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2,428,666

CATALYTIC CONVERSION OF HYDROCARBONS

Filed Feb. 10, 1940

2 Sheets-Sheet 1

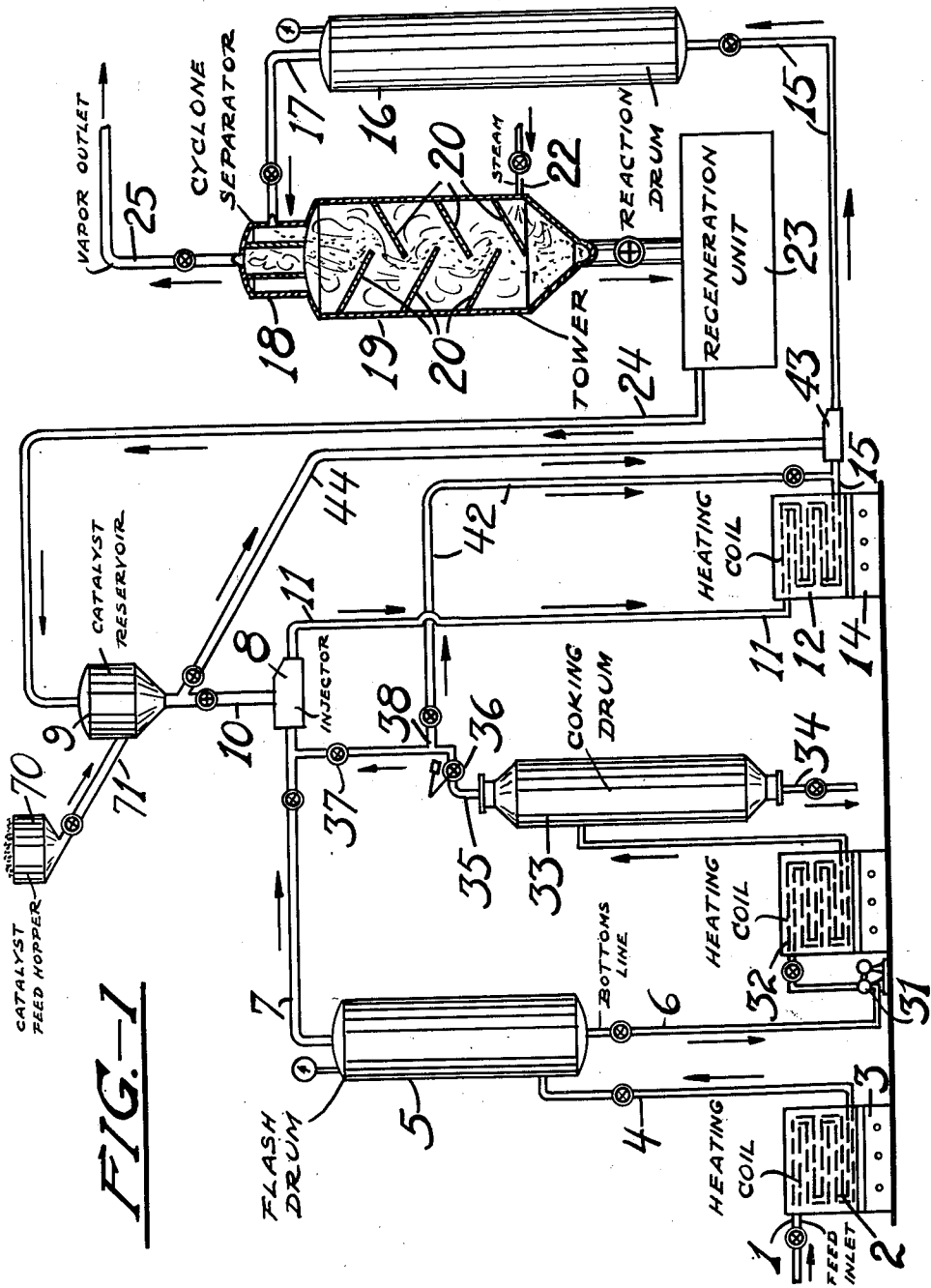


FIG-1

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2 Sheets-Sheet 2

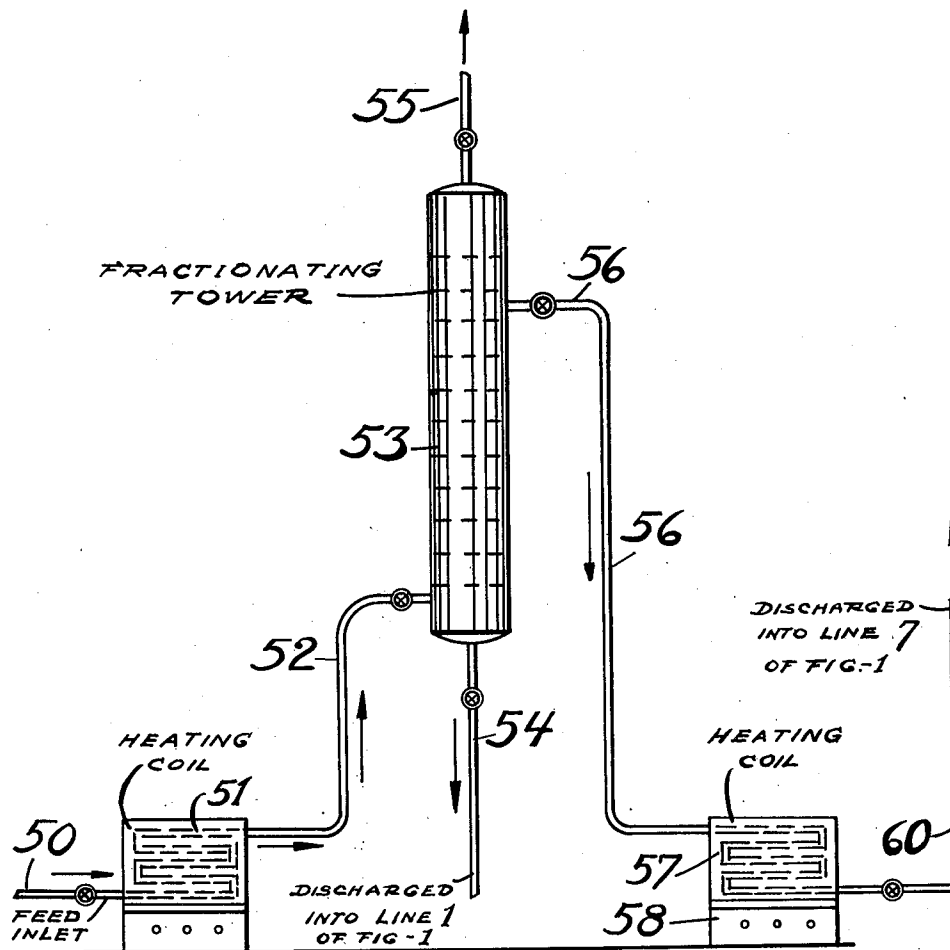


FIG.-2

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UNITED STATES PATENT OFFICE

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CATALYTIC CONVERSION OF HYDROCARBONS

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Application February 10, 1940, Serial No. 318,275

7 Claims. (Cl. 196—52)

1 The present invention relates to the art of treating hydrocarbon oils to obtain products of desired properties. More particularly, the present invention relates to the catalytic treatment of relatively high boiling hydrocarbons to produce relatively lower boiling hydrocarbons wherein the process is characterized by the feature that the catalyst is suspended in the vapors of the relatively high boiling hydrocarbons during the conversion.

It is a primary object of the present invention to convert hydrocarbons to desired products by vaporizing the hydrocarbons, adding a catalyst in the form of a powder, grains, granules, lumps, extruded rods or the like, to form a suspension of the said catalyst in the vapors and thereafter heating the vapors to reaction temperatures in the presence of the catalyst for a short period of time and conducting the same to a reaction zone where the desired conversion occurs.

A second object of the present invention is to treat a relatively high viscosity petroleum residue by first heating the crude to a temperature of say around 825° F., then conducting the heated material to a flash zone, withdrawing an overhead product from said zone while also withdrawing a high boiling fraction from the bottom thereof, mixing the heated overhead product with a hot catalyst, transferring the same to a heating zone where the vapors containing the catalyst are superheated to a temperature of say 925° F. during a short period of time, say about 4 seconds, and thereafter conducting the heated vapors to a reaction zone where they remain for a sufficient period of time, say about one minute, to convert the vapors to desired products, such as hydrocarbons boiling within the gasoline range.

As a corollary to the above, it is a further object of the present invention to viscosity break or coke the heavy bottoms from the flash zone to form further quantities of gas oil for catalytic treatment to form gasoline of good quality.

It is a highly important object of the present invention to produce the maximum amount of gasoline from a given charging stock such as a whole crude.

Other and further objects of the present invention will appear from the following detailed descriptions and claims considered in conjunction with the accompanying drawing.

Fig. I shows diagrammatically one form and arrangement of apparatus in which the present invention may be carried into effect; Fig. II shows a modification of the arrangement of Fig. I in which a whole crude is prepared for treatment in the apparatus of Fig. I.

Referring in detail to the drawing, a charging stock such as a residue from an East Texas crude, comprising about 40% of the original crude and having an A. P. I. gravity of the order of 22°

2 is introduced into the system through line 1 and passed through a heating coil 2 disposed in a furnace setting 3. The oil is resident in the coil 2 for a period of time sufficient to cause an increase in its temperature to about 800° F. or 850° F., whereupon it is discharged into line 4 and from there into a flash drum 5 maintained under a gauge pressure of say about 10 lbs. per square inch. The bottoms from this drum are withdrawn through line 6 and may be used as a heating oil as processed as hereinafter described, the said bottoms amounting to about 30% by weight of the original charge. The remainder of the material in vapor form passes out of the flash chamber through line 7 and is then discharged into injector 8. Meanwhile, a catalyst such as an acid treated clay in the form of a powder having a particle size of from 100 to 400 mesh is withdrawn from reservoir 9 through line 10 and then passed into the injector 8 wherein it is caused to be suspended in the vapors passing through the injector. The amount of catalyst added to the vapors may vary from about 0.1 to 2 lbs. of catalyst per cubic foot of oil vapors, the latter measured at reaction temperatures. The vapors containing the catalyst in suspension are withdrawn from the injector through line 11 and discharged into a fired coil 12 disposed in a furnace setting 14. The vapors are passed rapidly through this coil, that is to say, they remain in the coil for a period of time within the range of from about 3 to 5 seconds, and during their passage through the coil these vapors are heated from about 825° F. to about 925° F., preferably to about 900° F. The superheated vapors are withdrawn from coil 12 through line 15, forced through injector 43 where more catalyst may be added as will be presently explained, and then passed into a reaction drum 16 where they are maintained, for a period of from about 5 seconds to 1½ minutes, preferably 15 seconds, at the temperatures mentioned above, under a pressure of about 7 lbs. per square inch gauge. It will be noted that the injector 43 disposed in line 15 is in communication through valved line 44 with valved line 10 and hence catalyst from hopper 9 may be fed to injector 43 from said hopper. Good results are secured by adding 10% of the catalyst to the vapors in injector 8 and the remainder in injector 43. The reaction products are withdrawn from drum 16 through line 17 and then passed to a cyclone separator 18 superimposed on a tower 19 provided with inclined baffles 20. The catalyst is separated from the vapors and passes by gravity through the tower 19 against a current of steam introduced at near the base of said tower through line 22, which steam is at a temperature of about 800° F. The steam serves to purge the more volatile hydrocarbons from the catalyst. The purged catalyst is then conducted to a regeneration unit of known

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construction and arrangement represented merely diagrammatically by the element designated 23, where the carbonaceous deposits formed during the reaction are preferably removed by oxidation under known conditions of temperature, pressure and oxygen concentration in a regeneration gas. The regenerated catalyst which, at the end of the regeneration has a temperature of about 1000° F. to 1100° F., is conveyed by any convenient transfer means, e. g., pneumatic means, through line 24 to the reservoir 9 for reuse in the process.

Meanwhile, the vapors are withdrawn from the cyclone separator 18 through line 25, and usually are passed through a second cyclone separator (not shown) to remove a still further quantity of the catalyst from the vapors, and, if necessary, they may be passed through a third cyclone separator (not shown) to remove substantially the last traces of catalyst from the product, since, of course, the presence of catalyst would be detrimental in the final product, even in very small amounts. After removal of all the catalyst, the vapors are passed to fractionating equipment (not shown) to recover gasoline.

Referring to the bottoms withdrawn through line 6, the same may have an A. P. I. gravity of between about 8° to about 12°, and the said bottoms may be forced by pump 31 through fired coil 32 to a viscosity breaking drum 33 where the bottoms are subjected to a temperature of about 825° F. and a pressure of about 50 to 1500 lbs. per square inch gauge. This treatment results in the conversion of about 20% of the charge fed to the viscosity breaker, to gas oil, naphtha and normally gaseous hydrocarbons. The operation may be a coking of the charge in which case it may be carried out as liquid phase coking in drum 33 under pressure from atmospheric to 250 lbs. per square inch with or without steam or the oil, preferably, may pass through a spray nozzle and descend against a rising current of superheated steam. The tar bottoms withdrawn through line 34 may be employed as a heating fuel, or they may be processed to produce a petroleum asphalt. If coke is formed, it is withdrawn and disposed of in known manner.

The vapors are withdrawn from viscosity breaker 33 through line 35 and forced through pressure reducing valve 36 and then either discharged into line 7 by opening valve 37 and closing valve 38, or passed through line 42 by closing valve 37 and opening valve 38 to line 15 to a point intermediate the injector 43 and furnace 14.

In Fig. II, a whole East Texas crude may be fed to the system through line 50 and discharged into a fired coil 51 where it is heated to about 700° F. and then discharged through line 52 into a crude fractionating tower 53. From tower 53, about 40% of the crude is withdrawn through line 54 and discharged into line 1 and then processed as hereinbefore described. Approximately 37% gasoline based on the original crude is recovered from the tower through line 55 and this gasoline may be improved as to octane number by reforming thermally or catalytically in the presence or absence of hydrogen. About 23% of gas oil comprising the remainder of the original crude is withdrawn from the tower through line 56 and discharged into a fired coil 57 disposed in a furnace 58 where it is heated to a temperature of 825° F. to 975° F. and then transferred from said coil through line 60 to line 7 for confluence with the vapors from flash drum 5. When it is desired to add catalyst to the system the same

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may be added from feed hopper 70 through valved line 71 to hopper 9. It is desirable in operating my process to employ steam to aid in the vaporization of the oil. Thus, for example, steam may be admitted directly to coil 2 and/or to a point at near the base of drum 5.

It is obvious that numerous modifications to the present invention may be made without departing from the spirit of the present invention.

The invention claimed is:

1. In the method of treating a crude petroleum oil to produce, catalytically, hydrocarbon fractions boiling within the gasoline range, the improvement which comprises heating the crude petroleum oil to a temperature sufficient to vaporize a substantial portion of said oil, separating in a crude fractionating zone the vaporized portion from the unvaporized oil so as to provide a vapor fraction comprising a gas oil which may be catalytically treated, further heating the unvaporized oil portion to yield a further portion of vapors including a gas oil fraction, separating a gas oil fraction from the last named oil portion in a flashing zone and causing the confluence of gas oil vapors proceeding in confined streams from the fractionating and flashing zones, suspending about 10% of the amount of the powdered catalyst to be finally added in the vaporized gas oil, superheating the gas oil, adding the remainder of the catalyst, conducting the gas oil to a reaction zone, recovering the reaction products, and separating the catalyst therefrom.

2. The process of claim 1 in which catalyst at a temperature of about 1000° F. is suspended in the gas oil vapors.

3. The method of treating hydrocarbons which comprises heating a topped petroleum crude to a temperature of about 830° F., separating a vaporized portion from an unvaporized portion, adding a powdered catalyst to the vapors to form a suspension of catalyst in the vapors, heating the suspension of catalyst in vapors to a temperature of about 925° F. within a period of time of from about 3 to 5 seconds and passing the suspension of catalyst in superheated vapors to a reaction zone where they remain resident for a sufficient period of time to effect the desired conversion of the vapors.

4. The method of treating hydrocarbons which comprises heating a topped crude petroleum oil to a temperature of from about 800° F. to 850° F., separating a vaporized portion from an unvaporized portion, adding a portion of powdered catalyst to the vapors to form a suspension of catalyst in the vapors, heating the suspension of catalyst in vaporized oil to a temperature of about 825° F. to 925° F. in a heating zone during such a short period of time as to prevent substantial cracking of said oil, thereafter adding a second portion of said catalyst and passing the superheated vapors and catalyst through a reaction zone where they remain resident for a sufficient period of time to effect the desired conversion.

5. The method set forth in claim 4 in which the powdered catalyst which is added to the vaporized portion of the oil is at a temperature of about 1000° F.

6. A method of converting hydrocarbons to produce hydrocarbon fractions boiling within the gasoline boiling range which comprises heating a relatively heavy oil to vaporize at least a portion thereof, separating vapors from unvaporized

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oil, further heating the unvaporized oil to yield additional vapors, separating the additional vapors and mixing them with the first mentioned vapors, suspending a small amount of the powdered catalyst to be finally added in the mixture of vapors, superheating the suspension of catalyst in vapors, adding the remainder of the powdered catalyst to the vapor-catalyst suspension, passing the resulting suspension through a reaction zone, recovering reaction products in vapor form and separating the powdered catalyst therefrom.

7. A method of converting hydrocarbons in the presence of catalyst which comprises heating hydrocarbon oil to an elevated temperature to vaporize at least a portion of the oil, adding a portion of powdered catalyst to the oil vapors to form a suspension of catalyst in the vapors, heating the suspension of catalyst in the oil vapors in a heating zone during such a short period of time as to prevent substantial cracking of the oil, thereafter adding a second portion of powdered catalyst to the first mentioned suspension and passing the resulting suspension of

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catalyst in oil vapors through a reaction zone where the vapors remain resident for a sufficient period of time to effect the desired conversion thereof.

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