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[54] **COMBINATION CRACKING PROCESS**

[75] Inventors: **Andre W. Pollock; James M. Durrett,** both of West Chester, Pa.

[73] Assignee: **Sun Oil Company of Pennsylvania,** Philadelphia, Pa.

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[52] **U.S. Cl.** **208/78,** 208/56, 208/68, 208/80

[51] **Int. Cl.** **B01j 9/20,** C10g 37/02

[58] **Field of Search** 208/78, 68, 80, 56

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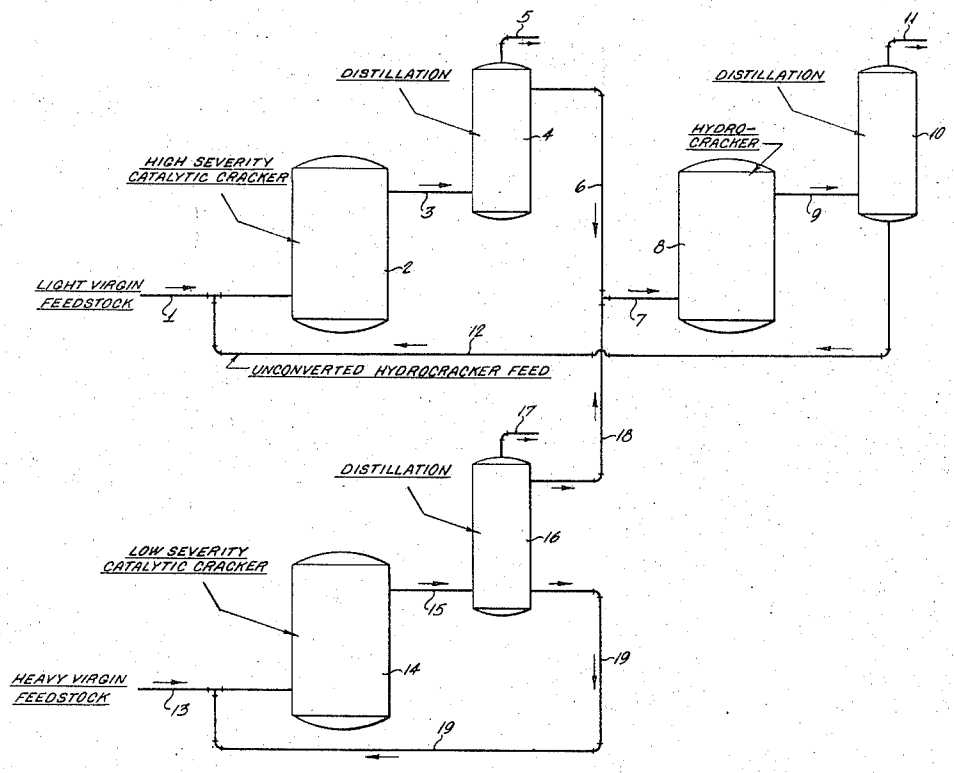
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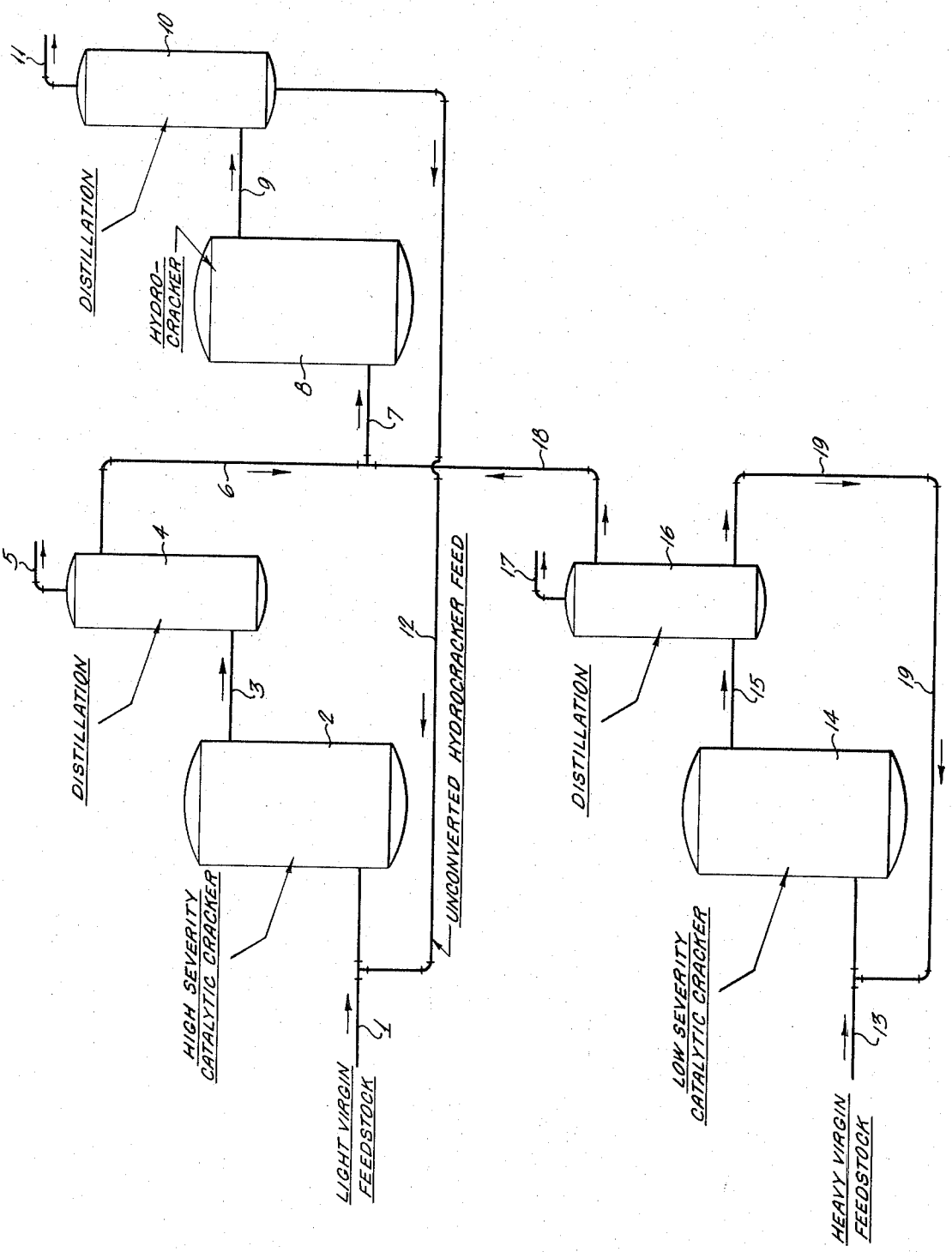
Primary Examiner—Paul M. Coughlan, Jr.
Assistant Examiner—G. E. Schmitkons
Attorney, Agent, or Firm—Mr. George L. Church; Mr. Donald R. Johnson; Mr. Anthony J. Dixon

[57] **ABSTRACT**

This invention relates to a process for combined catalytic cracking and catalytic hydrocracking comprising a hydrocracker, a low severity catalytic cracker operating at a reactor temperature of at least about 900° F., and a high severity catalytic cracker operating at a severity essentially greater than said low severity catalytic cracker. A heavy virgin petroleum feedstock boiling from at least about 700° F. to at least about 1,000° F. is cracked in the low severity cracking zone and a light virgin petroleum feedstock boiling from at least about 400° F. to at least about 700° F. is cracked in the high severity catalytic cracking zone. The combined catalytic gas oils produced from the two catalytic crackers are processed in the hydrocracking zone and the heavy product from the hydrocracker is recycled to the high severity catalytic cracking zone.

2 Claims, 1 Drawing Figure





INVENTORS
ANDRE W. POLLOCK
JAMES M. DURRETT
BY
ATTY.

COMBINATION CRACKING PROCESS

DESCRIPTION OF THE PRIOR ART

In the prior art, crude petroleum has been separated into fractions of different boiling range and the separate fractions treated individually by thermal, catalytic, hydrogenative, and hydrocatalytic processes. In each of these processes it is characteristically observed that a portion of the feed is converted to desired products leaving material which, when recycled, is less readily converted than the feed. For example, in catalytic cracking of gas oils, a part of the feed is converted to the desired gasoline and lighter products, a part is converted to coke, which provides most of the heat needed in the process, and the remainder is converted to light and heavy cycle oils which are considerably more refractory when recycled back to the cracking unit, i.e., more difficult to crack than the feed. The excess cycle oils produced are generally disposed of in heavy fuel oil. Likewise, in catalytic hydrocracking processes it is observed that a portion of the feed is readily hydrocracked to lower boiling distillates, leaving another portion, mainly paraffinic, which is more resistant to further hydrocracking.

It is therefore a primary object of this invention to combine hydrocracking and catalytic cracking processes in such a way as to use each process for the type of feed it is better suited to convert to the more desirable gasoline and lighter products. Hydrocracking is far superior to catalytic cracking in bringing polynuclear aromatic components down into the gasoline range. Catalytic cracking, on the other hand, can achieve higher conversions when operating at higher severity on paraffinic and naphthenic stocks. The highly aromatic cycle oils produced in the catalytic cracking process are an excellent feedstock for the hydrocracking process and the unconverted paraffinic portion of the hydrocracker feedstock is a suitable feed for a high-severity catalytic cracking operation.

The most pertinent prior art is U.S. Pat. No. 3,193,488 issued to Donald E. Carr of Phillips Petroleum Company, July 6, 1965. This patent discloses catalytically cracking, in separate zones, a topped crude and a gas oil, solvent extracting the aromatic extract from the resulting cycle oils, which is subsequently hydrocracked, leaving a paraffinic raffinate, which is recycled to the gas oil cracker. A heavy product from the hydrocracker is also solvent extracted to produce an aromatic recycle to the hydrocracker and a paraffinic recycle to the gas oil catalytic cracker.

SUMMARY OF THE INVENTION

If the respective catalytic cracking zones and the hydrocracking zone are operated at sufficient severity, the intermediate extraction zones can be deleted. Said severity levels are defined herein as a reactor temperature of at least about 900° F. in the low severity catalytic cracker, and a severity in the second catalytic cracking zone essentially above that in the low severity cracking zone. This higher severity can be obtained through increasing reactor temperature, increasing catalyst to oil ratio and other methods. The proper combination of conditions for a given operation can be readily determined through experimentation by one skilled in the catalytic cracking art.

A second object of this invention is to provide a process for the simultaneous conversion of two different virgin feedstocks in separate catalytic cracking zones under particular conditions suited to each feed whereby the maximum yield of lighter more valuable products is obtained.

These objects and other advantages of the invention will become apparent from the description of the process. By a light virgin feedstock, as the term is used in the description, is meant a distillation fraction obtained from natural crude oil, said fraction boiling mainly in the range from 400° to 700° F., and the use of the term heavy virgin feedstock is intended to mean that portion of natural crude oil which boils mainly in the range from 700° to 1,000° F. Recycle stocks and recycle oils are defined as cracked petroleum fractions boiling above gasoline. Low severity catalytic cracking is defined as a cracking operation of at least about 900° F., and high severity catalytic cracking is defined as a cracking operation at a severity essentially above the low severity temperature.

DESCRIPTION OF THE DRAWING

The invention is best explained by referring to FIG. 1.

A light virgin feedstock introduced from an outside source via conduit **1**, is charged to the high severity fluid catalytic cracking zone, **2**. The effluent from cracking zone **2** is withdrawn through conduit **3** and charged to the distillation zone, **4**, where it is fractionated into at least an overhead product and a catalytic gas oil. The overhead product is withdrawn via conduit **5** for further processing in an outside unit and the catalytic gas oil is withdrawn through conduit **6** and charged through conduit **7** to the hydrocracking zone, **8**. The effluent from the hydrocracking zone **8** is withdrawn through conduit **9** and routed to the distillation zone **10** where it is separated into at least an overhead product and a bottoms product. The overhead is withdrawn via conduit **11** and sent to an outside unit for further processing. The bottoms product is withdrawn via conduit **12** and recycled to the high severity catalytic cracker **2**, via conduits **12** and **1**.

A heavy virgin feedstock, introduced from an outside source via conduit **13**, is charged to the low severity fluid catalytic cracking zone, **14**. The effluent from cracking zone **14** is withdrawn through conduit **15** and charged to the distillation zone, **16**, where it is fractionated into at least an overhead product, a middle-boiling product and a heavy product. The overhead product is withdrawn via conduit **17** for further processing in an outside unit, and the mid-boiling catalytic gas oil is withdrawn through conduit **18** and charged through conduit **7** to the hydrocracking zone **8**. The effluent from the hydrocracking zone **8** is withdrawn through conduit **9** and routed to the distillation zone **10** where it is separated into at least an overhead product and a bottoms product. The overhead is withdrawn via conduit **11** and sent to an outside unit for further processing. The bottoms product is withdrawn via conduit **12** and recycled to the high severity catalytic cracker, **2**, via conduits **12** and **1**.

The heavy, high-boiling product from distillation zone **16** is withdrawn via conduit **19** and recycled to the low severity catalytic cracker via conduits **19** and **13**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

By operating the catalytic cracking zones and the hydrocracking zone at sufficient severity, each can supply a suitable feed for the other without the necessity of intermediate processing of said feed streams. An illustrative example shows the benefits that may be gained by practice of this invention.

Referring to Table 1, two catalytic cracking operations are shown, one at 950° F. reactor temperature and one at 1,000° F. reactor temperature.

TABLE I

Case	1	2
Fresh Feed	30.8°API Fresh Gas Oil	30.8°API Fresh Gas Oil
Fresh Feed Rate, B/D	60,000	60,000
Reactor Temperature, °F.	950	1000
Catalyst/Oil Ratio W/W[1]	7.4	9.0
Reactor Pressure, psig	21.0	21.0
Recycle Rate, B/D	0	0
Conversion, Vol. Percent Fresh Feed	71.64	80.11
Yields, Percent Fresh Feed:		
C_2 and lighter, Vol. Percent	4.68	6.00
C_3's, Vol. Percent	12.48	16.08
C_4's, Vol. Percent	18.10	23.33
C_5+ Gasoline, Vol. Percent[2]	47.34	47.66
Light Cycle Oil, Vol. Percent	17.36	13.89
Heavy Cycle Oil, Vol. Percent	10.00	5.00
Clarified Oil, Vol. Percent	1.00	1.00
Gasoline F-1 O.N. Clear	92.9	94.6
Heavy Cycle Oil Properties:		
Gravity, API at 60°F.	19.4	9.0
Initial B.P. TBP °F.	580	583
20% Pt., do.	598	596
80% Pt., do.	690	675
Final B.P. do.	766	708
C_A, %W[3]	44.8	64.9
C_N, do.[3]	11.3	7.4
C_P, do.[3]	43.9	27.7

[1]lb. catalyst/unit time divided by lb. oil/unit time.
[2]conversion basis, 375°F. at 90% point gasoline.
[3]weight percent carbon atoms in aromatic, naphthenic, and paraffinic structures, respectively.

As can readily be seen, the heavy cycle oil from Case 2 which would constitute the feed to the hydrocracking zone, is of sufficient aromaticity to be processed in said hydrocracking zone without intermediate processing. Further advantages can be seen in the high severity level which can be reached in the catalytic cracker which will handle the lighter feedstock, resulting in higher conversion levels and extremely high aromatic content in the heavy cycle oil produced therein.

The data on Table 2 represent a hydrocracking operation on heavy catalytic cycle oil of the type produced by the catalytic cracking phase of the novel combination process being described herein. The 400° F.+ bottoms product withdrawn from the hydrocracking zone constitutes an additional feedstream to the high severity catalytic cracker previously discussed.

TABLE II

Reaction Conditions:	
Hydrocracker Temp., °F.	726°F.
Pressure, psig	1550
LHSV, V/Hr./V	0.87
H_2 Consumption, SCF/Bbl. feed	2501
400 +°F. Product, Vol.% Fresh Feed	79.5
650 +°F. Product, Vol.% Fresh Feed	20.5
Properties, 450–650°F. Cut:	
Gravity, API at 60°F.	25.9
Nitrogen, PPM	1
Sulfur, PPM	15

If the heavy catalytic cycle oil is recycled directly to the high severity catalytic cracker, the product slate which results reflects the refractory nature of this stream, that is the difficulty with which it cracks. However, if the 400° F.+ hydrocrackate of this heavy cycle oil is recycled, to the high severity catalytic cracker, as is disclosed herein, the increase in conversion at identical conditions shows the improvement of this stock as a catalytic cracker feed. Such a comparison is shown in Table 3.

TABLE III

Case	Base	Case 1
Chargestock	Heavy Catalytic Cycle Oil	400°F.+ Hydrocrackate Bottoms
Operating Conditions:		
Reactor Temp. °F.	1010	1010
Catalyst to Oil Ratio, W/W	6.0	6.0
Pressure, psig	20	20
Conversion, Vol.% Fresh Feed[1]	28.3	60.2
Product Yields:		
C_2 and lighter, Vol.%	3.2	3.9
C_3's , do.	5.5	11.7
C_4's , do.	6.5	15.4
C_5+ Gasoline , do.	13.0	40.0
Coke , Wt.%	7.0	3.3

[1]375°F. at 90% basis

As seen in Table 3, 400° F.+ bottoms of Case 1 substantially out performs the straight heavy cycle oil as a catalytic cracker feed due to the hydrogenation of the polynuclear aromatic rings, which took place in the hydrocracking phase.

We claim as our invention:

1. A process for treating petroleum which comprises

a. catalytically cracking, in a first cracking zone, a heavy virgin feedstock at a temperature of at least about 900° F.,

b. catalytically cracking, in a second cracking zone, a light virgin feedstock at a severity essentially higher than that in step a,

c. separating in a distillation zone an aromatic cycle oil from the cracked products of steps a and b,

d. catalytically hydrocracking the aromatic cycle oil produced in step c in a hydrocracking zone,

e. separating the bottom fraction boiling above at least about 400° F. from the effluent of step d in a distillation zone, said bottom fraction, being of sufficient paraffin content, that is at least about 70 percent due to the catalytic hydrocracking of step d to comprise an acceptable catalytic cracker feedstock without further processing and

f. recycling said bottom fraction produced in step e to the catalytic cracking zone of step b.

2. The process of claim **1** wherein the bottom fraction from the distillation zone of step e is recycled to the catalytic cracking zone of step a.

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Disclaimer

3,869,378.—*Andre W. Pollock* and *James M. Durrett*, West Chester, Pa. COMBINATION CRACKING PROCESS. Patent dated Mar. 4, 1975. Disclaimer filed June 13, 1975, by the assignee, *Sun Oil Company*.

Hereby enters this disclaimer to claim 2 of said patent.

[*Official Gazette August 5, 1975.*]