

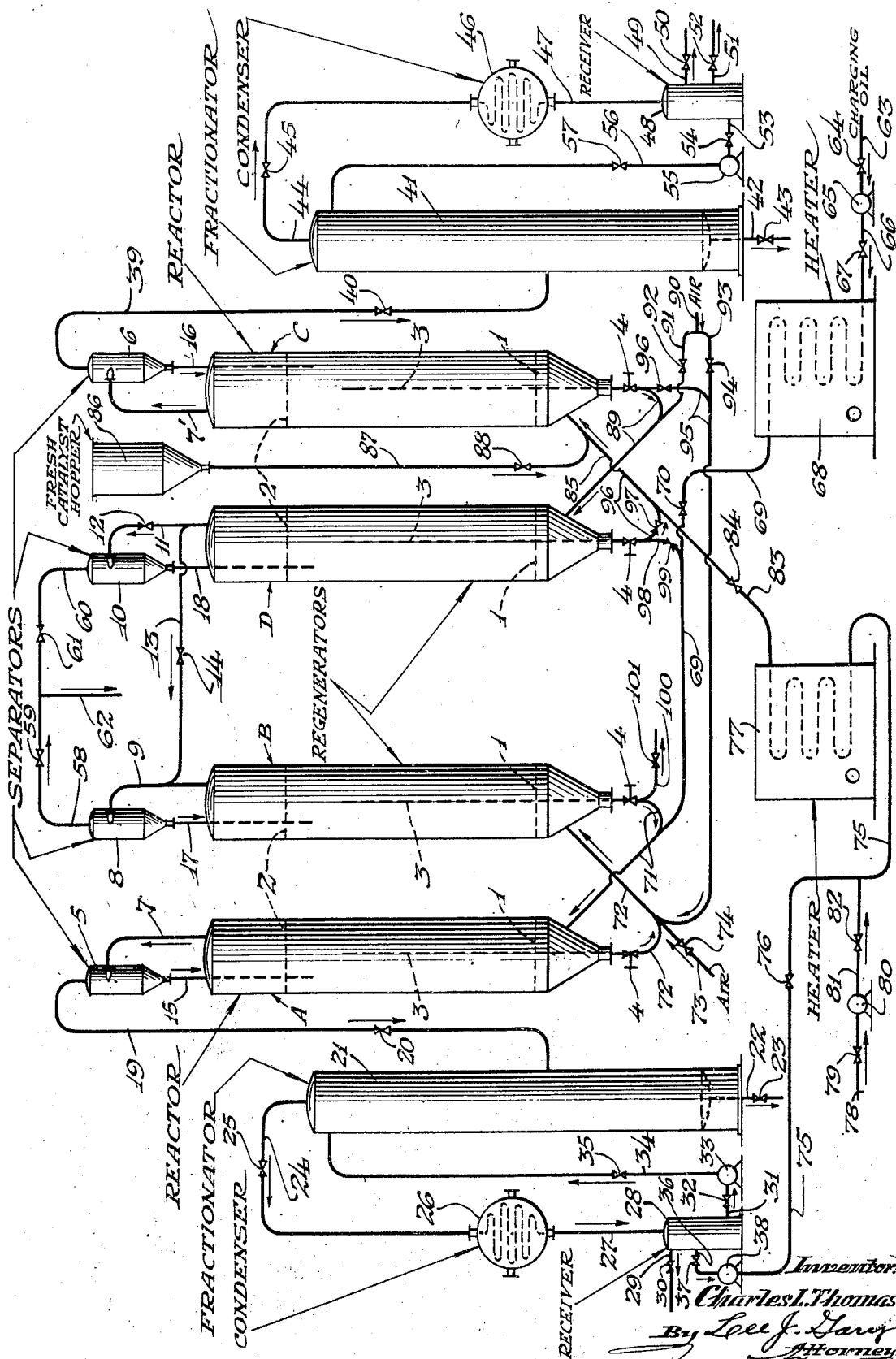
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CATALYTIC CONVERSION OF HYDROCARBONS

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## CATALYTIC CONVERSION OF HYDROCARBONS

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The invention is directed to an improved process and apparatus for producing gasoline suitable as aviation stock from higher boiling hydrocarbon oils by catalytically cracking said higher boiling oil to produce an olefin-containing gasoline and further treating the latter to convert the olefinic components thereof and improve its lead susceptibility.

High yields of good antiknock gasoline are produced from higher boiling hydrocarbon oils by a process of catalytic cracking which is now being rapidly adopted by the oil refining industry. However, in most instances, the gasoline so produced is unsatisfactory as aviation gasoline due to its relatively high olefin content. Although there is at present no acid heat test or bromine number requirement for aviation gasoline, the specifications limit the quantity of tetraethyl lead which may be employed to 4 cc. per gallon and also call for a minimum octane number of 100. Although the clear octane number of the highly olefinic gasoline produced by catalytic cracking is relatively high in comparison with gasolines of lower olefin content produced by other methods, such as thermal cracking, the lead response of olefins is so poor that, even when blended with substantial amounts of high octane paraffinic gasoline fractions, such as isopentane and alkylmer gasoline, more than 4 cc. of tetraethyl lead may be required to increase its octane number to 100. Thus, the presence of substantial quantities of olefins may preclude the use of catalytically cracked gasoline as a satisfactory base for aviation gasoline.

Treating the gasoline to actually remove the olefins is obviously undesirable, since it necessarily involves high treating losses and materially reduces its blending value as well as its clear octane rating. The most desirable procedure is to convert the olefins into corresponding saturated compounds which, although they may have a somewhat lower clear octane number, have a sufficiently superior lead response that 100 octane aviation gasoline may be produced by the addition of 4 cc. or less of tetraethyl lead and only a minor amount of high-octane, paraffinic blending stock such as alkylmer gasoline or hydrogenated polymer gasoline.

The conversion of olefinic components of the cracked gasoline to corresponding or similar saturated compounds which have the desired good lead response may be accomplished by subjecting the gasoline initially formed in the catalytic cracking operation to further treatment in the presence of the same type of cracking catalyst

as employed in the initial cracking step. Such treatment is not new, per se, in the present invention, but it is here employed in conjunction with the initial cracking operation, for the purpose above mentioned, in a novel and advantageous manner as will be later explained.

The secondary conversion step may be accomplished at a temperature within substantially the same range as that suitable for the initial cracking operation or at a materially lower temperature. Auxiliary charging stock of higher boiling nature than the cracked gasoline, such as virgin oil, heavy naphtha, kerosene or the like, may be employed in the second conversion step of the process as a so-called "hydrogen donor," or conversion of the olefins may be accomplished in the absence of such auxiliary charging oil. The most credible explanation of the mechanism of the olefin conversion step of the process is that hydrogen is split off from the "donor" and transferred to the olefins to hydrogenate the same. When the heavier secondary charging stock is not utilized in the olefin conversion step, the theory is that some of the gasoline is cracked to produce free hydrogen and heavier fractions, the free hydrogen being available for hydrogenation of the olefins. Regardless of the explanation or theory however, the secondary conversion step can be accomplished with or without the auxiliary charging stock.

I have found that cracking catalyst which has aged only moderately (i. e., has been used either in the initial cracking or the secondary olefin conversion step for a rather short time) is relatively inactive for the olefin conversion or so-called "hydrogen transfer" operation, although it is still quite active for promoting the initial cracking operation. In view of this, the present invention is directed to an improved process comprising an initial catalytic cracking step, wherein gasoline containing a substantial quantity of olefins is produced from heavier oil, and a secondary conversion step wherein the gasoline so produced is catalytically treated to convert a major portion of the olefins to saturated compounds boiling within the desired aviation gasoline range and having good lead susceptibility. The process is characterized in that fresh catalyst for both the primary and secondary operations is supplied to the secondary step of the process and, after being used to promote the desired reaction in this step for a relatively short time, a substantial quantity thereof is transferred to the initial cracking step wherein it serves to promote the initial cracking operation, the catalyst

thus transferred being regenerated to remove deleterious heavy conversion products therefrom subsequent to its removal from the secondary conversion zone and prior to its introduction into the initial conversion zone. The invention also provides an apparatus suitable for conducting the improved process.

The invention is accomplished in a system of the so-called "fluid bed" type wherein the catalyst is maintained in fluidized state to facilitate its transfer between the various reaction and regenerating zones. The apparatus comprises at least two reaction vessels, one of which is continuously employed for conducting the initial cracking operation, while the other is continuously employed for conducting the secondary or olefin conversion step. In one specific embodiment at least two individual vessels for regeneration of the catalyst are also employed, catalyst being continuously transferred during operation of the process from the reaction zone of the initial cracking step to the regenerating zone of that step wherefrom it is returned to the same reaction zone, while catalyst from the secondary reaction zone is supplied to a separate regenerating zone and supplied therefrom, at least in part, either directly to the reaction zone of the initial cracking step or to the latter via the first mentioned regenerating zone. Other specific embodiments will be subsequently described. In all cases the fresh catalyst for the process is continuously supplied to the reaction zone of the secondary conversion step.

Practically any of the known finely divided solid catalysts, capable of actively promoting catalytic cracking, may be employed in both steps in the present process. Such catalysts commonly comprise composites of difficultly reducible oxides, such as alumina and silica, for example. Catalysts of this type include both treated natural clays and synthetically prepared catalysts. The latter are generally superior in activity and are preferred in the present process. I specifically contemplate the use of a synthetically prepared catalyst comprising precipitated silica and alumina with or without one or more selected other difficultly reducible oxides such as, for example, zirconia, boron oxide and thoria. Neither the specific composition nor the method of preparing such catalyst comprise a novel part of the invention and the invention is not limited to the use of any specific cracking catalyst, except insofar as it is capable of promoting the desired reactions, can be successfully regenerated for further use, and is in sufficiently finely divided solid state to permit its use in the fluid bed type of operation.

The accompanying drawing diagrammatically illustrates one specific form of apparatus in which the improved process provided by the invention may be successfully conducted and the following description of the drawing specifies several alternative modes of operation which are possible in the apparatus shown and which are all within the scope of the invention.

Referring to the drawing, the system here illustrated comprises four similar reaction vessels designated as A, B, C and D. Initial catalytic cracking of the hydrocarbon oil charging stock is accomplished in vessel A and the catalyst employed in promoting this reaction is regenerated in vessel B by contacting the same therein with hot oxygen-containing gases to burn therefrom heavy combustible material deposited on the catalyst particles during the cracking

operation. Vessel C comprises the zone wherein olefin-containing gasoline produced in the initial cracking step is catalytically converted to reduce its olefin content and improve its lead susceptibility, and vessel D comprises a regenerating zone for the catalyst from vessel C.

The finely divided solid catalyst in active state or to be regenerated, as the case may be, is supplied to the lower portion of each of the vessels A, B, C and D, as will be later described, together with a fluidizing medium which, in the case of the active catalyst, comprises the hydrocarbon reactants to be converted and, in the case of the catalyst to be regenerated, comprises heated air or other hot oxygen-containing gas capable of igniting the deleterious combustible deposits and burning them from the catalyst particles. The catalyst and the fluidizing medium are supplied to each of the vessels A, B, C and D beneath a suitable perforate distributing plate or the like, indicated by the reference numeral 1, disposed within the lower portion of each of these vessels, and pass upwardly through member 1 into the main body of the vessel wherein a circulating fluidized bed of the catalytic material is maintained. The net upward velocity of the transporting fluid is greater than the net upward velocity of the catalyst particles and a large portion of the latter, after reaching a relatively high level in the vessel, fall back to a lower point where they are again picked up by the transporting fluid. Thus the fluid catalyst bed in each vessel comprises a relatively dense lower phase and a materially less dense upper phase, the approximate line of demarkation between the relatively light and relatively dense phases being indicated in each of the vessels A, B, C and D by the broken line 2.

A standpipe 3 in each vessel, extending downwardly from a suitable level in the dense phase in each zone and terminating in a control valve 4, which is preferably of the adjustable orifice type, serve as means through which regulated quantities of the catalyst are withdrawn from the dense phase in each of the vessels for transportation to one of the other vessels of the group, as will be later described.

Reactors A and C are each provided, in the case illustrated, with suitable equipment, such as the respective cyclone separators 5 and 6, for separating the vaporous hydrocarbon reactants from catalyst particles entrained therein and supplied to the respective separating zones from the relatively light phases of the catalyst beds in reactors A and C through the respective lines 7 and 7'. Similar equipment, such as the cyclone separator 8, employed in conjunction with the regenerating vessel B receives combustion gases produced in the regenerating step and entrained catalyst particles from the light phase of the catalyst bed in vessel B through line 9. Other suitable separating equipment, such as cyclone separator 10, may, when desired, be employed in conjunction with the regenerating vessel D to receive combustion gases and entrained catalyst particles from the relatively light phase of the catalyst bed in this zone through line 11 and valve 12 or, alternatively, combustion gases and catalyst from the relatively light phase in vessel D may be supplied from line 11 through line 13, valve 14 and line 9 to separator 8. Catalyst particles separated from the vapors or gases in the separating zones 5, 6 and 8 are returned through the respective lines 15, 16 and 17 to the relatively

dense phase of the catalyst bed in the respective vessels A, C and B. When separator 10 is employed in conjunction with vessel D, catalyst particles separated from the combustion gases in this zone are returned therefrom through line 18 to the relatively dense phase of the catalyst bed in vessel D.

Hydrocarbon vapors and gases from separator 5 are directed therefrom through line 19 and valve 20 to fractionator 21 wherein normally gaseous hydrocarbons and hydrocarbon vapors boiling within the range of the desired gasoline product are separated from higher boiling components of the conversion products by condensation of the latter. The higher boiling fractions are removed, in the case illustrated, from the lower portion of fractionator 21 through line 22 and valve 23 and may be supplied to storage or returned, all or in part, to further cracking treatment with the charging oil, by well known means not illustrated, or supplied elsewhere, as desired, such as, for example, to separate cracking treatment in a thermal cracking system, not illustrated.

Fractionated vapors and gases of the desired end-boiling point are directed from the upper portion of fractionator 21 through line 24 and valve 25 to condenser 26 wherefrom the resulting distillate, comprising the catalytically cracked gasoline and the normally gaseous fractions which remain uncondensed and undissolved in the distillate, are supplied through line 27 to separation in receiver 28. The uncondensed and undissolved gases are released from the receiver through line 29 and valve 30. Regulated quantities of the distillate collected in receiver 28 are preferably returned therefrom via line 31, valve 32, pump 33, line 34 and valve 35 to the upper portion of fractionator 21 to serve as a cooling and refluxing medium in this zone.

The net make of the catalytically cracked gasoline or light distillate produced by initial cracking of the charging oil in reactor A is directed from receiver 28 through line 36 and valve 37 to pump 38 by means of which it is supplied to the secondary conversion step of the system, as will be later described, for treatment therein to reduce its olefin content and materially improve its lead susceptibility.

Vaporous and gaseous hydrocarbon conversion products resulting from the treatment afforded the catalytically cracked gasoline in reactor C are directed from separator 6 through line 39 and valve 40 to fractionator 41 wherein any conversion products boiling above the range of the desired final gasoline product are condensed and separated from the gasoline vapors and gases. The relatively heavy materials condensed in fractionator 41 are directed, in the case here illustrated, from the lower portion of this zone through line 42 and valve 43 to storage or to any desired further treatment.

The fractionated gasoline vapors and gases are directed from the upper portion of fractionator 41 through line 44 and valve 45 to condenser 46, wherefrom the resulting distillate and the remaining uncondensed and undissolved gases are directed through line 47 to separation in receiver 48. The uncondensed and undissolved gases are released from the receiver through line 49 and valve 50 to storage or elsewhere, as desired, and the distillate, which comprises the final gasoline product of the process, is withdrawn from receiver 48 through line 51 and valve 52. Preferably, regulated quantities of the distillate col-

lected in receiver 48 are recycled via line 53, valve 54, pump 55, line 56 and valve 57 to the upper portion of fractionator 41 wherein they serve as a cooling and refluxing medium.

Combustion gases resulting from regeneration of the catalyst in vessel B or in vessels B and D, as the case may be, are withdrawn from separating zone 8 through line 58 and valve 59 and may be directed through line 62 to suitable heat recovery equipment, not illustrated, such as, for example, a waste heat boiler, steam superheater, hot gas turbine or the like wherein readily available heat in the combustion gas stream is recovered therefrom for any desired useful purpose. When separating zone 10 is employed, combustion gases from the regenerator D are also directed therefrom through line 60 and valve 61 and through line 62 to the same heat recovery equipment.

The hydrocarbon oil charging stock to be catalytically cracked in the initial conversion step of the system is supplied through line 63 and valve 64 to pump 65 wherefrom it is fed through line 66 and valve 67 to and through heater 68, therein quickly heated to a temperature suitable for conducting the catalytic cracking operation and thence supplied through lines 69, valve 70 and line 71 to the lower portion of reactor A. It is therein catalytically cracked in the presence of catalyst transported to this zone from regenerator B through standpipe 3 and valve 4 of this vessel and line 71. Regulated quantities of the catalyst from reactor A are transported through line 3 and valve 4 of this reactor and through line 72 to regenerator B, thus setting up a cyclic flow of catalyst between the dense phases of the catalyst beds in vessels A and B. Air or other oxygen-containing gas suitable for effecting regeneration of the catalyst in regenerator B is supplied thereto, at the temperature required for initiating and maintaining combustion of the deleterious heavy deposits on the catalyst, through line 73, valve 74 and line 72 and serves both as regenerating gas and as a medium for transporting catalyst from vessel A to vessel B.

The olefin-containing catalytically cracked gasoline produced in the initial conversion step of the process and supplied, as previously described, from receiver 28 to pump 38 is directed therefrom through line 75 and valve 76 to and through heater 77, either alone or together with a secondary charging oil, such as virgin gas oil, heavy naphtha, kerosene or the like. The secondary charging oil, when employed, is supplied to line 75, via line 78, valve 79, pump 80, line 81 and valve 82.

The gasoline or gasoline and heavier oil thus supplied to heater 77 is therein quickly heated to a temperature suitable for conducting the secondary conversion step of the system and the heated material is directed through line 83, valve 84 and line 85 to the lower portion of reactor C, together with fresh catalyst or fresh and regenerated catalyst, which is supplied to line 85 as will be later described. The substantial conversion of olefinic components of the gasoline to materials boiling within the range of the desired final gasoline product and of materially improved lead susceptibility is accomplished in reactor C, the final gasoline product being collected in receiver 48, as previously described.

Fresh catalyst for the entire operation is initially supplied to reactor C, and, in the case illustrated, is directed from the catalyst hopper 86 through line 87 and valve 88 into line 85 wherein

it is commingled with the stream of heated hydrocarbons from heater 77 and is supplied therewith to reactor C.

Catalyst is withdrawn in regulated quantities from the dense phase of the fluid bed in reactor C through standpipe 3 and valve 4 of this reactor and may be supplied, all or in part, through line 89 to the regenerating vessel D. Heated air or other hot oxygen-containing gas for accomplishing regeneration of the catalyst is supplied to line 89 through line 90, line 91 and valve 92 and serves as a transporting fluid for the catalyst being transferred from vessel C to vessel D. Provision is also made for supplying a regulated portion of the catalyst withdrawn from reactor C through line 3 and valve 4 of this vessel to regeneration in vessel B, when desired, via line 95, valve 96 and line 72, in which case a portion of the air or other hot oxygen-containing gas stream required for regeneration of the catalyst in reactor B is supplied to line 95 via line 90, line 93 and valve 94 to serve as a transporting fluid for the catalyst from reactor C, while another portion of the regenerating gas stream is supplied to line 72, as previously described, through line 73 and valve 74.

Regenerated catalyst is withdrawn in regulated quantities from the dense phase of the fluid bed in reactor D through standpipe 3 and valve 4 of this vessel and may be returned, all or in part, to reactor C via line 96, valve 97 and line 85. Provision is also made for supplying all or a portion of the regenerated catalyst from vessel D, when desired, to reactor A via line 98, valve 99 and lines 69 and 71, together with the heated charging oil from heater 68 and regenerated catalyst from vessel B.

As previously mentioned, the apparatus illustrated makes provision for several alternative modes of operation which are within the scope of the invention. In accordance with one specific mode of operation, all of the catalyst removed from the dense phase of the fluid bed in reactor C is supplied to and subjected to regeneration in the regenerating vessel D and all of the regenerated catalyst removed from the dense phase of the fluid bed in vessel D is returned to reactor C. With this mode of operation the only transfer of catalyst between the secondary conversion step and the initial cracking step is from the light phase of the fluid bed in vessel D to vessel B via line 13, valve 14 and separating zone 8. In some instances this light phase transfer alone will not keep the initial conversion step supplied with the required quantity of catalyst or will give a too prolonged residence time for the catalyst in the secondary conversion step. In such cases it is necessary to augment the supply of catalyst to the initial conversion step either by supplying a portion of the regenerated catalyst from the dense phase of the fluid bed in vessel D to reactor A, in the manner previously described, or by supplying a portion of the catalyst withdrawn from the dense phase of the fluid bed in vessel C to vessel B, in the manner previously described.

It is also within the scope of the invention, regardless of whether the light phase transfer between vessels D and B is employed, to supply all or a portion of the regenerated catalyst from vessel D to reactor A, or to supply a portion or all of the catalyst withdrawn from the dense phase of the fluid bed in reactor C to vessel B. When all of the spent or all of the regenerated catalyst from the secondary conversion step is

supplied to the primary cracking step in either of the last mentioned manners, the secondary conversion reaction will, of course, be conducted entirely with the fresh catalyst supplied to reactor C from hopper 86. When only a portion of the spent and regenerated catalyst from the dense phases of the fluid beds in the respective vessels C and D is supplied, as previously indicated, to the respective vessels B and A, the secondary conversion step will operate partially on the fresh catalyst from hopper 86 and partially on regenerated catalyst from vessel D. The latter is ordinarily the preferred mode of operation since it is usually not necessary for good results to employ fresh catalyst entirely in the secondary conversion step.

The rate at which fresh catalyst is supplied to reactor C and the rate at which catalyst is recycled from reactor C to regenerator D and back to reactor C are regulated to maintain a high order of activity for the catalyst in reactor C, sufficient to promote the secondary conversion reaction conducted in this zone.

In fluid bed operations of the type herein provided there is some loss of catalyst from the system in the form of fines which escape separation from the hydrocarbons and from the reactivating gases in the separating equipment. The rate at which fresh catalyst is supplied to reactor C is at least sufficient to compensate for the catalyst fines lost from the system and keep the total volume of catalyst within the system substantially constant. In case this minimum rate of fresh catalyst supply is not adequate to maintain the desired catalyst activity in the secondary conversion step of the system, it is increased to the required amount and provision is made for preventing the accumulation of excess catalyst within the system by withdrawing it therefrom. Preferably, the catalyst so withdrawn is of a relatively low order of activity and it is, therefore, preferably removed from the relatively dense phase of the catalyst bed in the regenerating vessel B through line 100 and valve 101, communicating with line 71, although it is within the scope of the invention to withdraw the excess catalyst from any other suitable point in the system.

The various alternative modes of operation above described are not fully equivalent but may be selected to suit requirements. The selection will depend upon the specific nature of the catalyst employed, particularly with respect to its initial activity and the rate at which its activity for promoting the secondary conversion reaction decreases. It will also depend to some extent upon the nature of the charging oil employed for the initial conversion step and the olefin content of the gasoline to be treated in the secondary conversion step. With any of the aforementioned methods of dense phase catalyst transfer from the secondary conversion step to the primary conversion step, the choice between transfer from the regenerating vessel D to reactor A or transfer from reactor C to regenerating vessel B will depend to a large extent upon the relationship between operating conditions in the initial and secondary conversion steps. For example, when the secondary conversion reaction is conducted at a substantially lower temperature than that employed for the initial cracking of the charging oil, and particularly in case regeneration of the catalyst in vessel D is accomplished at relatively low temperature, transfer of catalyst from this zone directly to reactor A may tend to

excessively reduce the operating temperature in the latter zone. In such instances, the dense phase transfer is preferably from reactor C to the regenerating vessel B with only a limited or no transfer of catalyst from regenerator D directly to reactor A.

It will be apparent that the various alternative modes of operation above mentioned enjoy, in common, the fundamental improvement provided by the invention, namely, the use of only catalyst having a relatively high order of activity in the secondary conversion step of the system and the transfer of catalyst of decreased activity from this step to the initial conversion zone following its regeneration either in the regenerating vessel D or in the regenerating vessel B.

The operating conditions employed within the system may be varied over a considerable range, depending upon the particular catalyst employed and the nature of the charging oil. The initial conversion step, wherein the charging stock is cracked to produce gasoline of relatively high olefin content, may employ a temperature in the reaction zone ranging from 850 to 1100° F., or thereabouts, with an operating pressure in this zone ranging from substantially atmospheric to 100 pounds or more per square inch, superatmospheric pressure. The weight ratio of catalyst to oil undergoing treatment at any given time in the reactor of the initial conversion stage may range from approximately 0.5:1 to about 10:1 and the hourly weight space velocity may range from approximately 0.5 to approximately 8.

The term "space velocity" as used herein designates the pounds of oil contacted, per hour, per pound of catalyst in the reaction zone.

The second conversion stage of the system, wherein distillate from the initial conversion step is converted to decrease its olefin content and improve its lead response, may employ a temperature in the reaction zone of from 700 to 1000° F., or thereabouts, with a superatmospheric pressure in this zone which may range from substantially atmospheric to 100 pounds or more per square inch, superatmospheric. The hourly weight space velocity may be from 0.25 to 6 or thereabouts and the weight ratio of catalyst to oil undergoing treatment at any given time in this zone may range from 2:1 to 20:1, or thereabouts.

In general, the ratio of catalyst to oil in the reaction zone is increased with an increase in the operating temperature employed. This applies to both the initial and the secondary stages of the system and the secondary conversion stage will normally employ a lower space velocity and higher catalyst to oil ratio than the initial conversion stage.

Each of the regenerating zones of the system may employ the temperature of the order of 1000 to 1300° F., but the two regenerating zones are not necessarily operated at the same temperature. The pressure employed in the regenerating steps may range from substantially atmospheric to 100 pounds, or thereabouts, per square inch, superatmospheric, and preferably regeneration is accomplished at a pressure relatively close to that employed in the reaction zones in order to facilitate transportation of the catalyst between the several zones.

As an example of one specific operation of the process, as it may be conducted in an apparatus such as illustrated and above described, the charging stock is a Mid-Continent gas oil of about 30° A. P. I. gravity and the catalyst employed is a relatively fine powder in which the particles com-

prise a precipitated composite of silica and alumina in the ratio of about 9:1.

The first stage of the process, wherein the charging stock is initially cracked to produce gasoline of high antiknock value and relatively high olefin content, is conducted at a temperature of approximately 925° F. in reactor A and at a superatmospheric pressure in this zone of approximately 5 pounds per square inch. The approximate weight ratio of catalyst to oil in this reaction zone is maintained at about 3:1 and the hourly space velocity expressed on a weight basis is approximately 2.

A distillate product of approximately 450° F. end-boiling point is collected in receiver 28 and supplied to reactor C as the charging stock for the second conversion stage of the system. The conversion temperature employed in this zone is approximately 900° F. and the operating pressure is approximately 5 pounds per square inch, superatmospheric. The weight ratio of catalyst to oil maintained in reactor C is approximately 8:1 and the hourly weight space velocity, as above defined, is approximately 1.5.

The regenerating zones A and B are each operated at a maximum temperature of approximately 1300° F. and at a superatmospheric pressure of about 5 pounds per square inch.

The above described operation will yield, per barrel of charging stock supplied to the initial conversion step, approximately 30% to 300° F. end-point gasoline having a bromine number of approximately 15 and a clear octane number of approximately 82.5. With the addition of 4 cc. tetraethyl lead to this product the octane number is increased to approximately 95 as determined by the motor method and by blending a relatively small amount of alkylmer gasoline, for example, to the leaded fuel, its octane number may be increased to 100. For the purposes of comparison the 300° F. end point fraction of the gasoline produced in the initial cracking step will have a bromine number of approximately 45, a clear octane number of approximately 82, as determined by the motor method, which is increased to only about 88-89 by the addition of 4 cc. of tetraethyl lead. In addition to the 300° F. end-point aviation gasoline stock recovered from the final conversion step of the system, about 15%, based on the gas oil charging stock, of 300 to 400° F. naphtha may be recovered. This material will have a clear octane number of approximately 85 and is suitable as blending stock for motor gasoline.

I claim as my invention:

1. In a two-stage hydrocarbon conversion process wherein charging oil boiling above the range of gasoline is catalytically converted in the initial stage with the resulting production of olefin-containing gasoline which is catalytically converted in the secondary stage of the process to materially reduce its olefin content and increase its susceptibility to tetraethyl lead for improving its antiknock value, the steps which comprise, supplying substantially all fresh catalyst employed in the process to the secondary conversion stage and, after a limited period of use in this stage regenerating the used catalyst and supplying it to the primary conversion stage to promote the primary conversion reaction.

2. A process such as defined in claim 1, wherein the initial conversion stage and the secondary conversion stage each employs a reaction zone and a catalyst regenerating zone individual thereto, regenerated catalyst from the regenerating

zone of the secondary conversion stage being returned in part to the reaction zone of this stage and, in part, to the initial conversion stage.

3. A process such as defined in claim 1, wherein the initial conversion stage and the secondary conversion stage each employs a reaction zone and a catalyst regenerating zone individual thereto, regenerated catalyst from the regenerating zone of the secondary conversion stage being returned in part to the reaction zone of this stage and, in part, to the reaction zone of the initial conversion stage, all of the regenerated catalyst from the regenerating zone of the initial conversion stage, which is further used within the system, being returned to the reaction zone of the initial conversion stage.

4. The process such as defined in claim 1, wherein each conversion stage of the process employs a reaction zone and a catalyst regenerating zone individual thereto, catalyst from the reaction zone of each stage being continuously supplied to the regenerating zone of that stage and returned therefrom to the reaction zone of the same stage, and wherein a regulated portion of the catalyst from the reaction zone of the secondary conversion stage, instead of being supplied to the regenerating zone of that stage, is supplied to the regenerating zone of the initial conversion stage.

5. The process of catalytically converting hydrocarbon oil boiling above the range of gasoline to produce a final gasoline product of low olefin content and good lead susceptibility which comprises, heating the charging oil to cracking temperature and contacting the heated material in a primary reaction zone with a cracking catalyst to produce gasoline of good antiknock value and relatively high olefin content with the resulting deposition on the catalyst of deleterious heavy conversion products, continuously supplying thus contaminated catalyst from said reaction zone to a regenerating zone, therein burning said deleterious heavy conversion products from the catalyst, continuously returning resulting regenerated catalyst from the regenerating zone to said reaction zone, supplying vaporous products of the catalytic cracking operation from said reaction zone to a fractionating zone, therein separating said highly olefinic gasoline from heavier conversion products, supplying the highly olefinic gasoline thus recovered to a separate reaction zone and therein contacting the same with an active cracking catalyst under conditions regulated to materially reduce the olefin content of the gasoline and improve its lead susceptibility without excessive loss in volume or antiknock value, separating resulting improved gasoline of the desired end-boiling point from higher boiling fractions of the conversion products formed in the last mentioned reaction zone and recovering said gasoline, continuously supplying catalyst which has become contaminated by the deposition thereon of deleterious heavy conversion products from the second named reaction zone to another regenerating zone and therein regenerating the same by burning the deleterious deposit therefrom, and continuously returning portions of the resulting regenerated catalyst from the last mentioned regenerating zone to the second mentioned reaction zone, fresh cracking catalyst for the process being supplied to the secondary conversion zone and regulated quantities of the regen-

erated catalyst from the second mentioned regenerating zone being returned to the first mentioned reaction zone for use therein to promote the initial cracking reaction.

6. The process of catalytically converting hydrocarbon oil boiling above the range of gasoline to produce a final gasoline product of low olefin content and good lead susceptibility which comprises, heating the charging oil to cracking temperature and contacting the heated material in a primary reaction zone with a cracking catalyst to produce gasoline of good antiknock value and relatively high olefin content with the resulting deposition on the catalyst of deleterious heavy conversion products, continuously supplying thus contaminated catalyst from said reaction zone to a regenerating zone, therein burning said deleterious heavy conversion products from the catalyst, continuously returning resulting regenerated catalyst from the regenerating zone to said reaction zone, supplying vaporous products of the catalytic cracking operation from said reaction zone to a fractionating zone, therein separating said highly olefinic gasoline from heavier conversion products, supplying the highly olefinic gasoline thus recovered to a separate reaction zone and therein contacting the same with an active cracking catalyst under conditions regulated to materially reduce the olefin content of the gasoline and improve its lead susceptibility without excess loss in volume or antiknock value, separating resulting improved gasoline of the desired end-boiling point from higher boiling fractions of the conversion products formed in the last mentioned reaction zone and recovering said gasoline, continuously supplying from the second mentioned reaction zone a regulated portion of the catalyst which has become contaminated therein to another regenerating zone, therein regenerating the same by burning said deleterious deposits therefrom, returning thus regenerated catalyst from the second mentioned regenerating zone to the second mentioned reaction zone and supplying another portion of the contaminated catalyst from the second mentioned reaction zone to the first mentioned regenerating zone.

7. A conversion process which comprises catalytically cracking hydrocarbon oil heavier than gasoline to produce olefinic gasoline therefrom, subjecting at least a portion of said gasoline to catalytic conversion in the presence of fresh cracking catalyst to reduce its olefin content, removing used catalyst from the last-mentioned conversion step and regenerating the same, and supplying thus regenerated catalyst to the heavy oil cracking step.

8. A conversion process which comprises catalytically cracking hydrocarbon oil heavier than gasoline in a first reaction zone, subjecting olefinic gasoline formed in said reaction zone to catalytic conversion in a second reaction zone to reduce its olefin content, introducing fresh cracking catalyst to said second zone, removing used catalyst from the second zone and introducing the same to a regenerating zone containing a body of used cracking catalyst undergoing regeneration, removing regenerated catalyst from the regenerating zone and supplying the same to said first reaction zone.

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