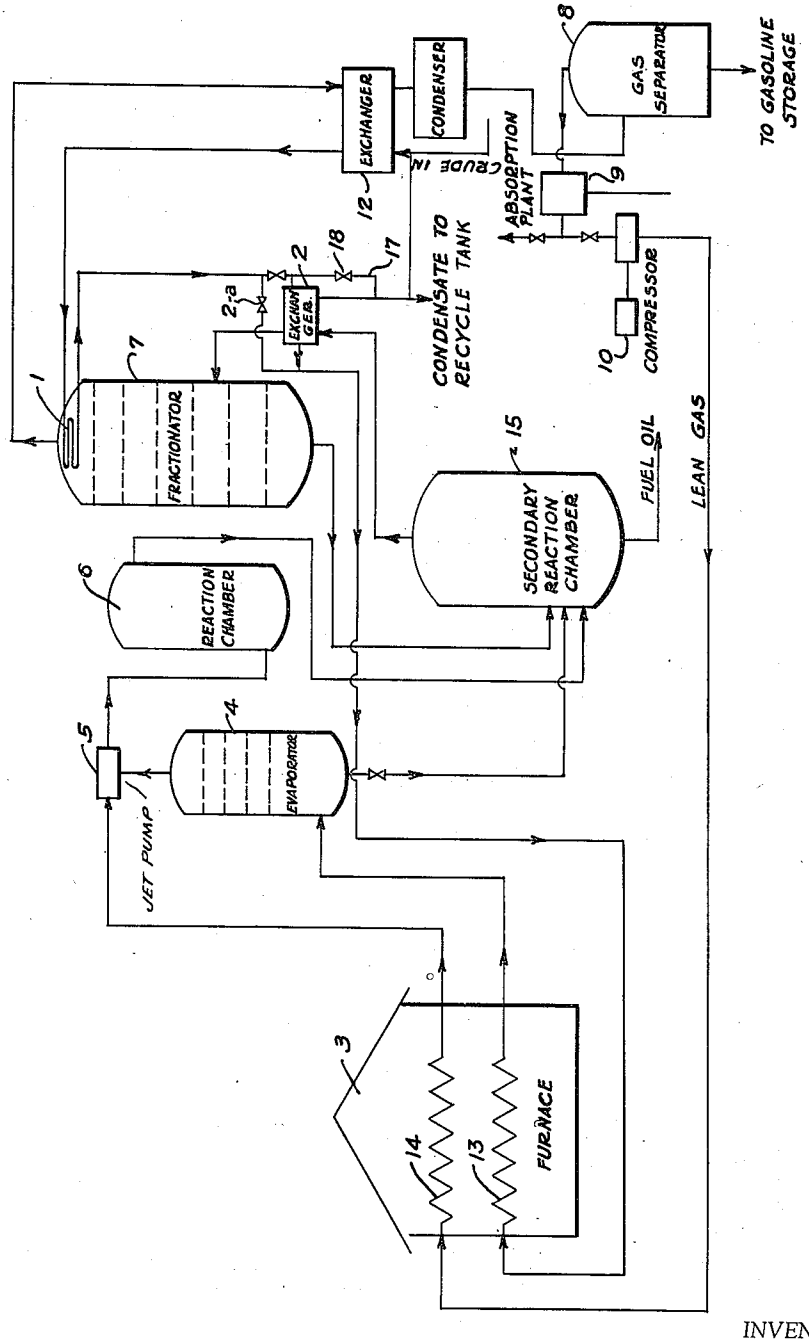
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CRACKING AND APPARATUS

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CRACKING AND APPARATUS

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4 Claims. (Cl. 196—66)

This invention relates to improvements in process and apparatus for cracking hydrocarbon oils and more particularly to methods and apparatus for the production of gasoline in high yield and of high octane value from crude oil or fractions thereof.

One of the objects of the invention is to produce gasoline of high octane number by cracking vapors of an oil having a boiling range substantially higher than that of gasoline simultaneously with re-forming of hydrocarbons of gasoline boiling range already existent in the oil in order to produce a product of much higher octane value, and also with polymerizing at least a portion of the fixed gases produced in the process to liquids from which a further portion of gasoline is obtainable.

Another object is to provide a novel means for very efficiently and rapidly transferring to the vapors the heat necessary for their conversion.

Another object of the invention is to provide a vacuum jet pump for aiding vaporization in such manner that increased vaporization is brought about at temperatures below that at which deposition of coke occurs.

Another object is to eliminate all recycle and reflux pumps and to provide a pump with no moving parts to transfer the vapors from the evaporator to the reaction chamber, whereby the cost of installation and upkeep of the cracking plant is materially lowered.

A still further object consists in providing a process and apparatus capable of giving a greater yield of gasoline than has heretofore been obtainable, such increase being accomplished by the polymerization of a portion of the constituents in the gas as a result of the heat treatment given it.

Other objects of the invention will appear from the following description thereof taken in connection with the attached drawing, which is a schematic diagram illustrating a flow circuit by which the advantageous features of the present invention may be attained.

With reference to the accompanying drawing, the cracking stock, comprising a crude oil or suitable fraction thereof, enters the heat exchanger 12 and then passes through the coil 1 situated within the top portion of fractionating tower 7, and thence is successively conducted through a further heat exchanger 2 and heating coil 13 situated in the furnace or still 3. The exchanger 2 may be wholly or partially by-passed if desired by manipulation of valve 2a. In the heating coil 13 the temperature of the oil is raised sufficiently to effect the vaporization of a substantial fraction thereof, the resulting mixture of liquid and vapors thus heated passing to the evaporator 4. This unit is preferably provided with bubble caps and trays. Due to the subsequent subjection of the partially vaporized oil to the action of a jet pump, as hereinafter more fully explained, the temperature to which the oil has to be heated in the coil 13 to effect the vaporization of the desired portion thereof is much lower than is necessary in processes practiced heretofore.

At the same time the fixed gases, preferably subsequent to their passage through an absorption plant 9 wherein they are deprived of gasoline constitutents, are compressed in the compressor 10 and passed through the superheating coil 14 where they are heated to a high temperature of the order of 1200° to 1800° F. The heated gases are then discharged through the jet pump 5, the suction side of which is connected to the top of the evaporator 4.

The commingled vapors and heat carrier gases pass from the siphon pump 5 into the reaction chamber 6 wherein there is consummated the cracking of the vapors initiated at the point of junction between the gases and vapors. The vapors then pass into the secondary reaction chamber 15 where they come in contact with the bottoms from both the evaporator 4 and the fractionator 7, the bottoms from the latter constituting the recycle stock. The temperature of the mixture of the bottoms and the hot processed vapors and gas, is still sufficiently high to effect the cracking of at least a portion of the recycled material. If the conversion of a greater portion of these bottoms is desired the tower may be provided with additional means for heating the contents, for instance, a means for introducing a further portion of heated gas or superheated steam. The portions of the vapors having the characteristics of fuel oil or heavier fractions remain in this tower together with any tar and coke that may also be present. Any constituents of the bottoms from evaporator 4 and fractionator 7 having like characteristics also remain in this chamber and are continuously withdrawn through the indicated fuel oil line. All of the constituents in the vapor state leave this tower 15 and are discharged through the exchanger 2 in which they impart some of their heat to the incoming stream of preheated oil and thence pass into fractionator 7. The contents of this fractionator undergo fractionation aided by the indirect heat exchange with the relatively cool oil

passing through the coil in the top of the tower with the result that the vapor leaving the tower is composed of gasoline or lower boiling compounds. This vapor is successively passed through exchanger 12 wherein it preheats the income stream of oil, condenser 16 where the gasoline is condensed, and finally through gas separator 8 wherein the gasoline is separated from the uncondensable gas.

The jet pump is so operated that the maintenance of a suitable pressure and flow at the gas intake causes a drop in pressure in the constricted portion of the pump, resulting in the suction of vapors from the evaporator into the pump wherein they are intimately commingled with the hot gases, the transfer of heat from the gas to the vapors being substantially instantaneous. The action of the pump also results in a decrease in pressure in the evaporator so that the required evaporation is effected at a temperature lower than otherwise would be necessary. The permissible use of lower temperature for vaporization is particularly important in the case of a high content of asphaltic materials in the oil being processed.

The optimum cracking temperature, which may vary from 950° to 1100° F., more or less, according to the oil being processed, and the optimum length of time during which the vapors are exposed to the cracking conditions are the two most important factors which determine the quantity of heat-carrying gas to be employed, the temperature to which it is to be heated in coil 14, and the degree to which it is to be compressed. The rate at which the vapor is withdrawn from the evaporator 4 by a jet pump of given dimensions is dependent on the kinetic energy of the actuating gas and, ultimately, on the pressure of said gas. Thus, from the established quantities of gas and vapor discharged from the pump, the reaction time can be calculated from which the optimum conversion temperature is determined and finally from a knowledge of this optimum temperature and the quantity of gas necessary, the temperature to which the gas must be heated is calculated. This method of establishing the operating conditions is one of many that may be employed. Another method is one based on a predetermined conversion temperature. The operating conditions are not only determined by the optimum temperature, the time of reaction and the motivating force for the pump, but they are further restricted to the extent that the temperature to which the gas must be heated to provide the vapors with the required quantity of heat, should be in the region of 1200° to 1800° F., preferably 1400° to 1500° F., in order to procure the highest yield of gasoline due at least in part to the polymerization of certain constituents of the gas at said temperatures.

The provision of the heat exchanging coil 1 obviates the use of a reflux pump. Furthermore, the process provides for the setting of the fractionator at a sufficient elevation above the secondary reaction chamber 15 that the recycle stock flows by gravity into the chamber 15, thus eliminating the use of a hot oil pump. Obviously, the evaporator 4 may also be set at an elevation high enough to effect the transfer of the evaporator bottoms to the chamber 15 by gravity. However, a pump may be used in this instance, if desired.

Although I have described the process making use of the gas produced in the system as the heat carrier for the vapors to be cracked I do not limit myself to this. Any gas produced either in a previous processing or even a processing extraneous to the plant may be utilized. However, I consider it most rational to conduct the process as described.

In the case that more relatively cool oil is required to operate the fractionating tower in the desired manner than is ultimately passed through the cracking system, the excess is withdrawn through line 17 by manipulation of valve 18. This excess and condensate from exchanger 2 may be conducted to the crude oil inlet conduit or to the same or a separate tank from the crude oil tank (not shown).

From the foregoing description it will be apparent that I have accomplished certain advantageous results, as follows:

1. Reflux and recycle pumps have been eliminated, and a jet pump having no moving parts has been provided, which brings about the transfer of the required heat to the vapors to be cracked and at the same time causes a lowering in temperature to effect vaporization. This results in a great saving and substantial freedom from mechanical troubles.

2. The gasoline already in the oil being cracked undergoes a molecular rearrangement to give a product of higher octane number.

3. A substantial portion of the uncondensable gas is transformed into gasoline, thus increasing the yield of this desired product.

While I have described the process in relation to a particular apparatus I wish it understood that the process claims include all variations, and that I have used it merely for illustrative purposes.

I claim:

1. A process for converting hydrocarbons of higher boiling range to substantially lower boiling range hydrocarbons and for simultaneously forming gasoline fractions in the production of anti-knock gasoline, which comprises the steps of partially vaporizing a cracking stock, intimately mixing highly heated lean gases formed in the conversion process with the resulting vaporized high boiling range hydrocarbons containing hydrocarbons of a boiling range substantially that of gasoline obtained from said cracking stock and introducing said intimately mixed gases and vapors at a cracking temperature into a reaction chamber in the presence of evaporator bottoms resulting from said vaporization step and recycle stock obtained as later specified herein under temperatures and pressures suitable for cracking, and subsequently passing the gaseous products therefrom into a fractionating tower from which gasoline of high anti-knock value and recycle stock is removed.

2. Apparatus for the conversion of higher boiling range hydrocarbons to substantially lower boiling range hydrocarbons which comprises a still, a duality of bubble towers, a reaction chamber, a jet pump, means for supplying heated gases to said pump to operate the same, means to heat oil to be converted in said still and to discharge said heated oil to one bubble tower, said jet pump being open to said last mentioned bubble tower in such manner as to withdraw vapors from the same and to bring about the intimate mixing of said gases at high temperature and pressure with the resultant vapors, means for introducing said mixture into said reaction chamber, means for introducing recycle stock from the other bubble tower to said reaction chamber, means for conducting vapors from said reaction chamber to said last mentioned bubble tower,

and means for conducting the recycle stock from said second bubble tower to said reaction chamber and means for conducting the bottoms from the first bubble tower into said reaction chamber by gravity to the same.

3. A process for converting hydrocarbons of higher boiling range to substantially lower boiling range hydrocarbons and for simultaneously forming gasoline fractions in the production of anti-knock gasoline, which comprises the steps of partially vaporizing a cracking stock, intimately mixing highly heated lean gases formed in the conversion process with the resulting vaporized high boiling range hydrocarbons containing hydrocarbons of a boiling range substantially that of gasoline obtained from said cracking stock, introducing said intimately mixed gases and vapors at a cracking temperature into a reaction chamber under temperatures and pressures suitable for cracking, conducting the mixture into a second reaction chamber in the presence of evaporator bottoms resulting from said vaporization step and recycle stock obtained as later specified herein under temperatures and pressures suitable for cracking and subsequently passing the gaseous products therefrom into a fractionating tower from which gasoline of high anti-knock value and recycle stock is removed.

4. Apparatus for the conversion of higher boiling range hydrocarbons to substantially lower boiling range hydrocarbons which comprises a still, a duality of bubble towers, a duality of reaction chambers, a jet pump having an intake side, a suction side and a discharge side, means for supplying heated gases under pressure to the intake side of said pump, means to heat oil to be converted in said still and to discharge said heated oil to one bubble tower, said jet pump having its suction side connected to said last mentioned bubble tower in such manner as to withdraw vapors from the same and to bring about the intimate mixing of said gases at high temperature and pressure with the vapors on the discharge side of said pump, means for introducing said mixture thus formed into one of said reaction chambers and then into the other chamber together with recycle stock from the other bubble tower, means for conducting vapors from said last mentioned reaction chamber to said last mentioned second bubble tower, and means for conducting the recycle stock from said last mentioned bubble tower to said last mentioned reaction chamber and the bottoms from the last mentioned bubble tower by gravity to said last mentioned reaction chamber.

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