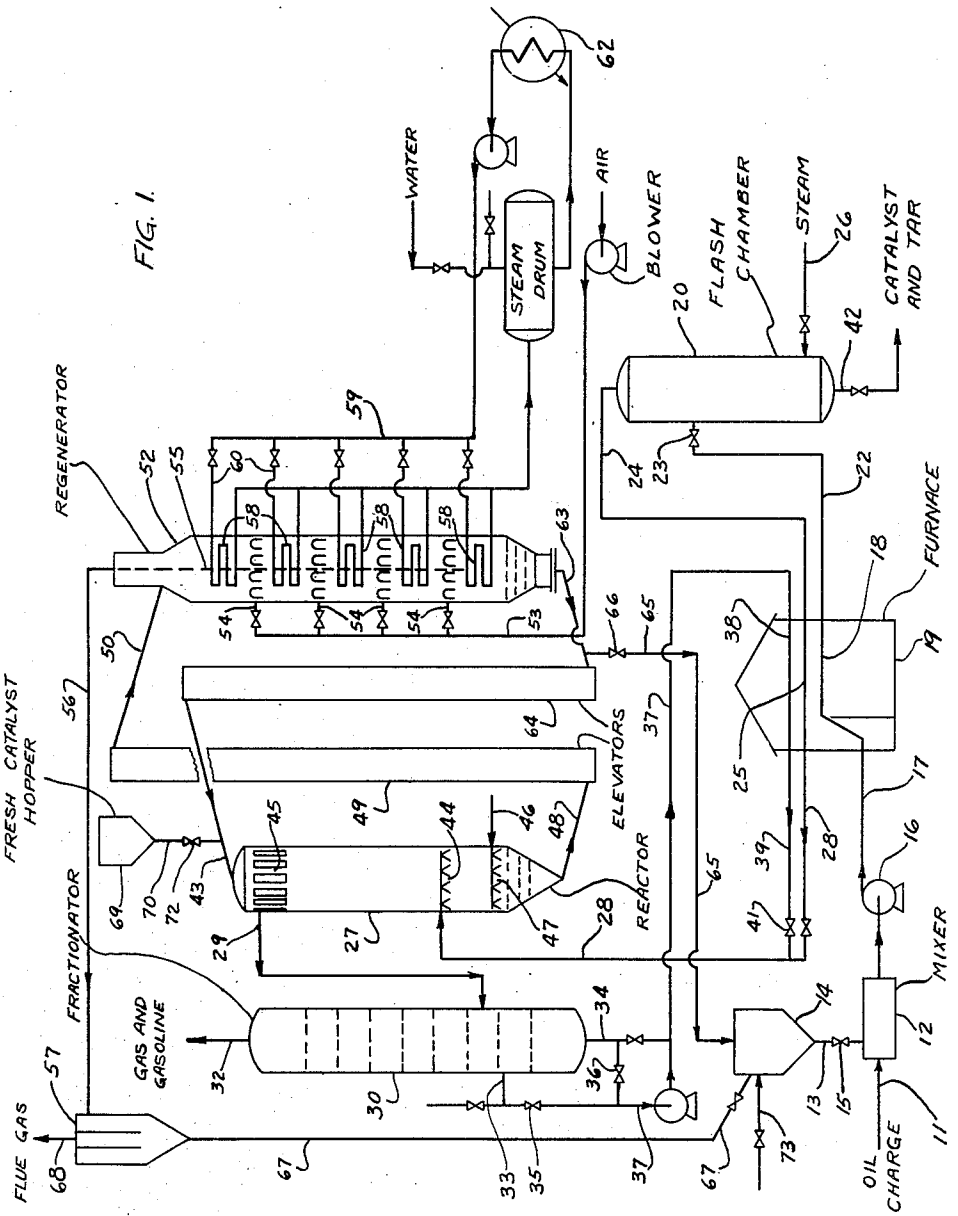
Sept. 12, 1950 E. A. SMITH 2,521,757

CONVERSION OF HEAVY HYDROCARBON MATERIALS

Filed Dec. 15, 1945 2 Sheets-Sheet 1

FIG. 1.



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CONVERSION OF HEAVY HYDROCARBON MATERIALS

Filed Dec. 15, 1945 2 Sheets-Sheet 2

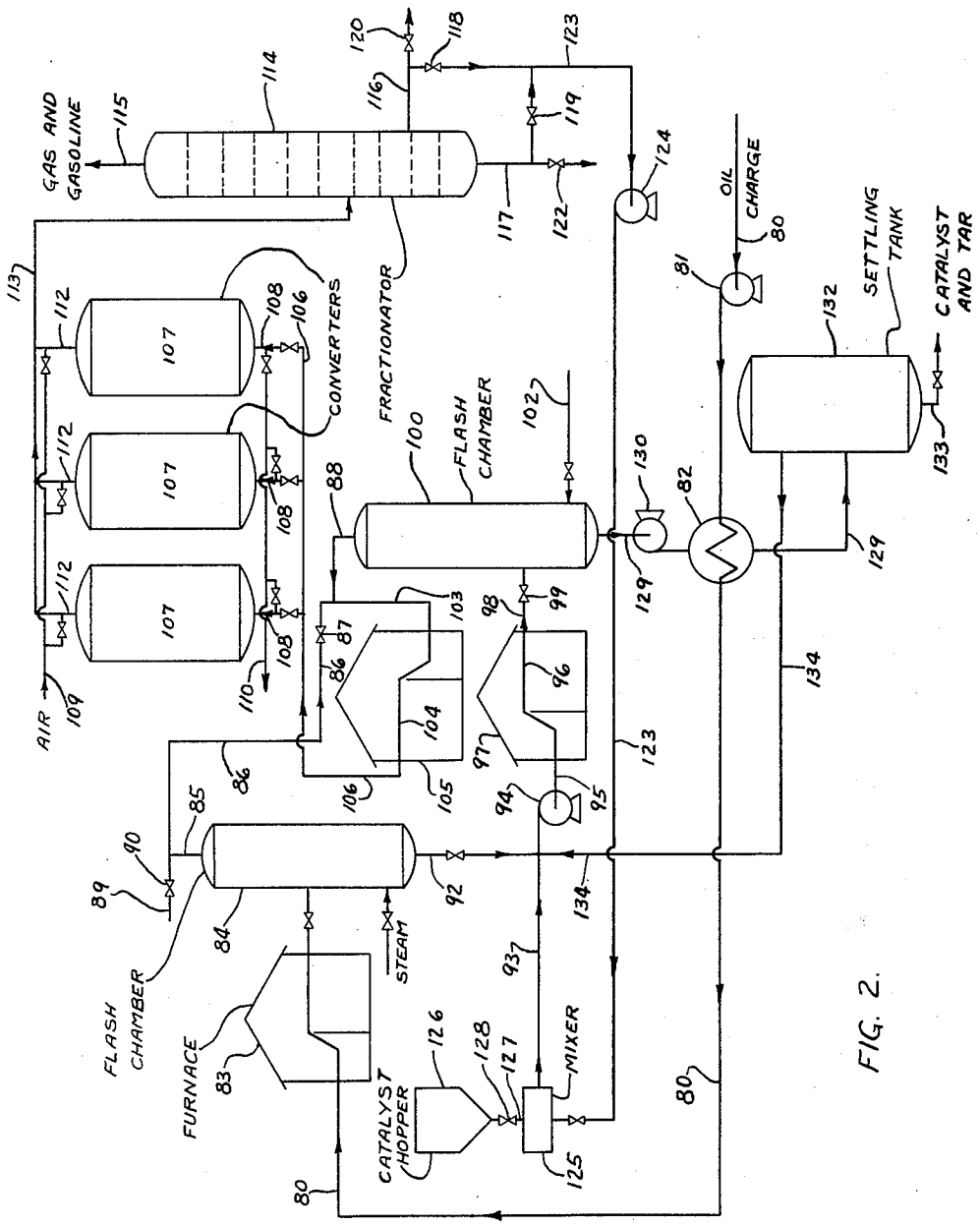


FIG. 2.

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Patented Sept. 12, 1950 2,521,757

UNITED STATES PATENT OFFICE

2,521,757

CONVERSION OF HEAVY HYDROCARBON MATERIALS

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Application December 15, 1945, Serial No. 635,324

1 Claim. (Cl. 196—49)

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This invention relates to the art of refining hydrocarbon materials and, in particular, is concerned with the conversion of high boiling or heavy hydrocarbon fractions to lower boiling products by the use of catalytic cracking. The invention involves an improved process for obtaining lower boiling products, such as motor fuels or clean fuel oil distillates, from heavy hydrocarbon charge stocks, such as reduced or topped crudes or heavy residua, which contain components normally liquid at conventional catalytic cracking temperatures and are therefore difficult to treat by conventional methods.

The object of this invention is to provide processes for converting heavy hydrocarbon fractions to lower boiling products wherein a given volume of crude oil yields an improved quantity and/or quality of products at low cost with simple equipment.

According to my invention, I subject a high boiling hydrocarbon fraction which is difficult to crack catalytically because of low volatility or excessive coke deposit to elevated temperatures in the presence of a suspended or slurried finely divided catalyst, which may be an inexpensive natural material or discarded commercial cracking catalyst, while maintaining the hydrocarbon fraction in the liquid phase by pressure. The conditions of this stage are selected so as to convert the hydrocarbon fraction to material of greater volatility (i. e., having a generally lower boiling range and/or lower dew point) without considerable formation of gasoline or gas. I then conduct the converted suspension of oil and catalyst to a flash distillation chamber where I separate, as vapor, an overhead fraction from a residuum of non-volatile material, coke and catalyst. If desirable, I may separate the catalyst prior to the flash distillation. The vaporous overhead fraction now has the low coke forming and other properties of a clean distillate stock. The residuum can be processed to recover the catalyst for reuse or preferably is discarded after removal of liquid hydrocarbon material therefrom. The hydrocarbon material taken overhead in the flash distillation is an excellent charge stock for catalytic cracking. In accordance with the invention, I prefer to employ at least a portion of this material either alone or in admixture with other hydrocarbons as the charge to a second stage, where the hydrocarbon material is subjected to brief intimate contact with a large body of moving or static solid cracking catalyst of high activity under conditions to produce a

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high yield of desirable products, such as gasoline or fuel oil.

My invention is used advantageously in processing those hydrocarbon charge stocks which, in conventional catalytic operations, would deposit large quantities of coke. High production of coke can occur when the hydrocarbon fraction is a distillate fraction which contains minor amounts of entrained very high boiling ends or when the hydrocarbon fraction contains large amounts of components which vaporize with attendant deposition of coke or when the hydrocarbon material, even though vaporizable with considerable amounts of steam or other inert vaporizing media, has a high dew point and therefore must usually be processed under conditions, such as high temperatures, which result in a large coke deposit. In general, hydrocarbon charge stocks suitable for processing by my invention are those having dew points in excess of 850° to 875° F. or those which are less than 90% evaporated at 800° F. (Boiling points and dew points throughout the specification and claim are referred to atmospheric pressure even though experimentally measured at lower pressures, as by a vacuum assay.) Also suitable are charge stocks which may be of wide boiling ranges so as to include material boiling as low as 500° to 600° F. but which also contain material boiling above 1000° F. The present invention can also be used advantageously to process stocks which contain asphaltic materials, since coke from such asphaltic materials is deposited on the catalyst in the first stage thereby reducing the coke deposit on the catalyst in the second stage. Indeed, the reduction of coke deposited on the catalyst in the main cracking operation is one of the advantages of my invention. Furthermore, reduction of the coke-forming properties of the charge stock to the second cracking stage permits additional severity of cracking with a consequent increase in the amount of conversion.

Suitable conditions for the first stage when using most catalysts include cracking temperatures which preferably do not exceed 850° F. and are above 500° F., as for example, a range of 650° to 800° F. However, higher temperatures, such as temperatures up to 950° F. can be used with a corresponding reduction in the time of treatment. The weight ratio of catalyst to oil should preferably not exceed 0.025 while in many instances the ratio will not be excess of 0.01 and may be of the order of 0.01 or less. In any event, the catalyst and oil should form a suspension which flows freely and handles with moderate ease. A

suitable amount of finely divided catalyst, such as that obtained by processing catalyst from the second cracking stage which has been discarded because of lowered efficiency, is one pound of catalyst per barrel of charge stock. The pressures used are sufficient to maintain the oil in liquid phase and generally are above 100 lbs. per square inch gauge as, for example, a range of 200 to 500 lbs. per square inch gauge. Higher pressures may be used if necessary to maintain the oil in liquid phase. The appropriate duration of heating of the suspension of oil and catalyst (i. e., the residence time) in the first stage is a function of the amount and activity of the catalyst and the temperature, and I prefer to restrict the residence time to periods which result in a production of gas and gasoline of less than 15 volume per cent of the charge and preferably less than 5 volume per cent. Thus, a residence time of about 10 minutes may be used with a relatively inactive catalyst at a low temperature, such as 700° F., while a residence time of less than a minute or even of the order of 5 to 10 seconds may produce the desired results when using a discarded commercial catalyst at a high temperature, for example, about 850° F. or above. If the catalyst manifests too much activity, I may heat the suspension of catalyst and oil at low temperatures, such as from 300° to 650° F. and for a short time, such as less than 5 minutes, in order to perform some preliminary cracking and to diminish the activity of the catalyst due to the concomitant deposition of coke thereon and then heat the suspension of partially converted oil and catalyst under the conditions described above. In general, I use more severe conditions (higher temperatures, longer residence time and a higher ratio of catalyst to oil or a more active catalyst) with the more refractory, lower boiling hydrocarbon fractions or with aromatic fractions, such as cracked residua, particularly from thermal processes, while less severe conditions are applicable to paraffinic and higher boiling charge stocks.

The catalyst is used in the first stage in the form of finely divided powder and preferably is inexpensive. In connection with my invention, I may use, in the first stage, catalysts having various activities and derived from various sources. A standardized test for the characterization and control of cracking catalysts used by a number of industrial laboratories is that known as the "CAT-A test" and is described in "Laboratory Method for Determining the Activity of Cracking Catalysts" by J. Alexander and H. G. Shimp, page R-537, National Petroleum News, August 2, 1944. In accordance with the method, a standardized light gas oil is subjected to contact with the catalyst to be tested under fixed cracking conditions of pressure, temperature and rate of oil flow. The cracked products are determined and analyzed to obtain the catalyst activity, called the activity index, which is the volume ratio of motor gasoline produced to charge stock. In one form of my invention, a low or moderate activity catalyst is used in the first stage which catalyst can be an inexpensive material, such as an untreated clay of natural origin, having an activity, as measured by the above test, of at least 15 and preferably above 20. In the case of the lower activity, the lack of activity can be compensated for by employing higher temperatures, such as 900° F. and over, or, when using lower temperatures such as 800° F. and lower, by longer residence times. However, irrespective of the activity of the catalyst used in the first stage, the hydrocarbon fraction is properly prepared in the first stage, as by reduction of boiling range, so as to furnish a charge stock to the second stage where it is catalytically cracked to high octane gasoline. Suitable materials are bauxite or other aluminous materials, decolorizing clay which may have been previously used in other operations, various clays of low catalytic activity such as raw bentonites or kaolins, other absorptive active naturally occurring solids, and catalysts of synthetic origin.

My basic invention is quite flexible and may be adapted to the needs of a particular refinery. For example, heavy gas oil from the second stage may be mixed with the hydrocarbon material in the first stage or the overhead fraction from the first stage can be combined with virgin or recycle distillates before cracking in the second or gasoline producing cracking stage. Under some conditions, I may distill a crude oil to a heavy residuum which is then blended with a recycle gas oil fraction from the second cracking operation in the proper proportion to yield a sufficiently liquid product for the adequate suspension and contact of the minor amount of added catalyst. The blending of the recycle gas oil provides a low boiling fraction, somewhat refractory under the conditions of the first stage operation, which aids in the volatilization of the heavy fraction and has little tendency to form gasoline while providing some recycling in the second stage. Other variations on my basic operation, some of which are indicated in the following description will occur to those skilled in the art.

In the accompanying drawings, which are schematic flow diagrams, two specific embodiments of the invention are set forth. Thus:

Figure 1 illustrates a process of the invention wherein a moving catalyst system is employed as the main catalytic cracking stage;

Figure 2 illustrates another application of the invention wherein a system of converters containing static beds of catalyst is used as the main catalytic cracking stage.

In the process illustrated in Figure 1, fresh charge stock, such as reduced crude from which light distillate fuel has been removed, is introduced to a two stage cracking system by a line 11 which leads to a suitable mixing device 12 into which finely divided catalyst is continuously fed by catalyst leg 13 from a supply in catalyst hopper 14. In mixing device 12, there is formed a suspension or slurry of charge stock and catalyst. Valve 15 regulates the admission of catalyst so that the proper amount is added to form a suitable suspension of the catalyst in the charge stock. The resulting suspension is forced by pump 16 through line 17 under superatmospheric pressure, for example, 200 to 500 pounds per square inch, into and through the first stage which comprises a heating tube 18 in furnace 19. The heating tube 18, which may be a coil or a series of tubes, is arranged so that the suspension may be heated to a temperature such as about 800° F. and maintained at that temperature for a time sufficient to effect conversion of heavy components into material of the character of a distillate gas oil. The catalytic treatment of the charge stock, under liquid phase conditions, results in a general lowering of boiling range of the charge stock without cracking the charge stock to considerable amounts of gasoline or gas. However, any gasoline that is formed has the high octane number characteristic of catalytic cracking. The suspension of converted charge stock and catalyst, still in the liquid phase,

is transferred to a flash chamber 20 by line 22. The liquid suspension passes through a throttling valve 23 and is discharged, at a moderate pressure of the order of 25 pounds per square inch, into the flash chamber where the reduction in pressure results in a flash distillation. The vapors resulting from the flash distillation are taken overhead by line 24 to heating tube 25 in furnace 19 and are there heated to a temperature suitable for introduction to the main catalytic cracking stage. Adjustment of the pressure within the flash distillation chamber controls the end point of the overhead vapors and it is preferred to operate the flash distillation chamber so that the overhead vapors do not contain liquid material when charged to the second cracking zone. In the operation of the flash chamber 20, suitable vaporizing fluids, as for example, steam, may be supplied by line 26 and utilized in a known manner to assist in controlling the boiling range characteristics of the overhead and residual fractions produced.

The vapor heated in tube 25 is charged by line 28 to reactor 27 which comprises the catalytic cracking zone for the production of gasoline and through which a continuous stream of catalyst preferably in granular or molded form is circulated at a rate controlled in such a manner that the weight ratio of catalyst to hydrocarbon charge present in the reactor is in excess of 0.5 and preferably in excess of 2. Cracked products issue from reactor 27 by line 29 and are sent to fractionator 30 and are there fractionated to produce an overhead gasoline and gas fraction which is conducted by line 32 to suitable equipment (not shown) for the separation of aviation or motor gasoline. A cracked gas oil fraction having distillate fuel characteristics is removed from fractionator 30 by line 33, while the residue, which may or may not have characteristics of a distillate fuel, is removed from the fractionator by line 34. The fractions removed by lines 33 and 34 may be separately or collectively sent to distillate fuel storage or alternatively circulated through the second catalytic zone for further conversion, as for example, by opening one or both of valves 35 and 36, and conducting such material through line 37 and heating tube 38 of furnace 19 wherein it is vaporized and heated to cracking temperature and from which it may be led by line 39 to line 28, valve 41 being open, and thence to reactor 27.

The flash distillation in flash chamber 20 results in a residue of heavy non-volatile material, such as tar, and used catalyst on which there is a coke deposit. This residue is removed from the flash chamber by line 42 and may be used as a fuel or may be mixed with fresh charge to the first stage, preferably after removal of the suspended catalyst therefrom. One method of processing residual hydrocarbons withdrawn from line 42 is described in more detail in connection with Figure 2.

The second cracking zone, as exemplified by reactor 27, contains a continuous stream of granular, molded or otherwise formed solid catalytic material admitted to the reactor by line 43. The catalyst flows by gravity through reactor 27, preferably as a continuous bed, and thereby cracks the countercurrently moving stream of vapors admitted to the reactor by line 28 through vapor manifold 44. In general, the conditions of cracking in the second cracking stage, as exemplified by reactor 27, are well known to the art and are varied depending on the nature of charge stock

and the type and quantity of products desired. Thus, the catalyst may be charged to the top of reactor 27 at temperatures in the range of 800 to 1050° F. and preferably in the range of 850 to 975° F. and the cracking reaction conducted at total pressures varying from atmospheric to 100 pounds per sq. in. and preferably below 50 pounds per sq. in. The vapors entering the reactor by line 28 may have been heated to temperatures above the catalyst temperature at that point so as to compensate, at least partially, for the drop in catalyst temperature occasioned by the endothermic heat of cracking. The cracked hydrocarbon material or synthetic crude is disengaged from the catalyst at the top of the reactor by vapor disengaging chamber 45 from which the synthetic crude is removed by line 29 and sent to fractionator 30 as previously described. At the bottom of the reactor, the catalyst is purged of volatile hydrocarbons by steam admitted thereto by line 46 through steam manifold 47. The purged catalyst then leaves the reactor by line 48 and is conveyed by elevator 49 and line 50 to the top of regenerator 52. This regenerator, which may be of the type known as a "Thermofor" kiln, provides for reactivation of the cracking catalyst by burning off the coky deposit thereon. Air for the combustion is supplied by manifold 53 and suitable inlet lines 54 while the resulting products of combustion are disengaged from the catalyst and removed by a manifold 55 and thence by line 56 to a cyclone separator 57. The major portion of the heat of combustion is removed from the regenerator 52 by the use of suitable heat exchange members 58 disposed in the path of the catalyst and containing a suitable heat exchange medium, for example, water fed through manifold 59 and lines 60. If desired, the water may be circulated, in a closed system containing a heat exchanger 62 or other suitable means of utilizing the heat generated in the regenerator. Thereafter the catalyst is withdrawn from the regenerator by line 63 and conveyed by elevator 64 which raises it to line 43 for recharging to reactor 27.

Catalyst from the second cracking stage can be utilized in the first stage in several ways. Freshly regenerated catalyst may be withdrawn from line 63 through line 65 by opening valve 66 and conducting the catalyst to catalyst storage hopper 14. In the event that the particles of catalyst so withdrawn are too large to form a suspension with the charge stock, the particles may be crushed or ground before admission to hopper 14. When, however, the catalyst is in the form of relatively fine particles as of the order 0.5 millimeter and preferably 100 mesh or finer, crushing or grinding will not be necessary. Certain types of catalytic cracking systems which may be employed in the second cracking stage instead of the type shown, use catalyst sufficiently fine to be suspended readily in the charge stock. The withdrawal of catalyst by line 65 may occur at infrequent intervals, as for example, when the catalyst used in the second cracking stage has deteriorated to an uneconomical cracking activity and it is desired to refill the system with fresh catalyst, or only a very small amount of catalyst may be continuously withdrawn. Another method of using the catalyst from the second stage in the first stage may be used, as in Figure 1, wherein finely divided material formed by abrasion of the catalyst moving through the second stage cracking system is removed from the flue gases leaving regenerator 52 by line 56 in

a cyclone separator 57. The catalyst particles separated in the cyclone separator are fed by line 67 to feed hopper 14, while flue gases freed of catalyst are discharged from the system by line 68. In order to make up for the catalyst removed from the second stage, fresh catalyst may be admitted to the system from hopper 69 by catalyst leg 70, the amount of such catalyst being controlled by valve 72. When catalyst from the second cracking stage is used in the first stage and too much gasoline or gas is formed in the first stage because of excessive activity of the catalyst, it may be treated to reduce its activity, as by calcination at temperatures above 1400° F. in the presence of steam, or the active catalyst may be diluted with a low activity catalyst, which can be added by line 73 to feed hopper 14 and which may be a spent decolorizing clay or similar inexpensive material or may be regenerated catalyst previously used in the first stage operation. For example, the residue from the flash distillation may be removed from chamber 20 by line 42 and the catalyst recovered and regenerated by suitable apparatus. Thus, the residue, which consists of heavy tar and coked catalyst, can be treated in a coking drum of an intermittent or continuous type to produce cracked tar and a friable mass of coked low activity catalyst. The coked catalyst can then be regenerated in suitable apparatus such as the rotary kilns used in cement production. Alternatively, the residue can be conveyed to settling tanks or filter presses where the liquid hydrocarbons are removed from the coked catalyst which can then be regenerated as described above. However, in most cases, I prefer to use a catalyst in the first stage operation whose cost, in terms of the amount used per barrel of charge stock, is so low that it can be discarded after a single pass.

The catalyst from the second stage may be used in the first stage, in a similar manner to that shown in Figure 2, by mixing the catalyst with a refractory recycle stock to form a suspension and then mixing the resulting suspension with the fresh charge to the first stage. The fresh charge may be heated to the desired temperature of treatment before admixture with the suspension containing the catalyst which may also be preheated in a similar fashion. The fresh charge is thereby subjected to the action of the catalyst for only a brief time which can be shorter than the time normally taken to heat the fresh charge to the desired temperature.

My invention may be used in connection with the processing of an original charge having a wide boiling range, by utilizing an operation of the type shown in Figure 2. The charge stock, which may be a crude from which a light naphtha fraction has been topped, is admitted to the system by line 80 and impelled by pump 81 through heat exchanger 82 and furnace 83 in substantially liquid phase to a flash chamber 84 where the pressure is reduced and the charge stock is flash distilled in a known manner to produce an overhead vaporous fraction, which may be a gas oil distillate fraction boiling up to 750° F. to 850° F., and a liquid residual fraction. The vaporous fraction is removed from flash chamber 84 by line 85 and thereafter may be sent to line 86, valve 87 being open, and admixed with material from the first stage in line 88 and catalytically cracked in the second cracking stage or alternatively may be conveyed by line 89 for other processing or to distillate fuel storage by closing valve 87 and opening valve 90.

The heavy liquid residual fraction is withdrawn from the flash chamber 84 by line 92 and mixed with a slurry of finely divided low activity catalyst, such a clay having a "CAT-A" activity which may be 15 to 25, and recycle gas oil in line 93. A suspension of finely divided catalyst in the residual fraction is thus formed and the suspension forced by high pressure pump 94 through line 95 and heating tube 96 in furnace 97 thereby performing an operation on the residual fraction in a similar manner to that described in connection with Figure 1. The resulting suspension of converted oil and catalyst passes by line 98 through throttling valve 99 to flash chamber 100 where the pressure is reduced and the suspension is flash distilled. A vaporous fraction, which consists of hydrocarbon material whose volatility has been considerably increased due to the first stage operation and any steam which has been added by line 102 to aid the flash distillation, is taken overhead from chamber 100 by line 88. The vaporous fraction in line 88 is mixed in any desired proportion with the gas oil distillate in line 86 to form the charge stock to the second cracking stage in line 103. The charge stock in line 103 is passed through heating tube 104 in furnace 105 where the charge stock is superheated and thereafter conducted by line 106 to a battery of catalytic converters 107 containing static beds of high activity cracking catalyst and operated alternately in cracking and regeneration periods in a known manner such as that disclosed in U. S. P. 2,167,648, issued on August 1, 1939, to Richard S. Vose. The converters may be of the type in which the excess heat of regeneration is removed by indirect heat exchange fluid such as those disclosed in U. S. Patent 2,283,208, issued on May 19, 1942, to Eugene J. Houdry or may be of the adiabatic type. In the former type of operation, I prefer to use temperatures of 750° to 900° F. while, in the latter, somewhat higher temperatures, such as 850 to 1100° F. are desirable. In either operation, the pressure may be varied from atmospheric to about 50 pounds per square inch and the space velocity (volumes of charge stock at 60° F. per volume of catalyst) from about 0.5 to 5. In order to provide a continuous stream of reactants and products, the charge stock in line 106 is alternately charged to the converters by lines 108. Similarly, air in manifold 109 for regeneration of the coked catalyst, is transferred from one converter to another, the flue gas from the regeneration operation being removed by lines 108 and manifold 110.

The charge stock, after conversion by passing through one of the converters 107, leaves the converters by one of lines 112 to line 113 and thence is sent to fractionator 114 where gasoline and gas is separated and taken overhead by line 115 and thereafter appropriately processed. The fractionator 114 also separates from the converted charge stock several fractions heavier than gasoline, such as catalytic gas oil in line 116 and the residue in line 117. Either or both of these heavy fractions can be recycled to the first stage operation as by opening either or both of valves 118 and 119, valves 120 and 122 being closed, and forcing the material in line 123 by pump 124 to mixing device 125 where the hydrocarbon material is mixed with the finely divided catalyst from hopper 126. The catalyst is introduced to mixing device 125 by catalyst leg 127, the amount being regulated by valve 128. The catalyst in

hopper 126 may be a spent decolorizing clay or a raw clay, as described above. Use of the recycle fractions provides a low viscosity medium for suspending the catalyst and subsequently insures better mixing with the residue from flash chamber 84 which may have a high viscosity and therefore is difficult to mix with the catalyst to form a well distributed suspension.

Figure 2 also illustrates a method of operation of the first stage when it is desired to realize maximum conversion of heavy components of the original charge to distillate gas oil charge to the second or catalytic cracking stage. In this operation, the liquid residue from the flash distillation in chamber 106 is removed by line 129 and forced by pump 130 through heat exchanger 82, where it can be used to heat the original charge stock in line 80. The cooled material in line 129 is conducted to a settling tank 132 from which the catalyst which settles out, together with associated tarry material, is removed by line 133 and the hydrocarbon material, which has thus been freed of catalyst, is returned by line 134 to be converted in the first stage.

The catalyst used in the second stage of processes of the types described in connection with either Figure 1 or 2 is a cracking catalyst having a catalytic activity that it will produce, under the conditions of operation, at least 30 volume per cent and preferably above 35 volume per cent of motor gasoline based on the stock charged to that stage. Suitable catalysts are surface active siliceous masses of either natural or synthetic origin. Clays, which may have been acid, alkali, or otherwise treated to produce or enhance catalytic activity may be used, such as bentonites and other clays of the montmorillonite type and the like. Synthetic colloid masses such as gels of silica-alumina, silica-zirconia, silica-thoria, silica-urania or combinations of these materials and the like, as well as catalysts such as zirconium phosphate can be used. These catalysts, as such, form no part of my invention and any material which produces the desired results can be used.

From what has been said above it will be apparent to those skilled in the art that the process has a number of important advantages among which may be mentioned the following. The operation carried out in the first stage effects a reduction of the dew point of the heavy charge stock. This result is accomplished with a residence time and other conditions milder than those necessary in a thermal operation effecting the same extent of conversion. Moreover, any gasoline produced in this stage is catalytically cracked gasoline rather than thermally cracked gasoline and, if included in the charge to the second stage as is preferred, the gasoline is catalytically treated in the second stage, resulting in further improvement in anti-knock rating. The treatment, in accordance with the invention, of sulfur-containing stocks in the presence of suspended catalyst results in selective catalytic cracking of sulfur compounds to products boiling below the range of gas oils. Accordingly the gas oils or similar fuels or cracking stocks, upon recovery, have a low sulfur content. The first stage operation is economical because the catalyst used may be inexpensive and, in most cases, would be a waste product such as catalyst discharged from the second stage. Because the boiling range of the charge stock is considerably lowered in the first stage, the amount of steam necessary to obtain complete vaporization of the charge stock as for charging to the second stage is considerably reduced even to the extent of needing no steam. This reduction of steam has a beneficial effect by lengthening the economic life of the catalyst used in the second stage. Charge stocks for catalytic cracking may be prepared in better yields according to the present invention than by methods such as vacuum distillation which use more complicated and expensive apparatus.

Since changes may be made in the processes described above without exceeding the scope of the invention, it is intended that the description shall be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

In a hydrocarbon cracking process wherein fluent particles of solid hydrocarbon cracking catalyst circulate through upflow and downflow paths comprising cracking and regeneration zones and thereby form fines by abrasion of said catalyst, wherein a downwardly moving non-turbulent bed of said catalyst in said cracking zone contacts hydrocarbon vapors higher boiling than gasoline under cracking conditions including a temperature of cracking in the range of about 800° to 1050° F. such that said hydrocarbon vapors are cracked to high yields of gasoline and concomitantly deposit coke on said catalyst and wherein a downwardly moving bed of coked catalyst in said regeneration zone contacts oxygen-containing gases under combustion conditions such that at least a portion of said coke is burned and flue gas is formed; the improvement which comprises calcining in the presence of steam fines separated from said particles of catalyst so as to reduce substantially the catalytic activity of said fines, mixing a minor amount of fines so calcined with a high boiling hydrocarbon charge stock having a dew point above said temperature of cracking so as to form a suspension, subjecting said suspension to elevated temperatures under liquid phase conditions for a length of time such that the dew point of said hydrocarbon charge stock is substantially lowered and less than 5 volume percent of said charge stock is converted to gas and gasoline, flash distilling the suspension so subjected so as to form a liquid residue containing said fines and a vaporous hydrocarbon fraction having a dew point below said temperature of cracking, passing said vaporous fraction directly to said cracking zone without intermediate condensation, and cracking said vaporous fraction to high yields of gasoline by said bed of cracking catalyst in said cracking zone.

ELGENE A. SMITH.

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