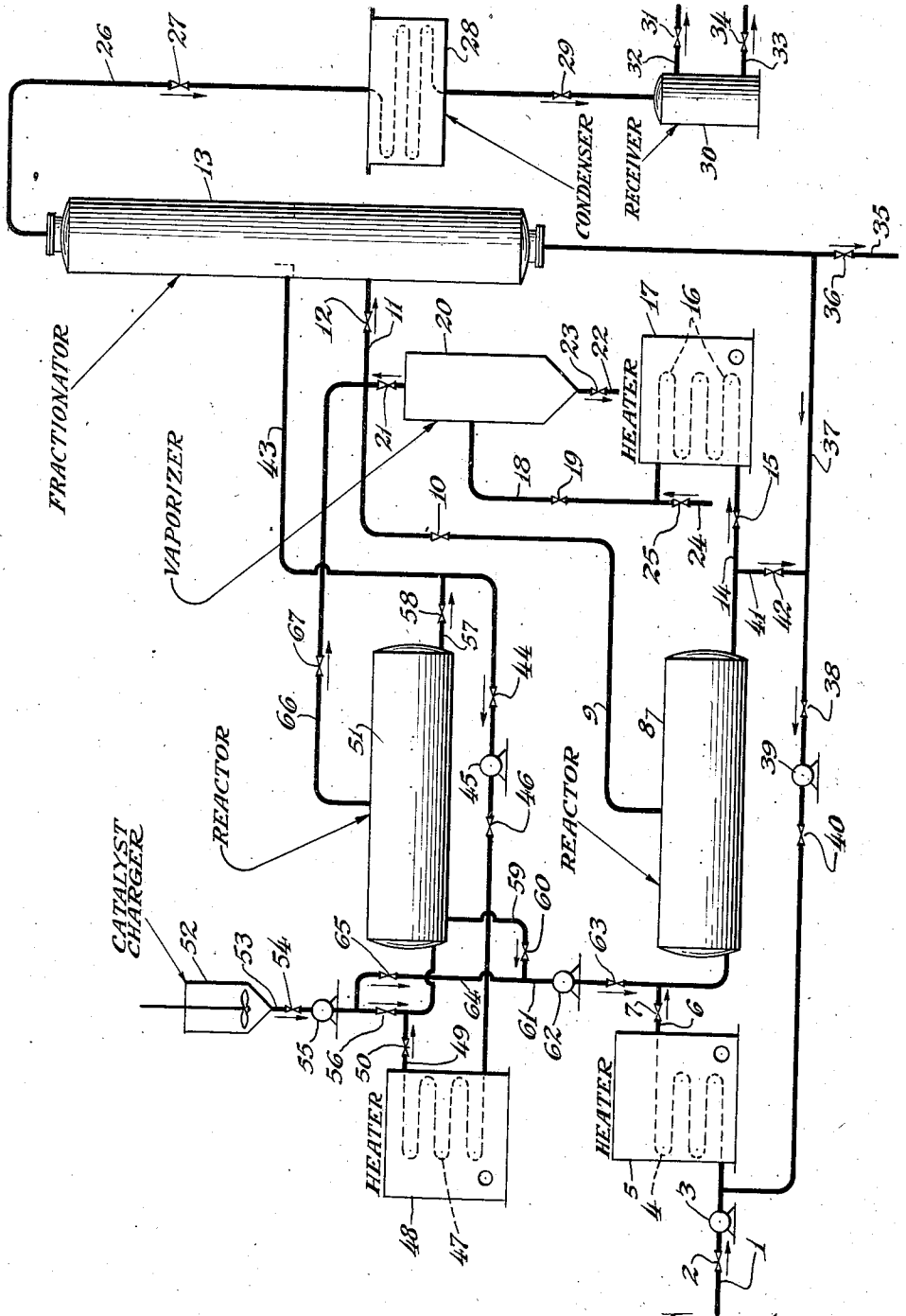
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CONVERSION OF HYDROCARBONS

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CONVERSION OF HYDROCARBONS

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2 Claims. (Cl. 196—52)

This invention relates to a process for converting hydrocarbon oil into substantial yields of high antiknock gasoline. More particularly it relates to the cracking of distillate fractions of hydrocarbon oil boiling substantially above the gasoline range in the presence of a powdered catalytic agent.

In one specific embodiment the present invention comprises a process for cracking hydrocarbon oil which consists in treating said hydrocarbon oil together with recycle oil with partially spent powdered catalyst produced as hereinafter described in a primary cracking step at a temperature within the range of approximately 500–1000° F. and a pressure of approximately 50–1000 pounds per square inch, fractionating the vaporous reaction products, recovering spent catalyst from residual hydrocarbon oil, subjecting a relatively low boiling fraction of insufficiently converted oil to catalytic cracking in a secondary step in the presence of fresh catalyst under conditions of temperature and pressure substantially within the range indicated above, fractionating the vaporous portion of reaction products and supplying a liquid portion of reaction products and partially spent catalyst as previously described for converting said hydrocarbon oil.

The invention is further understood by reference to the accompanying drawing which is diagrammatic and should not be construed as limiting the invention to the exact conditions or apparatus described.

The hydrocarbon oil charging stock which normally comprises a distillate fraction of crude hydrocarbon oil, usually of petroleum origin and boiling substantially above the gasoline range, is introduced through line 1, valve 2, pump 3 to coil 4 which is disposed in heater 5. The oil is heated to a temperature within the range of approximately 500–1000° F. and preferably within a range of approximately 650–850° F. The pressure may vary up to approximately 1000 pounds per square inch. The oil passes through line 6 and valve 7 to catalytic reactor 8 which may be a suitable vertical or horizontal reaction vessel in which adequate time for reaction may be maintained. The temperature conditions are approximately the same as those described for the coil, although the pressure may be somewhat lower. Sufficient pressure is maintained on the system so that a portion of the hydrocarbons is in the liquid phase. The liquid portion of hydrocarbons containers catalyst in suspension, the catalyst being derived from a source described later in the present specification. A vaporous fraction including the gasoline and gas formed is passed through line 9 and valve 10 to line 11 and valve 12 to fractionator 13. A portion of the liquid reaction products from reactor 8 is passed through line 14, valve 15, coil 16 disposed in heater 17, line 18 and valve 19 to vaporizer 20. The vaporous reactants pass through valve 21, line 11 and valve 12 to fractionator 13. Spent catalyst is removed through line 22 and valve 23. If desired, steam may be introduced through line 24 and valve 25 to assist in the vaporization of the oil in vaporizer 20. The catalyst may be removed in suspension in a residue, by proper regulation of the temperature, and if steam is introduced, it may be removed as a substantially oil free powder. The catalyst is reactivated by known methods, particularly by contacting with an oxygen-containing gas at a temperature in excess of 1000° F. The regenerated catalyst may be re-used in the system. Gasoline and gas may be removed through line 26 and valve 27 to condenser 28, thence through valve 29 entering receiver 30. The gaseous reactants may be removed through line 31 and valve 32 to gas absorption equipment not shown. The gasoline may be passed through line 33 and valve 34 to a stabilizer. The stabilizer gases may be subjected to alkylation and/or polymerization steps to increase the yield of motor fuel obtainable. A portion of insufficiently converted oil may be withdrawn from the system by way of line 35 and valve 36. A further portion of this heavy recycle oil may be passed through line 37, valve 38, pump 39 and valve 40 to line 1 and thus be returned to reactor 8 for further conversion. A part of the liquid reactants from reactor 8 may be passed through line 41 and valve 42 to line 37 and thus be recycled.

A light recycle oil may be removed from fractionator 13 through line 43, valve 44, pump 45, valve 46 to coil 47 which is disposed in heater 48. The temperature maintained in the heater is within the range of approximately 600–1000° F. The heated products pass through line 49 and valve 50 to reactor 51. Fresh powdered cracking catalyst is introduced from catalyst charger 52 through line 53, valve 54, pump 55 and valve 56. Catalytic agent which is used in amounts from approximately 0.1–20% by weight of the hydrocarbon oil undergoing conversion may comprise any suitable cracking catalyst, but is preferably of the type known as silica-alumina, silica-zirconia, silica-alumina-zirconia

etc., either alone or in combination with other promoting compounds which may be mixed with or impregnated on the catalyst. The catalysts are prepared by the separate or simultaneous precipitation by the composite under conditions such that a powder approaching colloidal dimensions is produced. The material is washed until substantially free of alkali metal ions and may be dried prior to use. Other powdered agents of small particle size may also be employed and these include naturally occurring clays or acid-treated earths. A further type of composite comprises a relatively inactive carrier having supported thereon minor portions of promoting oxides of elements appearing in the left-hand columns of groups IV, V and VI of the periodic table. It should be stated that the catalytic composites mentioned are not necessarily equivalent in their action.

The temperature and pressure maintained on the system is within the range previously described, sufficient pressure being applied so that a portion of the reactants is in liquid phase in reactor 51. As a rule this necessitates a somewhat higher pressure in this step than in reactor 8. A portion of the reaction products containing catalyst in suspension may be recycled through line 57, valve 58 and line 43. Another portion is withdrawn through line 59 and valve 60 to line 61, pump 62, and valve 63, passing by way of line 6 to reactor 8 wherein further conversion occurs. The catalyst for use in reactor 8 is supplied for the most part in this manner. Small quantities of fresh catalytic material may also be introduced through line 64 and valve 65. Vaporous reaction products including the gasoline formed are passed through line 66, valve 67, line 11 and valve 12 to fractionator 13.

The following example is given to illustrate the usefulness and practicability of the process but should not be construed as limiting it to the exact conditions described therein.

A Pennsylvania gas oil may be converted in the manner described with fresh powdered catalyst being added only to reactor 51. The catalyst which may be a silica-alumina composite of substantially colloidal dimensions, is used in amount of approximately 3% by weight of the gas oil charge. The temperature maintained in reactor 8 may be approximately 850° F. and that in reactor 51, 750° F. with 50 pounds per square inch pressure on both reactors. The amount of gasoline produced is approximately 70% of the gas oil charged and it has an octane number of 77. In addition, relatively small quantities of domestic fuel oil may be produced.

I claim as my invention:

1. A hydrocarbon oil conversion process which comprises heating the charging oil to a catalytic cracking temperature while passing in a restricted stream through a heating zone, introducing the heated oil to an enlarged reaction zone and cracking the same therein while in contact with powdered cracking catalyst, fractionating the resultant vapors and separating a relatively light reflux condensate therefrom, heating the latter to an independently controlled catalytic cracking temperature in a second heating zone and thereafter commingling the same with a powdered cracking catalyst, subjecting the mixture to catalytic cracking conditions in a second enlarged reaction zone and supplying cracked vapors thus formed to the fractionating step, passing admixed unvaporized oil and catalyst from said second reaction zone to the first-mentioned reaction zone directly and without passage through the first-mentioned heating zone, removing admixed residual oil and catalyst from said first-mentioned reaction zone and vaporizing hydrocarbons from the mixture, and supplying vapors thus formed to the aforesaid fractionating step, supplying heavy reflux condensate from the fractionating step to the first-mentioned heating zone, and finally condensing the fractionated vapors.

2. A hydrocarbon oil conversion process which comprises fractionating hydrocarbon vapors, formed as hereinafter set forth, to separate relatively light and heavy reflux condensates therefrom, cracking the lighter reflux condensate in admixture with a powdered cracking catalyst and separating vapors from admixed unvaporized oil and catalyst, independently cracking the heavier reflux condensate in admixture with said unvaporized oil and catalyst, separating the products of the last-named step into vapors and a catalyst-containing residual oil, vaporizing hydrocarbons from the catalyst-containing residual oil, supplying vapors thus formed and the vapors from both said cracking steps to the aforesaid fractionating step, and finally condensing the fractionated vapors.

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