

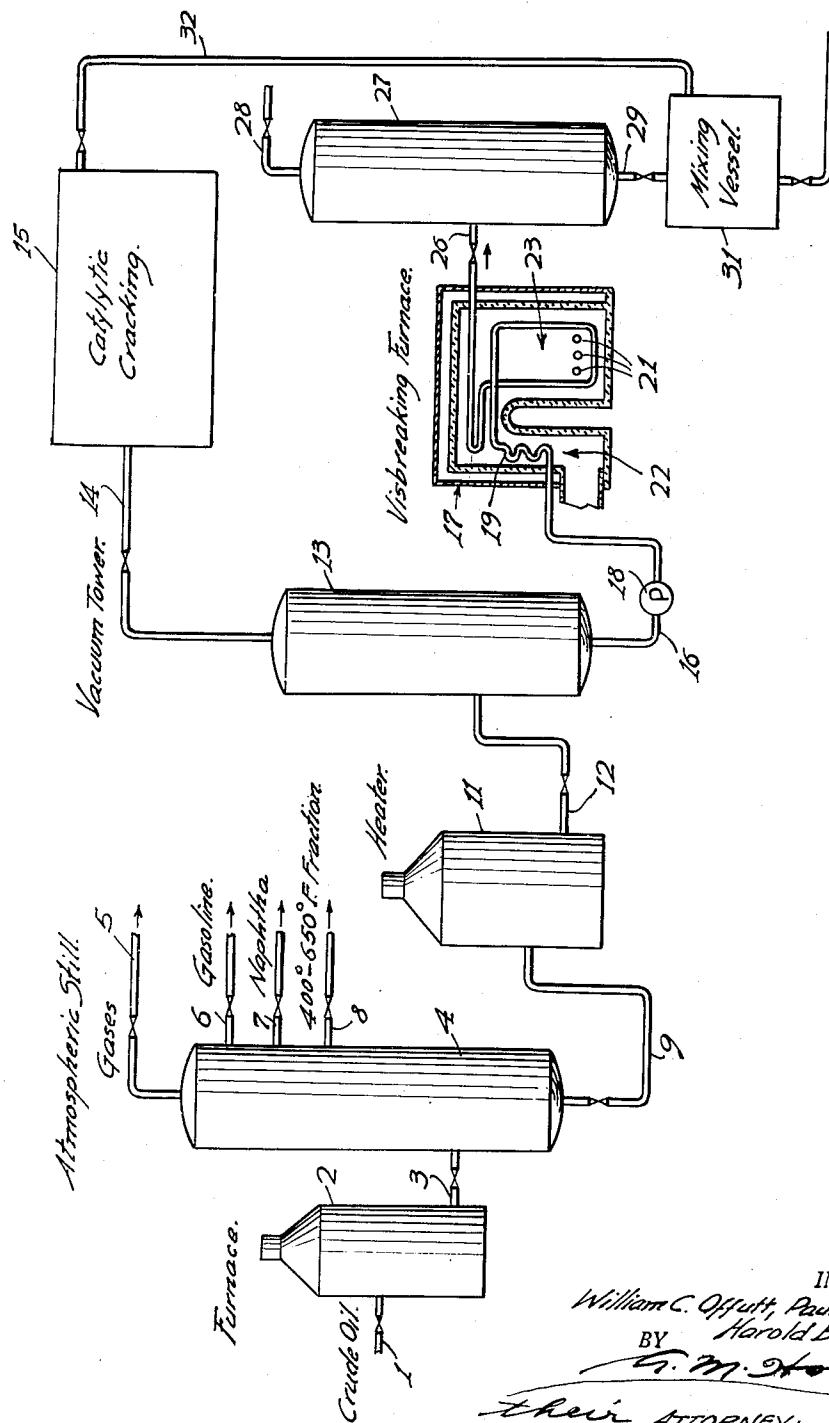
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W. C. OFFUTT ET AL

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THERMAL CONVERSION OF REDUCED CRUDES

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INVENTORS.

William C. Offutt, Paul Siecke and
Harold Beuther.

BY

G. M. Houghton
their ATTORNEY.

1

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THERMAL CONVERSION OF REDUCED CRUDES

William C. Offutt, Edgewood, Paul Siecke, Mount Lebanon Township, Allegheny County, and Harold Beuther, Penn Township, Allegheny County, Pa., assignors, by direct and mesne assignments, to Gulf Oil Corporation, Pittsburgh, Pa., a corporation of Pennsylvania

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3 Claims. (Cl. 196—50)

This invention relates to a thermal conversion process, and more particularly to a process whereby exceptionally heavy fractions of crude petroleum are converted to more valuable products by thermal conversion.

Methods of refining crude petroleum vary considerably depending upon the type of crude oil available, the market area in which the refinery disposes of the products, and other factors. The method probably most frequently employed in modern refineries involves first subjecting the crude oil to atmospheric distillation under conditions to recover distillate fractions including a gasoline fraction and a furnace oil fraction having an end point of about 650° to 750° F. The bottoms from this distillation is then subjected to distillation under a vacuum to remove overhead a charging stock for conventional catalytic cracking such as fluid catalytic cracking or moving bed catalytic cracking. In this last distillation step it has been the practice to produce a vacuum bottoms which contains not only the asphaltic constituents initially present in the crude oil but also certain of the heavier oil fractions. This final reduced crude has then generally been disposed of as a heavy fuel oil referred to as No. 6 or Bunker C fuel oil.

Despite the fact some of the oil constituents of the crude are generally retained in this bottoms product, it is normally too heavy and viscous a material to be sold as such, particularly if the vacuum distillation has been carried out so as to yield an efficient amount of catalytic cracking charge stock. In order to convert this heavy material to a salable product, it has been necessary to dilute it with a lighter oil, usually catalytic cycle stock which is frequently about 650° F. end point material; in other words, a No. 2 fuel oil, which would demand a relatively high price if sold as such. Inasmuch as a No. 6 fuel oil is a low-priced material, it has long been the desire of refiners to reduce the production of this product while increasing the production of more valuable products obtainable from the crude oil.

One procedure that has been given consideration involves subjecting the vacuum bottoms product to thermal conversion to accomplish conversion of a part of the product into gasoline and the remainder into a less viscous material than the charge stock. However, so far as known, attempts to subject the vacuum bottoms product obtained in the conventional operation to thermal cracking or visbreaking at temperature above 900° F. in the equipment generally employed for thermally cracking or visbreaking lighter charge stocks, have not been successful. This is because such products obtained from the types of crudes handled in the majority of domestic refineries have yielded an inordinate amount of coke and gas if subjected to thermal conversion under conditions sufficiently severe to obtain the desired conversion of the charge stock. Thus, if such a stock is subjected to visbreaking at a temperature sufficiently high to cause adequate conversion of the stock, such as conversion resulting in the production of 8 per cent or more gasoline by volume of the charge, the formation of coke

2

is such as to reduce to an uneconomically short time the period during which the conversion unit can remain on stream. On the other hand, if the maximum temperature to which the charge is heated is reduced to a point at which coke formation permits long on-stream periods, the amount of conversion is substantially reduced.

The coke deposited during thermal conversion operations of the type under consideration is a hydrocarbonaceous material in which the ratio of carbon to hydrogen is extremely high. It has long been accepted that under a given set of operating conditions the amount of coke produced in thermal conversion operations will vary generally in accordance with the carbon-hydrogen ratio of the hydrocarbon compounds making up the charge stock, and this has been confirmed by numerous experimental and commercial thermal operations on heavy gas oils and on typical reduced crudes containing asphaltic and heavy oil constituents of the original crudes. A recognized indication of the carbon-hydrogen ratio of a heavy oil, and therefore the coke-making tendency of the oil, is the Conradson carbon residue number of the oil. Thus it is accepted that by controlling the degree of reduction of a crude so as to produce a reduced crude having a relatively low Conradson carbon residue number, a charge stock suitable for thermal conversion without the production of undesirable amounts of coke can be obtained.

The present invention is based upon the discovery that by removing substantially more of the lighter compounds in reduced crude oils than is the conventional practice, the resulting residual product can be successfully visbroken in a single-pass operation by flowing the reduced crude through a thermal conversion zone under conditions including zone exit temperature of about 900° to about 1000° F., which is applied to a longer residuum of the same crude oil, would result in the production of coke and gas at rates such as to reduce to an uneconomically short period the time during which the operation could be continued. The product of the process comprises gasoline and a residue substantially less viscous than the charge material.

The extent of reduction of the crude required to produce a charge stock suitable for use in the process of the invention cannot adequately be defined as a percentage of the crude because of the wide variance in the composition and properties of crudes from different oil fields. In the case of a highly paraffinic crude, a bottoms product consisting of only 5 to 6 per cent by weight of the crude might be too light for effective use, whereas in the case of a crude containing a substantial amount of asphalt, a bottoms product consisting of as high as 30 per cent of the crude might be suitable. We have found that reduced crudes which have a Conradson carbon residue number of at least 18, an A. P. I. gravity below 10, and a viscosity, S. U. S. at 210° F., of at least 6000 can be employed successfully in the present process.

While it is not intended to limit the present invention to any particular theory, the research work leading to the development of the invention has indicated that the difficulties experienced in the past in attempting to visbreak deeply reduced crudes were due to the fact the reduced crudes employed contained oil components probably largely paraffinic in nature. These components, although lighter and having a smaller carbon residue number than the remainder of the reduced crude, apparently were converted readily to coke and may have tended to direct conversion of the remainder of the reduced crude towards high coke formation. Removal of lighter components in accordance with the invention has resulted in a charge stock which can be visbroken at temperatures above 900° F. without the production of excessive amounts of coke.

The deeply reduced crude charge stock for the present process is preferably prepared by subjecting the crude oil to conventional distillation at atmospheric pressure to remove overhead as distillate the gasoline, kerosene, and furnace oil cuts; for example, the fractions boiling below a selected temperature such as 650° or 750° F. The bottoms from this operation is then subjected to vacuum distillation under conditions to pass overhead an amount of catalytic cracking charging stock in excess of that conventionally produced from such a bottoms material and to yield a vacuum bottoms or tar having the characteristics discussed above; i. e., a Conradson carbon residue number of at least 18, an A. P. I. gravity of below 10, and a viscosity, S. U. S. at 210° F., of at least 6000. The production of a vacuum bottoms of this type is preferably accomplished by increasing the vacuum in the distillation, but also can often be accomplished by increasing the heat content of the charge to the vacuum still. The necessary adjustment of conditions to obtain the desired extent of reduction of the crude is fully within the skill of an operator of this type of equipment.

The vacuum bottoms constituting an exceptionally deeply reduced crude is then passed to a thermal cracking unit of conventional design comprising a conversion coil in a cracking furnace and means such as gas or fuel oil burners positioned in the lower part of the furnace. The conditions of the operation, including heat input, rate of flow of charge through the coil, and time, are adjusted so that the temperature of the charge at the outlet of the coil is about 900° to about 1000° F., preferably about 920° to about 980° F.; and the charge to the coil is converted to gasoline (C₄'s up to 400° F. end point) in an amount equal to at least 8 per cent and preferably not more than 20 per cent by volume of the charge. These conditions are preferably selected from within the ranges: coil volumes of about 0.012 to about 0.050 cubic feet of coil volume above 750° F. per barrel throughput per day; linear velocity of about 0.1 to 10 feet per second; pressure of about 50 to about 1000 pounds per square inch gauge (pressure is not an important factor because the extremely heavy charge will be in liquid phase and it is only towards the end of the coil that lighter hydrocarbons are formed in any substantial amount); and a heat input of about 5000 to about 15,000 B. t. u.'s per hour per square foot of outside heating surface.

A preferred embodiment of the invention will be understood more fully by reference to the accompanying drawing, the single figure of which is a diagrammatic representation of a suitable system for carrying out the embodiment. The drawing will be described in connection with the treatment of a typical West Texas crude oil. The crude oil is introduced into the system through a valved line 1 leading to a conventional furnace 2 wherein the crude is heated to a suitable elevated temperature such as a temperature of about 650° to 750° F. From the heater the crude flows through valved line 3 to an atmospheric distillation column 4. As is well known, such a distillation column may be operated so as to separate the crude into a variety of products; however, in this instance the column is operated so as to obtain the C₄ and lighter hydrocarbons as overhead products which are passed through line 5, a 300° F. end point gasoline which is passed through line 6, a 300° to 400° F. naphtha which is passed through line 7 and a 400° to 650° F. furnace oil fraction which is passed through line 8. Operating in this way the bottoms product will comprise of the order of about 40 per cent of the crude and this product is removed through line 9 leading to a heater 11 which supplies sufficient heat to the bottoms to raise this product to a temperature of about 700° to about 800° F. The heated material then passes through line 12 leading to a vacuum tower 13.

This tower is operated as previously described in order to produce as a vacuum bottoms or tar a deeply reduced

crude having the characteristics outlined above. To accomplish this on the bottoms from the atmospheric distillation column, an amount equal to about 30 volume per cent of the original crude, is passed overhead from the vacuum tower through line 14 as charge to a conventional catalytic cracking unit and auxiliary equipment indicated generally at 15. Thus, the vacuum bottoms comprises about 10 volume per cent of the crude and is a product having the properties specified above.

The vacuum bottoms is passed through line 16 leading to a conventional visbreaking or thermal cracking furnace indicated generally at 17. In order to move the vacuum bottoms from the vacuum tower to the furnace 17 and also to provide the desired pressure on the oil in the furnace, a pump 18 is employed in line 16. In the furnace the vacuum bottoms is passed through coil 19 and is heated by means of a plurality of burners 21, disposed in the lower portion of the furnace. In the arrangement shown, the furnace comprises a convection heating section indicated generally at 22 and a radiant heating section indicated generally at 23. The pressure in the coil may vary, for example, it may be about 50 to about 1,000 pounds per square inch, and preferably is about 100 to 600 pounds per square inch. In the coil the charge is subjected to visbreaking under conditions such that the coil outlet temperature is about 900° to 1000° F., preferably about 920° to about 980° F., and the coil volume is about 0.020 to about .035 (cubic feet of coil volume above 750° F. per barrel of throughput per day).

The product from the visbreaking furnace 17 is removed from the furnace through valved line 26 leading to a fractionator 27. In this embodiment the fractionator is operated so as to pass overhead the 400° F. end point gasoline and lighter materials through a line 28. This overhead product is sent to a stabilizer, not shown, wherein C₄'s through 400° F. end point gasoline is separated from the C₃'s and lighter gases. The gasoline removed through this line under the conditions stated will comprise of the order of 8 to 18 volume per cent of the vacuum bottoms and the bottoms product will comprise about 92 to 82 volume per cent of the vacuum bottoms.

The bottoms product is removed through valved line 29 to a mixing vessel 31. Since the product alone will be too heavy for sale as No. 6 fuel oil, it is mixed with catalytic cracking cycle stock from the catalytic cracking unit 15 through line 32.

In order that this embodiment of the invention may be understood more fully, there is presented below in Table I data obtained in a series of runs in which the charge to the visbreaker was a vacuum bottoms comprising 9.9 volume per cent of the West Texas crude. In all of the runs for which data are given in the table, coke deposition was insignificant and the runs were not extended to evaluate the advantages of the operation with respect to duration of on-stream periods. The inspections for the 9.9 volume per cent West Texas reduced crude were as follows:

60	Gravity, ° API	8.5
	Viscosity, SUS at 210° F.	7932
	B. S. & W., per cent	0.1
	Conradson carbon residue, per cent	19.8
	Sulfur, per cent	2.90
65	Pour point, °F.	100
	Melting point, °F. (R. & B.)	117
	Penetration (D5)	168

The gravity, viscosity, and Conradson carbon residue values given in this table were determined in accordance with the test methods given in "ASTM Standards on Petroleum Products and Lubricants" November, 1950. The gravity test bears ASTM designation D287-39; the viscosity test, the ASTM designation D88-44; and the Conradson carbon residue test, the designation D189-46.

The oil used to cut the various bottoms product was a light catalytic cycle stock having a gravity, °API, of 31.2. This oil is referred to as "cutting oil" in the following Table I.

Table I

Charge to Visbreaker Furnace.....	9.9 Vol. Percent West Texas Crude					
Run No.....	Charge	A		B		C
Period.....		1	2	1	2	1 2
Operating Conditions:						
Coil Outlet Temp., °F.....		920	940	960	980	950
Coil Pressure, p. s. i. g.....		200	200	200	200	600
Coil Volume above 750° F. (Cu. Ft./Bbl. throughput/day).....		0.019	0.020	0.020	0.020	0.016
Length of Test Period, hours.....		6	6	6	6	6
Yields, Vol. Percent of Charge to Furnace:						
Gas (C ₃ and Lighter) (FOE).....		1.5	2.0	2.0	2.2	2.3
C ₄ 400° F. Gasoline.....		9.3	10.7	12.3	17.3	18.2
300°-400° F. Naptha.....		4.8	5.3	4.7	5.3	8.6
400° F. + Bottoms.....		91.6	89.8	88.0	84.2	83.4
Fuel Oil Blends (200 SFS at 122° F.):						
Yield of Bottoms (Vol. Percent of Crude).....		9.9	9.0	8.7	8.3	8.3
400° F. + Bottoms of Visbroken Products.....						8.6
Cutting Oil Required to Make Fuel Oil (Vol. Percent of Crude).....		4.9	2.8	2.7	2.6	2.3
Yield of Fuel Oil (Vol. Percent of Crude).....		14.8	11.8	11.6	10.9	10.6
Fuel Oil Inspection Data:						
Gravity, °API.....		15.0	12.4	12.4	11.5	11.5
Viscosity, SUS at 130° F.....		1,400	1,630	1,440	1,680	1,710
Viscosity, SUS at 210° F.....		192	179	161	223	274
Viscosity, SFS at 122° F.....		194	214	202	210	174
B. S. & W., Percent.....		trace	0.05	0.4	0.5	0.2
Carbon Residue, Percent (Conradson).....		14.9	18.5	21.2	21.9	21.9
Sulfur, Percent.....		2.14	2.38	2.46	2.47	2.56
Pour Point, °F.....		10	20	30	25	45
Flash Point, °F.....		230	230	225	230	230
Sediment by Extraction, Percent (D473).....		0.01	0.01	0.06	0.15	0.40

F. It is pointed out that these runs and the runs described later in this specification were carried out in pilot plant equipment. It is a generally accepted rule that the period during which a commercial visbreaking plant can remain

Each of the runs A, B, and C was a continuous operation over the two periods named, although the products were analyzed at the end of each period. No important coke deposition occurred and the light gas production was satisfactory during the runs. It was apparent that each run could have been continued for a period many times as long as the periods named in the table, and this despite the facts that the reduced crude charge was an extremely heavy material and that the coil outlet temperatures were substantially above 900°

on-stream without excessive coke deposition is many times that for a pilot plant when charging the same stock under comparable operating conditions.

From a study of the results set out in Table I, it will be seen that the operation described has important advantages with respect to the reduction of heavy fuel oil production and an increase in the total amount of lighter products obtained from the crude. For example, when the reduced crude charge was employed for making heavy fuel oil, 14.8 per cent by volume of the original crude

Table II

Charge to Visbreaker Furnace.....	Charge I		Charge II		
Run No.....	Charge I	D	Charge II	E	
Duration of Run, Hours.....		27		72	
Period.....		1		1	2 3
Remarks—Coil Condition		Coked		OK	OK OK
Operating Conditions:					
Coil Outlet Temp., °F.....		950		950	950
Coil Pressure, p. s. i. g.....		200		200	220
Coil Volume above 750° F. (Cu. Ft./Bbl. throughput/day).....		0.020		0.020	0.020
Length of Test Period, hours.....		24		20	24
Yields, Vol. Percent of Charge to Furnace:					
Gas (C ₃ and Lighter) (FOE).....		1.7		1.9	1.7
C ₄ 400° F. Gasoline.....		14.1		14.0	12.4
300°-400° F. Naptha.....		6.4		5.0	4.7
400° F. + Bottoms.....		87.7		88.3	89.4
Fuel Oil Blends (200 SFS at 122° F.):					
Yield of Bottoms (Vol. Percent of Charge).....		100.0		100.0	88.3
400° F. + Bottoms of Visbroken Products.....					89.4
Cutting Oil Required to Make Fuel Oil (Vol. Percent of Charge).....		45.0		68.2	60.2
Yield of Fuel Oil (Vol. Percent of Charge).....		145.0		168.2	148.5
Fuel Oil Inspection Data:					
Gravity, API.....		15.0		13.1	14.8
Viscosity.....					
SUS at 130° F.....		1,266		1,458	1,315
SUS at 210° F.....		178		166	190
SFS at 122° F.....		173		219	180
B. S. & W., Percent.....		0.1		2.0	0.1
Carbon Residue, Percent (Conradson).....		13.3		17.4	16.8
Sulfur, Percent.....		2.14		2.37	2.02
Pour Point, °F.....		5		35	—5
Flash Point, °F.....		224		235	208
Sediment by Extraction, Percent (D473).....		0.01		0.46	0.01

had to be disposed of as heavy fuel oil. Moreover, in order to produce a salable fuel oil from the reduced crude charge, it was necessary to employ 4.9 per cent by volume of the cutting oil, which was a light TCC cycle stock suitable for incorporation in a No. 2 fuel oil. Proceeding in accordance with the invention reduced the total amount of heavy fuel oil to from 11.8 to 10.5 volume per cent of the crude, and perhaps more important, reduced the cutting oil required to an amount from 2.8 to 1.9 vol-

Gravity, ° API ----- 5.4
Viscosity, SUS at 210° F----- 16,200
Conradson carbon residue, per cent----- 22.0
Sulfur, per cent----- 5.30
Pour point, ° F----- 110

The oil used to cut the various bottoms product was a light catalytic cycle stock having a gravity, ° API, of 31.2. This oil is referred to as "cutting oil" in Table III.

Table III

		17.7 Vol. percent Kuwait Crude								
Charge to Visbreaker Furnace.....		Charge	F	G	H	I	J	K	L	M
Run No.....										
Duration of Run.....		20	10	40	48	21	13	12	10	
Remarks—Coil Condition.....		OK	OK	OK	OK	OK	OK	OK	OK	
Operating Conditions:		925	955	955	925	900	930	900	900	
Coil Outlet Temp., ° F.....		200	200	200	200	200	200	200	200	
Coil Pressure, p. s. i. g.....		0.0255	0.0236	0.0248	0.0300	0.0247	0.0246	0.0303	0.0343	
Coil Volume above 750° F. (Cu. Ft./Bbl. throughput/day).....		8	8	24	48	8	8	8	8	
Length of Test Period, hours.....										
Yields, Vol. percent of Charge to Furnace:		1.9	2.7	2.7	1.5	1.6	1.9	1.1	1.4	
Gas (C ₂ and Lighter) (FOE).....		14.2	17.1	18.3	12.3	10.9	14.9	10.1	11.6	
C ₄ 400° F. Gasoline.....				6.9	4.3	3.2	3.0	3.0	3.8	
300°-400° F. Naphtha.....		87.3	85.1	83.5	90.6	91.0	87.1	91.6	90.2	
400° F. + Bottoms.....										
Fuel Oil Blends (200 SFS at 122° F.):										
Yield of Bottoms (Vol. percent of Crude 400° F. + Bottoms of Vis-		17.7	15.5	15.1	14.8	16.1	16.1	15.4	16.0	
broken Products).....		10.2	5.6	5.5	5.4	5.7	6.3	5.2	5.5	
Cutting Oil Required to Make Fuel Oil (Vol. percent of Crude).....		27.9	21.1	20.6	20.2	21.8	22.4	20.6	21.5	
Yield of Fuel Oil (Vol. percent of Crude).....										
Fuel Oil Inspection Data:		13.9	10.6	9.5	9.6	11.1	11.3	9.7	10.5	
Gravity, API.....		1,450	1,294	1,511	1,358	1,236	1,375	1,475	1,486	
Viscosity, SUS at 130° F.....		202	164	166	152	162	175	174	182	
Viscosity, SUS at 210° F.....		184	172	205	192	171	187	203	202	
Viscosity, SFS at 122° F.....		trace	trace	0.05	0.05	trace	trace	trace	trace	
B. S. & W., percent.....		14.6	20.5	21.5	21.9	19.9	20.1	22.0	20.4	
Carbon Residue, percent (Conradson).....		3.71	4.24	4.42	4.47	4.29	4.28	4.53	4.41	
Sulfur, percent.....		5	5	15	15	10	15	15	20	
Pour Point, ° F.....		224	230	230	225	224	210	196	220	
Flash Point, ° F.....		0.01	0.02	0.02	0.09	0.01	0.02	0.02	0.01	
Sediment by Extraction, percent (D473).....										

ume per cent of the crude. Moreover, in each of the runs the gasoline produced varied from 9.3 to 18.2 per cent by volume of the reduced crude charge.

To illustrate the importance of extremely heavy reduced crudes as charge stocks in the process of the invention, there is presented in the following Table II the results obtained in visbreaking operations with two charge stocks, one of which was the bottom 70 volume per cent of the other. The lighter stock was a reduced crude prepared from a mixture of Venezuela and Oklahoma crude oils. This stock will be identified as charge I. The other stock was the bottoms prepared by distilling off under a vacuum the lighter 30 volume per cent of the first stock. This bottoms will be identified as charge II. The inspections for these charge stocks are as follows:

	Charge I	Charge II
Gravity, ° API-----	9.0	5.6
Viscosity, SUS at 210° F-----	3,667	49,960
Conradson Carbon Residue, percent-----	19.0	26.2
Sulfur, percent-----	2.76	2.93
Meiting Point, ° F. (R & B)-----	99	145
Penetration (D5)-----	285	16

The oil used to cut the various bottoms products was a catalytic cycle stock having a gravity, ° API, of 31.2. This oil is referred to as "cutting oil" in Table II.

From the results set out in Table II, it will be seen that run D using charge I had to be discontinued after 27 hours because of serious coking difficulties experienced in the coil. This is to be contrasted with run E which, although it was continued almost three times as long as run D, did not result in the formation of any serious amount of coke in the coil.

Additional runs in accordance with the invention have been made with other charge stocks. For example, successful results were obtained employing as the charge stock a 17.7 volume per cent reduced Kuwait crude. The inspections for this reduced crude were as follows:

It will be seen that practice of the present process on the heavy reduced crude of Table III substantially reduced the amount of heavy fuel oil prepared from the whole crude and correspondingly reduced the amount of cutting oil required for blending with the bottoms to produce the heavy fuel oil. Also, although the temperatures were as high as 955° F. in these runs, the visbreaking operation was carried out without coking in the visbreaker coil. This is surprising in view of the fact that the reduced crude charge had the low gravity, ° API, of 5.4; the high viscosity, S. U. S. at 210° F., of 16,200; and the Conradson carbon residue of 22.0.

The present process, when applied to the treatment of typical crude oils, has the advantages of permitting visbreaking without heavy coke depositions so that long on-stream periods are feasible, and substantially reducing not only the total heavy fuel oil produced from the crude but also the amount of light oil such as a No. 2 fuel oil obtained as a fraction from the products of catalytic cracking required for diluting the reduced crude to form the heavy fuel oil. However, when visbreaking bottoms fractions of certain crudes which are frequently referred to as tar oils, the visbreaking operation in accordance with the invention is successful with respect to coke deposition and the production of gasoline, but, due to the almost coal-like nature of the bottoms of the visbroken product, a substantial amount of light fuel oil is required to make a heavy fuel oil, an amount which may even exceed that required for dilution of the charge to visbreaking to form a similar heavy fuel oil.

From all of the foregoing, it will be seen that the invention provides a process of visbreaking extremely heavy reduced crudes that had previously been considered unsuitable for visbreaking under conditions adequate to produce commercially valuable conversion of the charge. In general, the thermal conversion conditions are such as to yield at least 8 per cent gasoline (C₄s to 400° F. end point) by volume of the reduced crude and include a thermal conversion zone exit temperature of about

900° to 1000° F. These conditions are such that when applied to a longer residuum of the same crude oil (i. e. a residuum constituting a higher percentage of the crude oil and having a higher API gravity than 10, a lower S. U. S. viscosity at 210° F. than 6000, or a Conradson carbon residue number less than 18) would cause the formation of coke at a rate such as to reduce materially the time during which this longer residuum could be charged to the thermal conversion zone. A striking example of this is shown in Table II above. The viscosity of charge I was below 6000 and this stock coked the conversion coil in 27 hours, whereas charge II which had a viscosity substantially above 6000 did not cause substantial coking after 72 hours of operation.

The stocks suitable for use as charge stocks in accordance with the invention have the characteristics: °API less than 10; Conradson carbon residue of at least 18; and viscosity S. U. S. at 210° F. of at least 6000. These characteristics represent the best practical manner of defining reduced crudes that crack at sufficiently low rates (reaction velocity constants) to keep coke formation low during visbreaking operations. Reaction velocity constants of the charge stocks in Table II show that charge I has the higher reaction velocity constant, and therefore, would be expected to coke more readily. In the past it was thought that the coking rate (or reaction velocity constant) increased with an increase in the molecular weight of a cracking charge stock (prepared by deeper vacuum topping of the reduced crude). However, we have discovered that continued reduction of a crude apparently removes high boiling oils which have high reaction velocity constants and coke readily. After this heavy oil is removed, the deeply reduced crude can be visbroken without serious coke formation. Since reaction velocity constants of reduced crudes can only be calculated after cracking data have been determined, and the values differ depending on methods of calculation and equipment used, etc., the values have a relative meaning only, and therefore they have not been employed to characterize charge stocks. As indicated above, it is believed that the characteristics given constitute a means of defining stocks having suitable reaction velocity constants.

Obviously many modifications and variations of the invention, as hereinbefore set forth, may be made without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claims.

We claim:

1. A process for the conversion of petroleum hydrocarbons comprising distilling from a crude oil kerosene and lighter fractions to form a bottoms fraction, vacuum distilling the bottoms fraction under conditions of temperature and vacuum to form a residuum having a gravity less than 10° A. P. I., a Conradson carbon residue number of at least 18 and an S. U. S. viscosity at 210° F. of at least 6000, and thermally cracking the residuum at a temperature in the range of approximately 900° to 1000° F. and a pressure of about 50 to 1000 pounds per square inch in a once-through visbreaking operation to yield at least 8 per cent, by volume of the residuum, 400° F. end point gasoline.

2. A process for the conversion of petroleum hydrocarbons comprising distilling from a crude oil kerosene and lighter fractions to form a bottoms fraction, vacuum distilling the bottoms fraction under conditions of temperature and vacuum to form a residuum having a gravity less than 10° A. P. I., a Conradson carbon residue number of at least 18 and an S. U. S. viscosity at 210° F. of at least 6000, and thermally cracking the residuum at a temperature in the range of approximately 920° to 980° F. and a pressure of about 50 to 1000 pounds per square inch in a once-through visbreaking operation to yield at least 8 per cent, by volume of the residuum, 400° F. end point gasoline.

3. A process for the conversion of petroleum hydrocarbons to more volatile products comprising passing a charge stock consisting of a deeply reduced crude having an A. P. I. gravity lower than 10°, a Conradson carbon residue number of at least 18, and an S. U. S. viscosity at 210° F. of at least 6000 through a cracking coil, the temperature at the outlet of the coil being in the range of 900° to 1000° F., the pressure being in the range of 50 to 1000 pounds per square inch gauge, and the volume of the coil above 750° F. being in the range of 0.012 to 0.05 cubic feet per barrel of throughput per day, whereby about 8 per cent to 20 per cent 400° F. end point gasoline, by volume of the deeply reduced crude, is formed.

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