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TREATMENT OF HYDROCARBON OILS

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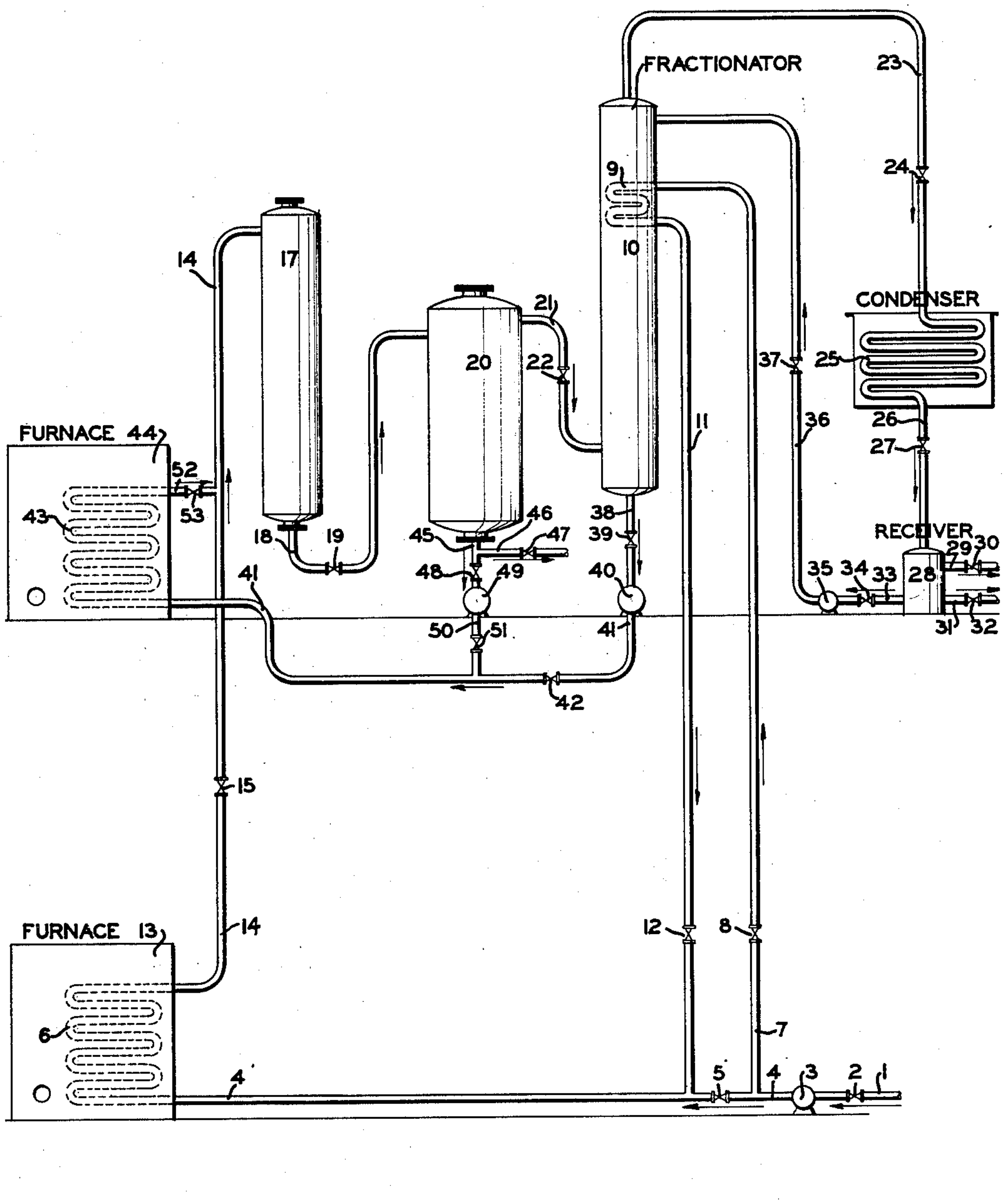

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TREATMENT OF HYDROCARBON OILS

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1 Claim. (Cl. 196—59)

This invention relates to the treatment of hydrocarbon oils and particularly refers to an improved process and apparatus for the production of valuable products such as motor fuel, from relatively heavy oils or oils of inferior quality.

With the advent of high compression internal combustion engines and the popular demand for motor fuel of high anti-knock characteristics, it has become expedient for many refiners to reform or convert their straight-run gasoline or other motor fuel of low anti-knock value, as well as distillates containing or consisting of fractions boiling within the range of motor fuel, for the production of motor fuel of high anti-knock value. I have found that in these and similar operations utilizing relatively light charging stocks such as, for example, naphthas, kerosene distillates, a mixture of these and other light distillates, it is often advantageous to employ conversion conditions which result in a high rate of conversion during the initial passage of the oil through the heating element and in some cases, in a low reflux ratio, i. e. relatively low production of insufficiently converted intermediate products. The ratio of raw oil to reflux condensate may, for example, be of the order of one to one or even less and in some cases e. g. with low boiling primary charging stocks, the reflux condensate produced may comprise substantially only relatively heavy polymerization products. Obviously a reflux condensate of this nature is not converted to best advantage under the same conditions as those employed in the conversion of the charging stock, and it is among the objects of the present invention to provide a method and means of subjecting this intermediate product to further conversion, in the same system in which it is produced, under independently controlled heating conditions. The improved process of the present invention also provides for further conversion of a portion of the residual liquid product of the system, when so desired, said residual product preferably being commingled with said reflux condensate and subjected therewith to the same heating conditions.

In the process of the present invention, the residual or non-vaporized oil so treated contains the minimum of suspended coke forming products.

It will be understood that while the principles of the present invention are especially applicable to the treatment of relatively light charging stocks, such as motor fuel of inferior quality and relatively light distillates comprising or containing a large proportion of fractions falling within the range of motor fuel, the invention is not limited to this type nor to any other specific type of charging stock. It is, however, generally best suited to the conversion of a charging stock, the optimum conversion conditions for which are more severe than those best suited to the conversion of the reflux condensate produced or the commingled reflux condensate and residual oil.

One specific embodiment of the invention may comprise subjecting a hydrocarbon oil to conversion conditions in a heating element, introducing the heated material into an enlarged reaction zone, withdrawing both liquid and vaporous products from said enlarged reaction zone to a zone of reduced pressure wherein further vaporization of said non-vaporous products and separation of the vaporous and non-vaporous products is effected, introducing the vapors into a fractionating zone wherein their relatively light desirable components are separated from their relatively heavy insufficiently converted components, subjecting said desirable components of the vapors to condensation, cooling and collecting the products, withdrawing the non-vaporous residual liquid from said zone of reduced pressure or vaporizing zone, withdrawing a portion of it from the system, commingling the remaining portion with said insufficiently converted components of the vapors withdrawn as reflux condensate from the fractionator, subjecting the commingled oils to independently controlled conversion conditions in a separate heating element and introducing the heated materials into said enlarged reaction zone together with heated charging stock from said first mentioned heating element.

The attached diagrammatic drawing illustrates one form of apparatus embodying the principles of the present invention, and in which operation of the process may be accomplished. Raw oil charging stock may be supplied through line 1 and valve 2 to pump 3 from which it may be fed through line 4 and valve 5 into heating element 6. A portion or all of the charging stock may, if desired, be preheated by any well known means prior to its introduction into heating element 6. One method of accomplishing this is illustrated in the drawing and comprises diverting a portion or all of the oil from line 4 through line 7 and valve 8 into preheating coil 9, which is located within fractionator 10 and wherein the charging stock is preheated by indirect contact with the relatively hot vapors in the fractionator. The preheated oil passes from coil 9 through line 11 and valve 12 back into line 4 and thence to heating element 6.

Heating element 6 is located in any suitable form of furnace 13 and the oil fed therethrough is heated to the desired conversion temperature under any desired pressure conditions and preferably under a substantial super-atmospheric pressure. The heated oil passes through line 14 and valve 15 into reaction chamber 17, which is also preferably maintained under a substantial superatmospheric pressure which may be substantially the same or somewhat lower than that employed in the heating element. Substantially no liquid products are allowed to accumulate within chamber 17 but are withdrawn therefrom, together with vaporous products, through line 18 and valve 19 into vaporizing chamber 20. Chamber 20 is preferably maintained under a substantially reduced pressure relative to that employed in chamber 17 whereby further vaporization of the non-vaporous products from chamber 17 is effected and wherein vaporous materials are separated from the non-vaporous residual conversion products. Vapors from chamber 20 pass through line 21 and valve 22 into fractionator 10 wherein their relatively heavy insufficiently converted components may be condensed and separated from their lighter desirable components. The relatively light desirable components of the vapors pass from fractionator 10 through line 23 and valve 24, are subjected to condensation and cooling in condenser 25, distillate and uncondensable gas from which may pass through line 26 and valve 27 to be collected in receiver 28. Uncondensable gas may be released from the receiver through line 29 and valve 30 while distillate may be withdrawn through line 31 and valve 32. A portion of the distillate may, if desired, be withdrawn from receiver 28 through line 33 and valve 34 to be recirculated by means of pump 35 through line 36 and valve 37 to the upper portion of fractionator 10 to assist fractionation of the vapors and to maintain the desired vapor outlet temperature from this zone.

The relatively heavy insufficiently converted components of the vapors, which intermediate product has been condensed in fractionator 10, is withdrawn therefrom through line 38 and valve 39 to pump 40 from which it is fed through line 41 and valve 42 to a separate heating element 43, which is located in any suitable form of furnace 44, wherein the oil passing through the heating element is subjected to independently controlled conversion conditions preferably of a milder nature than those to which the raw oil charging stock is subjected in heating element 6.

Non-vaporized residual liquid may be withdrawn from chamber 20 through line 45 and may be withdrawn, in part, through line 46 and valve 47 to cooling and storage or to any desired further treatment. The remainder of said residual oil, which may be either the major or the minor portion of this product or may be substantially equal in quantity to that portion withdrawn from the system, passes through valve 48, in line 45, to pump 49 from which it is fed through line 50 and valve 51 into line 41 commingling therein with reflux condensate from fractionator 10 and passing therewith to further conversion in heating element 43.

The commingled oils subjected to independently controlled conversion conditions in heating element 43 are withdrawn therefrom at the desired conversion temperature through line 52 and valve 53, and may pass either directly into chamber 17, by well known means not illustrated in the drawing, or may pass as illustrated, into line 14 to commingle therein with the heated products discharged from heating element 6, in either case being subjected in chamber 17 and in subsequent portions of the system, to the same treatment as that afforded the heated charging stock from heating element 6.

It will be apparent that the process and apparatus described offers an improved method and means whereby a relatively light or low boiling charging stock may be subjected to relatively severe conversion conditions while the relatively heavy commingled intermediate and residual conversion products of the system may be subjected to further conversion in the same system under less severe or milder conversion conditions, thus permitting utilization of the optimum conversion conditions for the two types of oils for the purpose of effecting the maximum production of desirable light products such as motor fuel of high anti-knock value.

Pressures employed within the system may range from substantially atmospheric to superatmospheric pressures as high as 2000 pounds per square inch or more. Conversion temperatures employed may range from 800 to 1200° F., more or less. The primary heating element, wherein the raw oil charging stock is heated, preferably employs conversion temperatures of the order of 900 to 1050° F., and super-atmospheric pressures of the order of 100 to 500 pounds per square inch. The secondary heating element, wherein reflux condensate and residual oil from the system are subjected to further conversion, preferably employs temperatures of the order of 800 to 900° F., more or less and super-atmospheric pressures ranging from 100 to 500 pounds per square inch or thereabouts. Pressures ranging from 100 to 500 pounds per square inch are preferably employed in the reaction chamber while the vaporizing chamber and the succeeding fractionating, condensing and collecting portions of the system preferably employ reduced pressure of the order of substantially atmospheric to 100 pounds per square inch.

As a specific example of the operation of the process of the present invention, a 48–50° A. P. I. gravity Pennsylvania naphtha is the charging stock for the process and is subjected, in the primary heating element, to a temperature of about 950° F. under a superatmospheric pressure of approximately 500 pounds per square inch. The reflux condensate from the fractionator of the system and the major portion of the residual oil from the vaporizing chamber are commingled and subjected in the secondary heating element to a temperature of about 875° F. under a superatmospheric pressure of approximately 350 pounds per square inch. A super-atmospheric pressure of about 350 pounds per square inch is maintained in the reaction chamber and the pressure in the vaporizing, fractionating, condensing and collecting equipment is reduced to approximately 100 pounds per square inch. This operation may yield approximately 80% of motor fuel having an anti-knock value equivalent to an octane number of about 75. The additional products of the system are about 6 to 8% of heavy residual oil, about 10% of rich uncondensable gas, and a small amount of coke or carbonaceous material. Similar results may be obtained with kerosene distillate, light gas oils and the like, although in general the yields of motor fuel are somewhat less than in the example cited above.

I claim as my invention:

A process of hydrocarbon oil conversion which comprises, forcing a stream of a relatively light charging stock not heavier than kerosene distillate through a heating zone where it is raised to cracking temperature, discharging said heated stream into an enlarged reaction zone, maintaining said heating zone and said enlarged reaction zone under super-atmospheric pressure, removing all of the products of reaction from said reaction zone, discharging same into a zone of reduced pressure where vapors separate from non-vaporous residue, subjecting the vapors to fractionation to condense the heavier fractions thereof as reflux condensate, removing the vapors remaining uncondensed after fractionation and condensing and collecting same as a distillate product of the process, combining regulated portions of reflux condensate with regulated portions of the residue and forcing a stream of said mixture through a second heating zone maintained under relatively milder conditions of temperature than said first mentioned heating zone, discharging the heated mixture from said second heating zone into the enlarged reaction zone where it commingles with the heated charging stock.

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