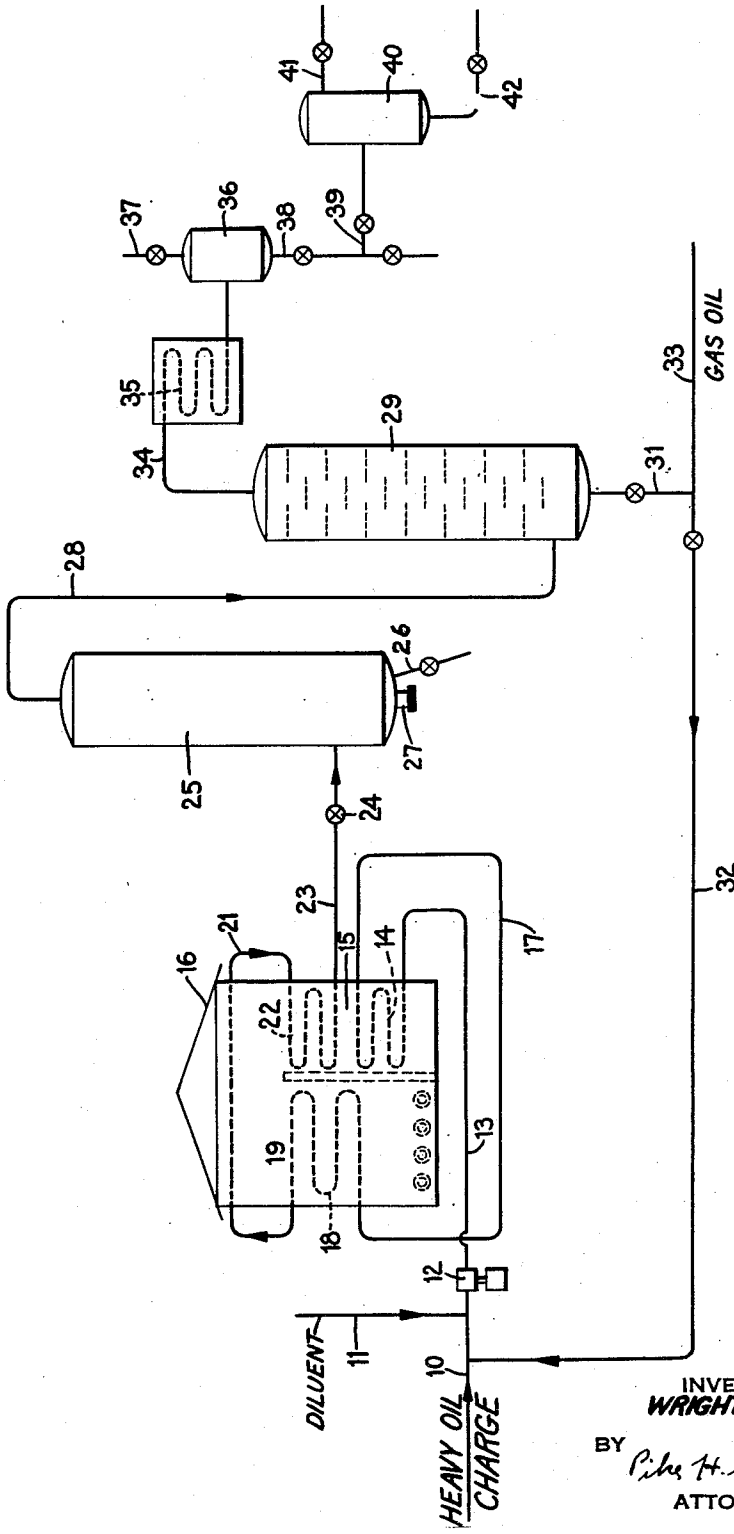

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CONVERSION OF HYDROCARBON OIL

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2 Claims. (Cl. 196—62)

This invention relates to the conversion of hydrocarbon oil and pertains more particularly to a method of cracking relatively heavy oil.

One of the principal objects of my invention is to provide a process for cracking heavy oils of residual character such as reduced crude, which will produce an improved yield of lighter oil amenable to high temperature, high crack per pass cracking treatment and a gasoline of improved anti-knock properties.

It is generally understood in the refining art that heavy oils of the character hereinbefore mentioned are not suitable for high temperature, high crack per pass cracking treatment which will produce high anti-knock gasoline, within a heating coil, due to the presence of constituents which are readily convertible into coke. The coke thus formed deposits on the walls of the heating equipment, necessitating premature discontinuance of the cracking process, and thus rendering such a process economically impractical. In view of this it has heretofore been a practice to subject heavy hydrocarbon oils of this character to relatively mild cracking treatment, generally known as viscosity breaking treatment, within a heating coil, to convert a substantial portion thereof into lighter oil which is amenable to high temperature, high crack per pass cracking treatment. In addition to the production of relatively lighter oil suitable as cracking stock for high temperature cracking treatment there is also produced as a result of the low temperature treatment a substantial yield of low grade gasoline.

I have found that under certain controlled conditions hereinafter specified it is possible to subject heavy oil of residual nature to relatively drastic cracking conditions which will produce high anti-knock gasoline.

In accordance with my invention a relatively heavy oil, such as reduced crude, other heavy oils of residual nature or a heavy gas oil, consisting principally of constituents boiling above 700° F., is subjected to high temperature cracking treatment while in admixture with a diluent gas such as steam, low boiling hydrocarbon gases or fixed gases. While the pressure, employed in some instances, may be as low as 300 pounds per square inch, advantages may be realized by operating under materially higher pressures such as in excess of 1000 pounds and preferably in the neighborhood of 2000 to 3000 pounds per square inch. The temperature of the mixture should be in excess of 900° F. and preferably in the neighborhood of from 960 to 975° F. or more. The amount of diluent gas should be in excess of 10% by weight of the original charging stock and preferably considerably more. For example, the oil may be first admixed with equal parts by weight of water or steam.

When carrying out the operation the mixture is heated under conditions which will avoid substantial cracking at temperatures below 900° F. The cracking conditions are preferably controlled with respect to time and temperature to produce more than 30% of constituents of lower boiling point than the original charging stock of which less than half may be within the boiling range of gasoline.

The invention will be better understood by referring to the accompanying drawing which is a schematic illustration of an apparatus suitable for carrying my invention into effect.

Referring to the drawing, the reference character 10 designates a charging line for introducing a heavy oil consisting mainly of constituents boiling above 700° F. This heavy charging stock is merged with a diluent gas or a liquid which will be converted into a gas under conditions subsequently obtaining, introduced through line 11.

The mixture of heavy oil and diluent is forced by means of pump 12 through line 13 into preheating coil 14 located in the convection section 15 of the furnace 16 where it is preheated to a temperature just below cracking, such as 650° to 700° F., for example. The mixture, after being preheated, is passed through line 17 to coil 18 located in the radiant section 19 of the furnace 16 wherein it is rapidly heated to a temperature in excess of 900° F.

In lieu of first admixing the oil and diluent gas and then heating the mixture to the final cracking temperature the oil may be separately preheated, for example, to a temperature just below active cracking before being admixed with the diluent, which has been previously preheated to any desired temperature.

The products after being heated to the desired cracking temperature within the radiant heat section 19 of the furnace 16 may be transferred through line 21 to coil 22 located in the convection section 15 of the furnace wherein the desired conversion is carried to completion. The converted products from the heating coil 22 thereafter pass through transfer line 23 provided with a reducing valve 24 to the evaporator 25 wherein vapors separate from residue. The residue separated in evaporator 25 may be either a solid or liquid depending upon temperature and pressure conditions maintained within the chamber. In

case the process is controlled to produce a liquid residue the residual liquid is withdrawn from the evaporator 25 through line 26.

When operating the process to produce petroleum coke the coke may be removed through manway 27 by means of conventional coke-removing apparatus not shown. In the latter case a plurality of chambers 25 connected in parallel are preferably provided so that one or more may be disconnected for removing the coke without interrupting the process.

Vapors separated in evaporator 25 pass overhead through line 28 to a fractionating column 29 wherein they undergo fractionation to separate higher boiling constituents therefrom. The fractionating tower 29 is provided with suitable fractionating elements for effecting gaseous liquid contact and for condensing the higher boiling constituents of the vapors. The tower 29 is controlled to take overhead a distillate product having a desired boiling range for gasoline. The heavier constituents thereof are condensed and are withdrawn from the bottom of the fractionating tower 29 through line 31 and may be returned to the cracking zone through line 32 for re-treatment but are preferably withdrawn through line 33 and subjected to separate cracking treatment under conditions more suitable for clean condensate stock.

Vapors remaining uncondensed in the fractionating tower 29 pass overhead through line 34 to a condenser 35 and then to a receiver 36 wherein the distillate separates from fixed gases. Fixed gases are withdrawn from the receiver 36 through line 37, and the distillate is withdrawn through line 38. In event water or steam is used as a diluent the distillate is passed through lines 38 and 39 to a separating chamber 40 wherein the water and the desired distillate separate. The latter is withdrawn from the separator through line 41 and the water through line 42.

When operating in accordance with the process hereinbefore described it has been found, contrary to what would naturally be expected, that less coking difficulties are encountered within the heating coil when operating under the high temperature high pressure conditions than are encountered under low temperature low pressure conditions. While the exact explanation for this is not definitely known there is reason to believe that the heavier constituents, particularly when admixed with the diluent gas, under the high temperature high pressure conditions are in different physical state than is the case under lower temperature and pressures. For example, it is reasonable to suppose that these heavier oils are substantially vaporized under the conditions obtaining within the heating furnace and that under the pressures there obtaining the compressed vapors act as a solvent for the heavy asphaltenes and viscous materials which tend to adhere to the walls of the furnace tubes and are converted into coke by being subjected to the higher temperature of the tube walls and by the prolonged heating within the heating zone. Under the conditions which I maintain there is reason to believe that all of the constituents of the heavy oil are swept through the heating tubes at substantially the same velocity. As a practical matter it has so far been impossible to determine the physical state or phase condition of the products within the heating coil at the high temperatures and pressures there obtaining. Whatever the underlying causes may be definite advantages may be realized by carrying out the process according to my invention.

The following example will serve to illustrate one mode of carrying out my invention, it being understood that the invention is not limited to the specific conditions hereinafter set forth.

Reduced crude having constituents boiling mainly above 700° F. is first admixed with equal parts by weight of water. This mixture, after being preheated to a temperature of about 700° F., is heated to a temperature of about 960° to 975° F., at a rate which will avoid any substantial cracking at temperatures below 900° F., while being maintained under a pressure of the order of 2000 to 3000 pounds per square inch. The products are maintained at about this temperature for a period sufficient to convert more than 30% thereof into materials boiling below the initial boiling point of the original charging stock, of which less than half thereof will be within the normal boiling range of gasoline.

The pressure maintained in the separating chamber 25 and fractionating tower 29 is preferably below that at the outlet of the heating coil and may be substantially atmospheric or from 100 to 300 pounds per square inch or more.

Having described the preferred embodiments of my invention, it is understood that it embraces such other variations and modifications as come within the spirit and scope thereof and that it is not my intention to limit the invention except as necessary to distinguish from prior art or to dedicate any novel features thereof.

I claim:

1. A method of converting higher boiling petroleum oil of the nature of reduced crude and consisting mainly of constituents boiling above about 700° F. and containing residual constituents into lower boiling products which comprises admixing said oil with from 10% to about equal parts by weight of water which under conditions subsequently obtaining will enable more drastic cracking of said oil than could be obtained in its absence without deleterious coke formation, subjecting said mixture to a temperature of from about 960°–975° F. while being maintained under superatmospheric pressure to effect substantial cracking thereof without substantial hydrogenation into lower boiling hydrocarbons, separating the cracked products and recovering said lower boiling products.

2. A method of converting higher boiling petroleum oil of the nature of reduced crude consisting mainly of constituents boiling above about 700° F. and containing residual constituents into lower boiling products which comprises admixing said oil with from 10% to about equal parts by weight of water which under the conditions subsequently obtaining will enable more drastic cracking of said oil than could be obtained in its absence with deleterious coke formation, subjecting said mixture to a cracking temperature of between about 960° and 975° F. while being maintained under a pressure of from about 2000 to 3000 pounds per square inch to crack at least 30% thereof into lower boiling hydrocarbons, separating the cracked products and recovering said lower boiling products.

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