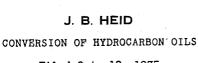
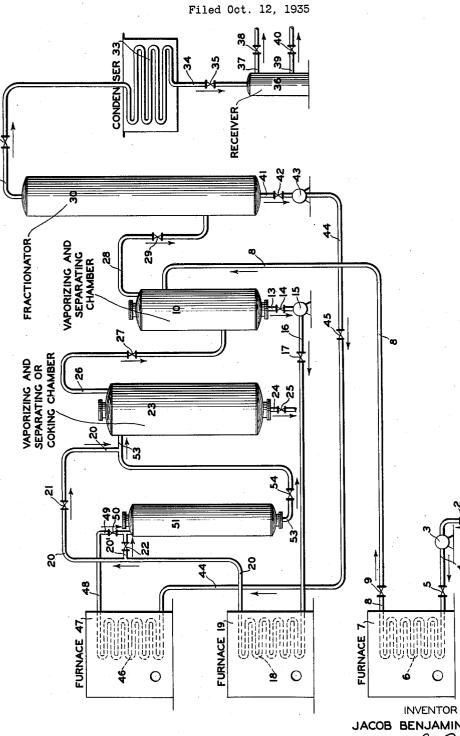
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CONVERSION OF HYDROCARBON OILS

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3 Claims. (Cl. 196-48)

This invention particularly refers to an improved process for the selective conversion of hydrocarbon oil charging stock for the process, residual liquid resulting from said conversion,

- and intermediate liquid products of both crack-5 ing operations, for the production of major yields of desirable light distillate, such as motor fuel of good antiknock value, and minor yields of good quality residual liquid or coke and gas.
- In one specific embodiment, the present in-vention comprises subjecting hydrocarbon oil 10 charging stock for the process to conversion conditions of cracking temperature and superatmospheric pressure in a heating coil, introducing
- 15 the resulting heated products into a reduced pressure vaporizing chamber wherein separation of vaporous and liquid conversion products is accomplished, withdrawing liquid conversion products from said vaporizing chamber, subjecting the
- 20 same to independently controlled conversion conditions of cracking temperature and superatmospheric pressure in a separate heating coil, introducing the heated products from said separate heating coil into another vaporizing and separat-
- ing or coking chamber, wherein the final residual liquid conversion product of the process is separated from vaporous conversion products, and either withdrawn from the system or reduced therein to coke, supplying the vaporous conver-
- 30 sion products from said separate vaporizing and separating chamber to the first mentioned vaporizing and separating chamber, wherein high boiling components of the vapors are condensed, collected with the liquid conversion products from
- 35 the first mentioned cracking step, and supplied therewith to said separate heating coil, withdrawing vaporous conversion products remaining uncondensed from the first mentioned vaporizing and separating chamber, subjecting the same to
- 40 fractionation for the formation of reflux condensate, subjecting fractionated vapors of the desired end boiling point to condensation, collecting and separating the resulting distillate and gas, subjecting said reflux condensate to inde-
- pendently controlled conversion conditions of cracking temperature and superatmospheric pressure in another separate heating coil and communicating enlarged reaction chamber, withdrawing both vaporous and liquid conversion
- 50 products from said reaction chamber, and introducing the same into said separate vaporizing and separating chamber.

As an alternative to the method of operation above outlined, which however is not to be con-

55 sidered equivalent, the heated products from the

last mentioned heating coil, instead of being subjected to continued conversion in a high pressure reaction chamber, may be supplied, all or in part, direct to said separate vaporizing and separating chamber. On the other hand, the heated products from both the second mentioned and last mentioned heating coils may, when desired, be supplied to the reaction chamber for further conversion,

It is also within the scope of the invention, par- 10 ticularly in case the charging stock comprises an oil of relatively high boiling characteristics or contains a relatively large proportion of high boiling materials, to eliminate the first-mentioned heating coil and to supply the charging stock di- 15 rectly to the first mentioned vaporizing chamber, wherein it is subjected to substantial vaporization by contact with the hot vaporous products from said separate vaporizing and separating chamber. 20

The accompanying diagrammatic drawing illustrates one specific form of apparatus for carrying out the invention.

Referring to the drawing, hydrocarbon oil charging stock for the process is supplied through 25 line I and valve 2 to pump 3, by means of which it is fed through line 4 and may be directed through value 5 in this line to heating coil 6. Heating coil 6 is located within a furnace 7 of any suitable form, by means of which the required 30 heat is supplied to the oil passing through the heating coil to subject the same to the desired conversion conditions of cracking temperature and superatmospheric pressure in this zone. The heated products are discharged from heating coil 35 6 through line 8 and valve 9 into vaporizing and separating chamber 10. It will be understood, of course, that the charging stock may, when desired, be preheated in any well known manner not illustrated in the drawing to any desired 40 temperature below that at which substantial conversion thereof will occur prior to its introduction into heating coil 6.

Chamber 10 may be operated at any desirable pressure ranging from 100 pounds or thereabouts 45 per square inch superatmospheric down to substantially atmospheric pressure and is preferably operated at a substantially reduced pressure relative to that employed in the outlet from the heating coil. Separation of the vaporous and liquid 50 conversion products from this zone is accomplished in chamber 10 by means of their contained heat assisted by their reduction in pressure. The relatively high boiling liquids remaining unvaporized in chamber 10 are withdrawn 55 from the lower portion of this zone through line \$2 and valve 14 to pump 15, by means of which they are supplied through line 16 and valve 17 to conversion in heating coil 18 under independently controlled conversion conditions of cracking temperature and superatmospheric pressure. Heat for conversion of the relatively high boiling oil, passing through heating coil 18, is supplied thereto from a furnace 19 of any suitable form, and heated products from this zone are directed

10 heated products from this zone are directed through line 20, and valve 21 into another vaporizing and separating chamber 23.

Chamber 23 is preferably operated at a substantially reduced pressure relative to that employed at the outlet from heating coil 18, which

- ployed at the outlet from heating coil 18, which however is somewhat higher than the pressure employed in chamber 10. Separation of vaporous and residual liquid conversion products is accomplished in chamber 23. The latter may be withdrawn from the lower portion of this zone and directed through line 24 and valve 25 to cooling and storage, or elsewhere as desired,
- or when desired they may be reduced in chamber 23 to substantially dry coke. In the latter case, 25 the coke may be allowed to accumulate within chamber 23, to be removed therefrom in any
- well known manner not illustrated after this zone has been substantially filled with coke or after its operation has been completed for any 30 other reason, and after it has been isolated from
- the rest of the process. It will be understood that a plurality of coking chambers may be employed, when desired, although not illustrated, in which case they preferably are alternately oper-
- ated, cleaned and prepared for further operation.
 In case coking is employed in chamber 23, line
 24 may serve as a drain line and may also serve, when desired, as a means of introducing steam, water or other suitable cooling material into the
 40 chamber in order to hasten cooling and facilitate

removal of coke.

The vaporous conversion products supplied to chamber 23, as well as any vapors evolved in this zone, are withdrawn from the upper portion thereaf and directed through line 26 and related

- 45 thereof and directed through line 26 and valve
 27 into chamber 10, wherein they commingle with the charging stock or with the conversion products from heating coil 6, and wherein any heavy components of the vaporous products un50 suitable for conversion, together with reflux con-
- densate, may be separated therefrom and supplied, together with other heavy liquids from this zone, to conversion in heating coil **18**, as previously described.
- The total vaporous conversion products of the process remaining uncondensed in chamber 19 are withdrawn from the upper portion thereof and directed through line 28 and valve 29 to fractionation in fractionator 30. The compo-
- 60 nents of vapors supplied to fractionator 39 beiling above the range of the desired final light distillate product of the process are condensed in this zone as reflux condensate. Fractionated vapors of the desired end boiling point are with-
- 65 drawn, together with uncondensable gas produced in the operation, from the upper portion of fractionator 30 and are directed through line \$1 and valve 32 to condensation and cooling in condenser 33. The resulting distillate and gas
- 70 passes through line 34 and valve 35 to collection and separation in receiver 35. Uncondensable gas may be released from the receiver through line 37 and valve 38. Distillate may be withdrawn from receiver 36 through line 39 and valve 48 to atomic on the original for the second sec

75 49 to storage or to any desired further treatment.

When desired, a regulated portion of the distillate collected in receiver 36 may be recirculated by well known means (not illustrated) to the upper portion of fractionator 39 to serve as a cooling and refluxing medium in this zone for 5 assisting fractionation of the vapors and to maintain the desired vapor outlet temperature.

The reflux condensate formed in fractionator 30 may be withdrawn from the lower pertion of this zone through line 41 and valve 42 to pump 10 43, by means of which it is fed through line 44 and valve 45 to heating coll 48.

Heating coil 46 is located in a furnace 47 of any suitable form, by means of which heat is supplied to the oil passing through the heating 15 coil to subject the same to independently controlled conversion conditions of cracking temperature and superatmospheric pressure. The heated products are discharged from heating coil 46 through line 48 and are directed through valve 20 49 in this line into reaction chamber 5!.

It is also within the scope of the present invention, when desired, to introduce all or a regulated portion of the heated products from heating coil 18 into reaction chamber 51 by means of line 25 20', valve 22 and line 49.

Reaction chamber 51 is preferably maintained at a substantial superatmospheric pressure which may be substantially the same or somewhat lower than the pressure employed at the outlet from 30 heating coil 46, or from heating coil 18 in case products from the latter zone are supplied to the reaction chamber and heating coil 18 is operated at a lower pressure than that employed in heating coil 46. The conversion products supplied 35 to the reaction chamber, and particularly their vaporous components, are subjected to appreciable further conversion in this zone, and preferably although not illustrated is insulated in order to conserve heat. In the case here illus- 40 trated both vaporous and conversion products are withdrawn in commingled state from the lower portion of chamber 51 and are directed through line 53, valve 54, into chamber 23.

The preferred range of operating conditions 45 which may be employed in accordance with the process of the present invention utilizing an apparatus such as illustrated and above described may be approximately as follows: The heating coil wherein the charging stock is subjected to 50 conversion may employ an outlet conversion temperature ranging for example from 800° to 950° F., preferably with a superatmospheric pressure at this point in the system of from 100 to 500 pounds or more per square inch. The succeed- 55 ing vaporizing chamber, as previously mentioned, is preferably operated at a substantially reduced pressure, which may range for example from 100 pounds per square inch superatmospheric pressure down to substantially atmospheric pres- 60 sure, and the pressure employed in this zone may be substantially equalized or reduced in succeeding fractionating, condensing and collecting portions of the system. The heating coil to which the residual liquid from said vaporizing chamber 65 is supplied may utilize an outlet conversion temperature ranging for example from 300° to 1000° F. or thereabouts, preferably with a superatmospheric pressure at the outlet from this zone ranging from 30 pounds or thereabouts per square 70 inch to 300 pounds or more per square inch. The heating coil to which the reflux condensate is supplied for conversion may utilize an outlet temperature ranging for example from 900° to 1000° F., preferably with a superatmospheric 75

5

pressure at this point in the system of from 200 to 800 pounds or more per square inch. The reaction chamber, as previously mentioned, may be operated at a atmospheric pressure substantially the same or somewhat lower than that employed in the preceding heating coil utilizing the lowest pressure. The vaporizing or coking chamber to

- which products from the reaction chamber are supplied, in case the reaction chamber is utilized,
 is operated at a superatmospheric pressure of from 30 to 100 pounds, or thereabouts, per square inch, which however is somewhat higher than the pressure employed in the first mentioned
- vaporizing chamber, and is preferably somewhat
 15 lower than the pressure employed in the reaction chamber or in the preceding heating coils.
 As a specific example of the operation of the

As a specific example of the operation of the process of the present invention as it may be accomplished in an apparatus such as illustrated
20 and above described, the charging stock, which comprises a 30° A. P. I. gravity Mid-Continent

- comprises a 30° A. P. I. gravity Mid-Continent topped crude, is subjected in the first heating coil to an outlet conversion temperature of approximately 930° F. at a superatmospheric pres-
- 25 sure of about 300 pounds per square inch, and the succeeding vaporizing chamber to which the products from this heating coil are supplied is operated at a superatmospheric pressure of approximately 50 pounds per square inch. The
- 30 liquid products from this vaporizing chamber are quickly heated in a separate heating coil to an outlet conversion temperature of approximately 980° F. at a superatmospheric pressure of about 60 pounds per square inch and are introduced
- 35 into a coking chamber maintained at substantially the same pressure. The reflux condensate is heated in another separate heating coil to an outlet conversion temperature of approximately 950° F. at a atmospheric pressure of about 350
- 40 pounds per square inch, and the heated products from this zone are introduced into a reaction chamber maintained at substantially the same pressure. Both vaporous and liquid products from the reaction chamber are supplied to the
- **45** coking chamber. Vaporous products from the coking chamber are supplied to the same vaporizing chamber to which the heated products from the charging stock heating coil are supplied, and the vaporous products from this zone are sub-
- 50 jected to fractionation for the formation of reflux condensate and recovery of desirable light distillate. This operation will yield, per barrel of charging stock, approximately 65% of motor fuel of good anti-knock value, and approximately
- 55 75 pounds of low volatile coke, the remainder being chargeable principally to uncondensable gas.

I claim as my invention:

- A process for the conversion of hydrocarbon
 oils, which comprises subjecting hydrocarbon oil charging stock for the process to cracking temperature and superatmospheric pressure in a heating coil, introducing the heated products into a reduced pressure vaporizing chamber
 wherein vaporous and liquid conversion products
- are separated, withdrawing the latter from the vaporizing chamber and subjecting the same to independently controlled conditions of cracking temperature and superatmospheric pressure in a
- **70** separate heating coil, introducing heated products from said separate heating coil into a coking chamber wherein the non-vaporous high-boiling conversion products are reduced to coke, withdrawing the vaporous products from the coking

75 chamber and introducing the same into the va-

porizing and separating chamber, subjecting vaporous products from the vaporizing and separating chamber to fractionation for the formation of reflux condensate comprising their insufficiently converted components, subjecting 5 fractionated vapors of the desired end boiling point to condensation, recovering the resulting distillate, subjecting reflux condensate formed by said fractionation to independently controlled conversion conditions of cracking temperature 10 and superatmospheric pressure in another separate heating coil and communicating enlarged reaction chamber, and introducing both vaporous and liquid conversion products from the reaction chamber into the coking chamber, the process 15 being further characterized in that at least a regulated portion of the heated products from the second-mentioned heating coil is passed through said reaction chamber prior to their introduction to the coking chamber.

2. In a process for the conversion of hydrocarbon oils, wherein reflux condensate, comprising insufficiently converted intermediate liquid conversion products of the process, is subjected to conversion conditions of cracking temperature 25 and superatmospheric pressure in a heating coil and communicating reaction chamber, both vaporous and liquid conversion products withdrawn from the reaction chamber and introduced into a coking chamber wherein their high-boiling non- 30 vaporous components are reduced to coke, the improvement which comprises introducing vaporous products from the coking chamber into a vaporizing and separating chamber, simultaneously heating hydrocarbon oil charging stock 35 for the process to cracking temperature under pressure in a separate heating coil and then introducing the same to said vaporizing and separating chamber, wherein it is contacted with the hot vaporous products from the coking chamber, withdrawing unvaporized high-boiling fractions of the charging stock and high-boiling components of the vaporous products, which are condensed in the vaporizing and separating chamber, from the latter zone, subjecting the same to 45 independently controlled conversion conditions of cracking temperature and superatmospheric pressure in another separate heating coil, introducing separate portions of the resulting heated products into the reaction chamber and into the 50 coking chamber, withdrawing vaporous components of the charging stock and components of the vaporous products from the coking chamber remaining uncondensed in the vaporizing chamber from the latter zone, subjecting the 55 same to fractionation for the formation of said reflux condensate, subjecting fractionated vapors of the desired end boiling point to condensation, and recovering the resulting distillate.

3. In a process for the conversion of hydrocar- 60 bon oils, wherein reflux condensate, comprising insufficiently converted intermediate liquid conversion products of the process, is subjected to conversion conditions of cracking temperature and superatmospheric pressure in a heating coil 65 and communicating reaction chamber, both vaporous and liquid conversion products withdrawn from the reaction chamber and introduced into a reduced pressure vaporizing and separating chamber, wherein vaporous and residual liquid 70 conversion products are separated, and the latter recovered, the improvement which comprises introducing vaporous products from the vaporizing and separating chamber into a second vaporizing and separating chamber, simultaneous- 75

ly heating hydrocarbon oil charging stock for the process to cracking temperature under pressure in a separate heating coil and then introducing the same to said second vaporizing and

5 separating chamber, wherein it is contacted with the hot vaporous products from the first-named vaporizing and separating chamber, withdrawing unvaporized high-boiling fractions of the charging stock and high boiling components of the 10 vaporous products, which are condensed in said

o vaporous products, which are condensed in salu second vaporizing and separating chamber from the latter zone, subjecting the same to independently controlled conversion conditions of cracking temperature and superatmospheric pressure in another separate heating coil, introducing separate portions of the resulting heated products into the reaction chamber and into said reduced pressure chamber, withdrawing comfrom said second vapors and cracked vapors from said second vaporizing chamber, subjecting the same to fractionation for the formation of said reflux condensate, subjecting fractionated vapors of the desired end boiling point to con-10 densation, and recovering the resulting distillate.

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