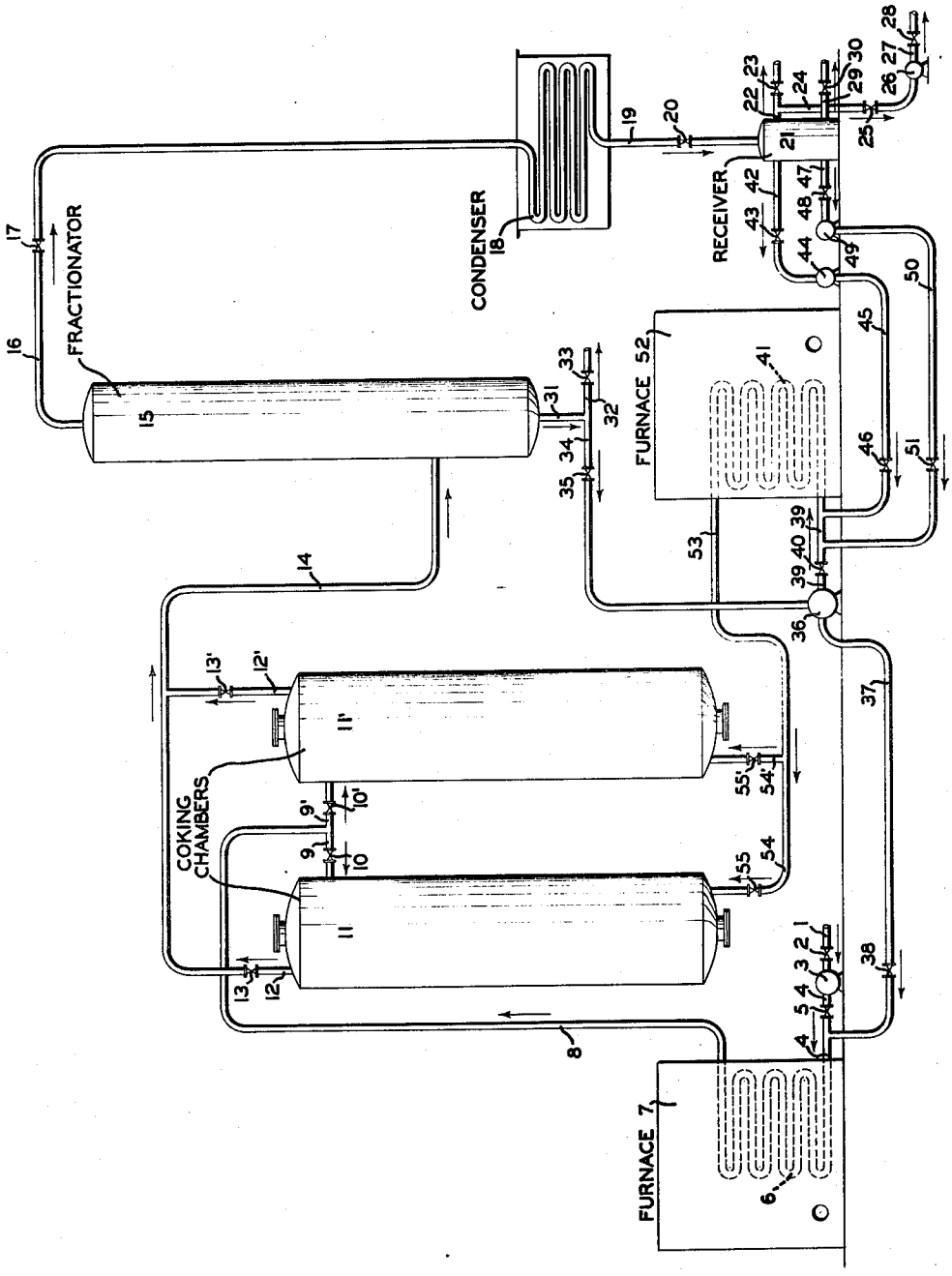
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TREATMENT OF HYDROCARBON OILS

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TREATMENT OF HYDROCARBON OILS

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1 Claim. (Cl. 196—56)

This invention relates to the treatment of hydrocarbon oils and more particularly refers to the conversion of relatively heavy oils with simultaneous reduction of the residual conversion products to substantially devolatilized coke.

The present invention offers an improved method and means of attaining continuous extensive conversion of relatively heavy hydrocarbon oils and simultaneous low pressure continuous coking of the residual products of conversion in the single system. Provision is made for conversion of the charging stock and, when desired, conversion of intermediate and/or end products of the primary conversion at substantial superatmospheric pressure thus insuring the production of maximum yields of light products of the desired quality. At the same time the invention provides for continuous coking of the residual conversion products at low pressure or under partial vacuum which insures the recovery of maximum yields of lighter products and substantial devolatilization of the carbonaceous residue.

In accordance with the invention, only the heat required for the desired degree of conversion of the raw oil charging stock need be supplied thereto during its passage through the heating element, all or a substantial portion of the heat required to complete coking of the residual products and devolatilization of the coke being supplied to a heat carrying medium which may comprise any desired intermediate product or light end product of the system or combinations thereof. In this manner deposition of coke or carbonaceous material in the heating element is avoided while the additional heat required is imparted to products of the system which it is desired to further convert or reform.

One specific embodiment of the invention may comprise subjecting a hydrocarbon oil to conversion at substantial super-atmospheric pressure in a heating element, introducing the heated material into a coking chamber operated at substantially atmospheric or subatmospheric pressure, subjecting vapors from the coking chamber to fractionation, subjecting reflux condensate from the fractionator to more severe conversion conditions at substantial superatmospheric pressure in a separate heating element and introducing the heated materials into direct contact with the residual conversion products in the coking chamber to assist their reduction to coke and effect its substantial devolatilization, subjecting vaporous products from the fractionator to condensation and collecting the resulting distillate and uncondensable gas.

As a modification of the above specific embodiment, distillate or uncondensable gas or both may be supplied to said separate heating element where they may be subjected to conversion or reforming, serving as a portion or all of the heat carrying medium supplied, as described, to the coking chamber. In case distillate and/or uncondensable gas is utilized, as described, reflux condensate from the fractionator may be withdrawn from the system, may be supplied together with the distillate and/or gas to the separate heating element for further conversion, or it may be returned to the heating element to which the raw oil charging stock is supplied.

One specific form of apparatus in which the process of the present invention may be practiced, is illustrated in the attached diagrammatic drawing and a description of the drawing embracing a description of the process of the invention, as it may be practiced in the apparatus illustrated, follows.

Raw oil charging stock may be supplied through line 1 and valve 2 to pump 3 from which it is fed through line 4 and valve 5 to heating element 6 which is disposed within a furnace 7 of any suitable form wherein the oil is heated to the desired conversion temperature preferably at substantial superatmospheric pressure. The heated oil is discharged from heating element 6 through line 8 and may pass through line 9 and valve 10 into coking chamber 11 or through line 9' and valve 10' into coking chamber 11'.

Chambers 11 and 11' are similar coking zones preferably operated at substantially atmospheric or sub-atmospheric pressure wherein coking of the residual conversion products and substantial devolatilization of the coke is accomplished. It will be understood that only one coking chamber or any number of a plurality of such zones may be employed, a plurality of such zones operated alternately being preferred although simultaneous operation may be employed, if desired.

Vapors from chamber 11 are withdrawn through line 12 and valve 13 while vapors from chamber 11' are withdrawn through line 12' and valve 13'. Said vapors thence pass through line 14 to fractionator 15 wherein their relatively light and relatively heavy components are separated, the latter condensing as reflux condensate and collecting in the lower portion of the fractionator while the former are withdrawn through line 16 and valve 17, are subjected to condensa-

tion and cooling in condenser 18, distillate and gas from which pass through line 19 and valve 20 to be collected in receiver 21. Uncondensable gas may be released from the receiver through line 22 and valve 23 or, in case sub-atmospheric pressure is employed in the coking range, the gas from receiver 21 may pass through line 24 and valve 25 to vacuum pump 26 from which it is discharged through line 27 and valve 28. Distillate may be removed from the receiver through line 29 and valve 30.

Reflux condensate accumulating in the lower portion of fractionator 15 is withdrawn through line 31 and may be discharged, all or in part, from the system through line 32 and valve 33, a suitable pump, not illustrated, being employed in case sub-atmospheric pressure is employed in the fractionator. When desired, instead of being withdrawn from the system, a portion or all of the reflux condensate may be directed through line 34 and valve 35 to pump 36 from which it may be directed, all or in part, either through line 37, valve 38 and line 4 to heating element 6 for further conversion together with the raw oil charging stock, or through line 39 and valve 40 to heating element 41 for separate treatment.

In a similar manner a portion of uncondensable gas from the receiver of the system may be directed through line 42, valve 43, pump or compressor 44, line 45, valve 46 and line 39 to heating element 41. A portion or all of the distillate may likewise be withdrawn from receiver 21 through line 47 and valve 48 to pump 49 to be fed therefrom through line 50, valve 51 and line 39 to heating element 41.

It will be understood that, depending primarily upon the nature of the charging stock, the operating conditions employed and the desired results, any one, any combination or all of the materials mentioned may be supplied to heating element 41 in the manner described. When the reflux condensate formed is of relatively light nature and the process is operated for the production of maximum yields of light distillate such as, for example, motor fuel of high anti-knock value, said reflux condensate from the fractionator of the system is preferably supplied to heating element 41 where it is subjected to more severe conversion conditions than those to which the raw oil charging stock is subjected in heating element 6. When substantial yields of intermediate liquid products such as good quality fuel oil or cracking stock are desired, conversion and coking conditions may be so controlled as to permit the removal of the product of the desired nature as reflux condensate from the fractionator. When it is desired to reform the distillate produced, regulated portions thereof may be withdrawn from the receiver and subjected to reforming conditions in heating element 41. Distillate may also, when desired, be blended with the reflux condensate supplied to heating element 41 for the purpose of diluting this material, in which case the conversion conditions employed in heating element 41 are not necessarily sufficiently severe to involve any substantial conversion or reforming of the distillate. Uncondensable gas from the receiver of the system, alone or together with distillate, may also be supplied to heating element 41 together with reflux condensate, in which case some recombination of light gaseous hydrocarbons and heavier liquids may take place under the conditions employed in heating element 41. In case the process is operated for the production of high yields of gas a portion or all of the distillate produced and, when desired, a portion of gas may be recycled to heating element 41 for further conversion in which case reflux condensate, if not withdrawn from the system, is preferably returned to heating element 6 but may, when desired, be supplied all or in part, to heating element 41.

Heating element 41 is located in a furnace 52 of any suitable form capable of heating the material supplied thereto to the desired conversion conditions which may range, for example, from conversion and reforming conditions of the order of 900 to 1050° F., and substantial super-atmospheric pressure to gas-making conditions employing temperatures as high as 1800° F. or more, and preferably atmospheric or relatively low super-atmospheric pressure or even, when desired, partial vacuum. The heated materials from heating element 41 are discharged through line 53, entering coking chamber 11 through line 54 and valve 55 or entering coking chamber 11' through line 54' and valve 55'. Temperatures of the order of 800 to 950° F. and substantial super-atmospheric pressures of the order of 100 to 500 pounds per square inch, or more, are preferably employed in the heating element to which the raw oil charging stock is supplied. Temperatures of the order of 900 to 1050° F. and substantial superatmospheric pressures of the order of 100 to 800 pounds or more per square inch are preferably employed in the secondary heating element of the system when the substantial recovery of light liquid products is desired. For gas-making purposes, higher temperatures of the order of 1000 to 1800° F. and sub-atmospheric to relatively low super-atmospheric pressures are preferably employed in the secondary heating element. The coking zone is preferably operated at a pressure ranging from sub-atmospheric to relatively low super-atmospheric pressure not exceeding, for example, 50 pounds or thereabouts per square inch.

As a specific example of the operation of the process of the present invention utilizing as charging stock a 25° A. P. I. gravity Mid-Continent fuel oil, this material is subjected in the primary heating element to a temperature of approximately 900° F. under a super-atmospheric pressure of approximately 250 pounds per square inch. Reflux condensate from the fractionator of the system is subjected, in the secondary heating element, to a temperature of approximately 950° F., under a super-atmospheric pressure of approximately 500 pounds per square inch. The coking chambers are operated under a slight sub-atmospheric pressure. This operation may yield, per barrel of charging stock, about 65% of material of motor fuel boiling range having an anti-knock value equivalent to an octane number of approximately 72. The additional products of the system may be, per barrel of charging stock, approximately 88 pounds of coke having a volatile content of less than 10% and about 700 cubic feet of uncondensable gas.

By recirculating a portion of the distillate product to the secondary heating element, in an operation such as above described, its anti-knock value may be increased to an octane number of 80 or better, in which case the quantity and volatility of the coke will not be materially affected but the gas production will be somewhat increased at the expense of the yield of distillate.

As an example of another type of operation, utilizing as charging stock a poor quality of residual oil of about 12° A. P. I. gravity, the charging

stock is subjected, in the primary heating element, to a temperature of about 800° F. under a super-atmospheric pressure of approximately 150 pounds per square inch. Slight sub-atmospheric pressure is employed in the coking chambers and substantially all of the distillate produced is subjected, together with a portion of the gas to a temperature of approximately 1600° F. at substantially atmospheric pressure in the secondary heating element. Reflux condensate is withdrawn from the system. This operation may yield approximately 120 pounds of coke having a volatile content of less than 4%, about 2700 cubic feet of gas having a calorific value of approximately 1000 B. t. u. per cubic foot and in addition about 30%, based on the charging stock, of reflux condensate suitable as premium motor fuel or for use as cracking stock, may be produced.

The foregoing examples illustrate only a few of the many types of operation to which the process of the present invention is applicable and are not intended to limit the invention with respect to either operating conditions or results.

We claim as our invention:

A cracking and coking process which comprises heating hydrocarbon oil to cracking temperature under super-atmospheric pressure while flowing in a restricted stream through a heating zone, subsequently reducing the pressure on such heated oil and introducing the same to an enlarged coking zone, separating vapors from unvaporized oil and distilling the latter to coke in the coking zone, fractionating the vapors to condense fractions thereof heavier than gasoline, separately condensing gasoline vapors uncondensed by said fractionation, combining a substantial portion of the separately condensed gasoline with reflux condensate formed by the fractionation and heating the resultant mixture in a second heating zone to higher conversion temperature than the oil in the first-mentioned heating zone, and subsequently introducing the thus heated mixture into the coking zone to assist the reduction of the unvaporized oil to coke therein.

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