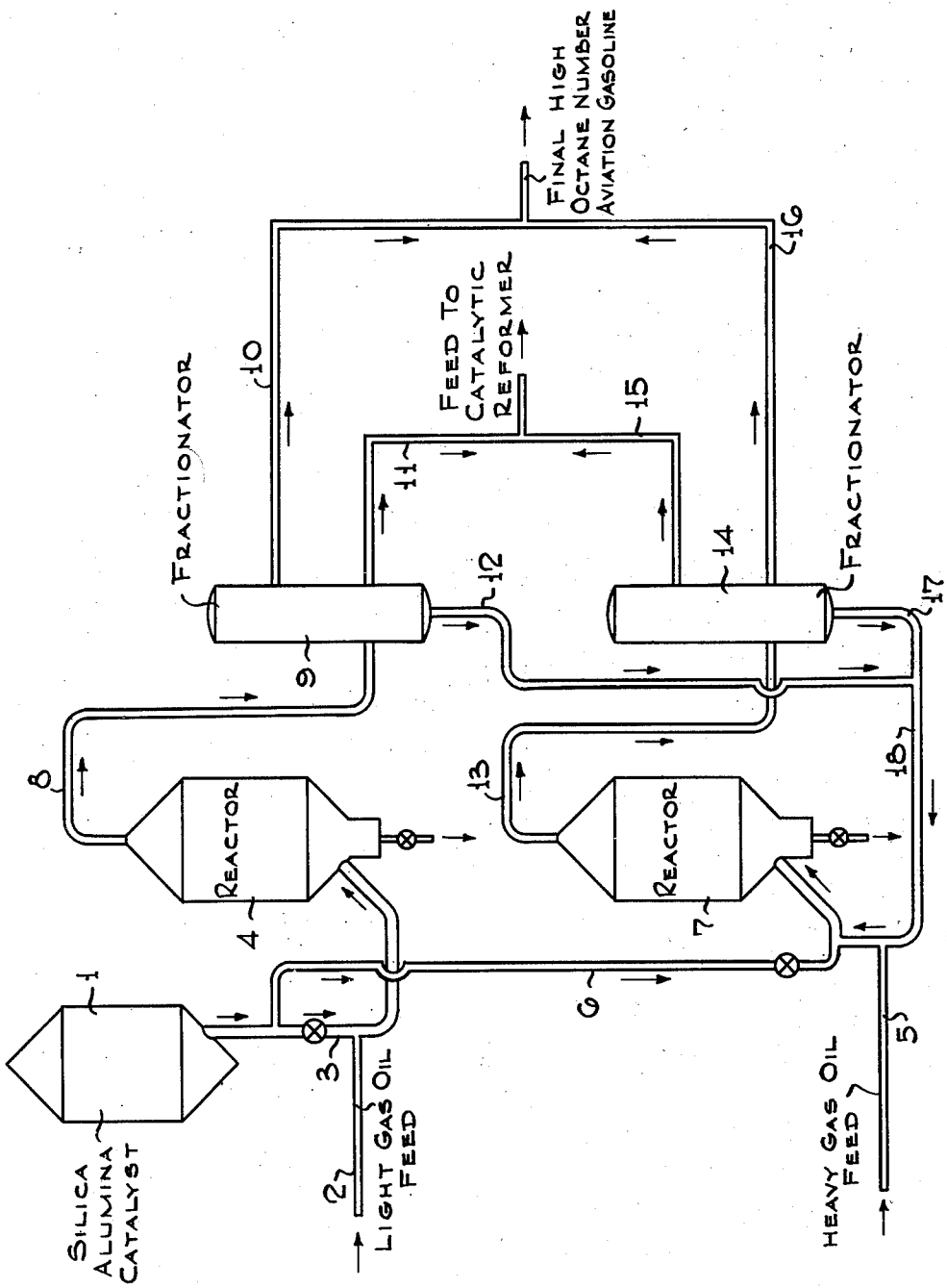
May 17, 1949. K. M. PURDY 2,470,445

PRODUCTION OF HIGH OCTANE NUMBER AVIATION GASOLINE

Filed Oct. 29, 1947



Kenneth M. Purdy Inventor

By P. J. Whelan Attorney

Patented May 17, 1949

2,470,445

UNITED STATES PATENT OFFICE

2,470,445

PRODUCTION OF HIGH OCTANE NUMBER AVIATION GASOLINE

Kenneth M. Purdy, Baton Rouge, La., assignor to Standard Oil Development Company, a corporation of Delaware

Application October 29, 1947, Serial No. 782,735

4 Claims. (Cl. 196—49)

1

This invention pertains to the production of motor fuels and particularly to the production of high octane number aviation gasoline from hydrocarbon feed stocks of substantially different characteristics by an integrated process in which light gas oil is catalytically cracked under certain relatively mild conditions while gas oil is subjected to a catalytic cracking under more rigorous cracking conditions and blending together separate fractions from each of these cracking operations.

Catalytic cracking of light gas oil to obtain high octane aviation gasoline has been difficult to carry out since the temperature of cracking must be kept quite low and conversion levels must also be kept fairly low. Even by controlling the temperature and the conversion levels, the product formed (325° F. end point) has a high gravity, a very high Aniline Point, moderately high acid heat and A. S. T. M. octane number below 80 and only fair 3C rich mixture performance.[1]

[1] CRC Knock Testing Manual—1946 edition.

The catalytic cracking of heavy gas oil to form high octane aviation gasoline has not offered the same problem as the cracking of light gas oil since temperatures can be considerably higher and conversion levels can also be quite high. The 325° F. end point product formed has good gravity, a very low Aniline Point but has a very high acid heat. Moreover, while 3C rich mixture performance is somewhat better than that of the comparable product obtained from light gas oil, A. S. T. M. octane number of the unleaded as well as the leaded fuel is below that of the product obtained from the catalytic cracking of light gas oils at low temperature and low conversion levels.

I have now found that surprisingly if the catalytic cracking of light gas oil is carried out at low temperature and low conversion levels as described above and the catalytic cracking of regular or heavy gas oil is carried out at high temperatures and high conversion levels and a C_6 to about 230° F. fraction is taken from the product of the light gas oil cracking and combined with a 230° F. to final aviation boiling point (325° F.) fraction taken from the product of the heavy gas oil cracking, a blended product is obtained which possesses properties which are substantially superior to those of the products of either of the separate cracking operations.

The light gas oils which may be used in accordance with the present invention are those portions of petroleum crude oils boiling between 360° F. and 750° F.

2

The light gas oil is catalytically cracked preferably in a fluid catalyst unit in contact with a suitable cracking catalyst such as an acid-activated clay or a synthetic metal oxide gel such as silica-alumina, silica-magnesia or silica-alumina-magnesia gels. The temperature of cracking of this feed stock must be kept quite low, generally at between 800 and 850° F., preferably at about 820–825° F. It is also important that conversion level be carefully controlled by controlling the feed rate (Volume of feed per volume of catalyst per hour). This should be so controlled that conversions of about 45–55 volume per cent, preferably about 50% of the light gas oil is converted to motor fuels boiling below 430° F. The product of this mild cracking of light gas oil is fractionated and a C_6 to 230° F. cut is taken for blending as described below.

The heavy or regular gas oils which may be used in accordance with the present invention are those portions of petroleum crude oils boiling between 500° F. and 900° F.

The heavy gas oil is catalytically cracked preferably in a fluid catalyst unit in contact with an active cracking catalyst such as an acid-activated clay, or a synthetic metal oxide gel such as silica-alumina, silica-magnesia, or silica-alumina-magnesia gels. The cracking of the heavy gas oil must be effected at high temperatures, i. e. 950–1000° F. preferably at about 975° F. The conversion level in the heavy gas oil cracking can be controlled by controlling the feed rate so that from 55 to 85 volume per cent of the gas oil is converted to liquid motor fuels boiling below 430° F. The product of this cracking operation is fractionated and a 230° F. to 325° F. fraction is taken for blending purposes.

The C_6 to 230° F. fraction from the cracking of the light gas oil is blended with the 230° to 325° F. fraction from the cracking of the heavy gas oil. The resultant blend has a substantially higher A. S. T. M. octane number than either of the aviation fuels obtainable from the feed stocks used and shows a 3C rich mixture performance that is particularly outstanding.

The remaining fractions from each of the above cracking operations boiling within the motor fuel range are combined and passed to reforming means while the higher boiling stocks are recycled, the cycle stock from the light gas oil cracking operation being preferably combined with the cycle stock from the heavy gas oil cracking operation and recycled to the heavy gas oil cracking step where it is combined with fresh heavy gas oil, and subjected to drastic cracking conditions,

My invention is illustrated in the accompanying drawing in which the single figure is a diagrammatic flow plan of my process.

Referring to the drawing, 1 is a catalyst hopper for the supply of silica-alumina or other suitable cracking catalyst, preferably heated to a sufficient temperature to vaporize the respective oil stocks and bring them to reaction temperature. Light gas oil feed stock is supplied through line 2 and after the addition of catalyst through line 3 the mixture is introduced into reactor 4 wherein the cracking of the light gas oil feed to motor fuel is effected. Heavy gas oil feed stock is supplied through line 5 and is mixed with catalyst supplied through line 6 and the resultant mixture is introduced into reactor 7 wherein the heavy gas oil is cracked to motor fuel. While I have shown a single hopper for the supply of catalyst to both feed stocks, it will be understood that separate hoppers may be provided, particularly if it is desired to use different catalysts for cracking the different feed stocks.

The reaction products are taken overhead from reactor 4 through line 8 and are separated in the fractionator 9 into a C_6–230° F. fraction withdrawn through line 10 a 230–325° F. fraction withdrawn through line 11 and a bottom fraction withdrawn through line 12.

The reaction products from reactor 7 are taken overhead through line 13 and are separated in the fractionator 14 into a C_6–230° F. fraction withdrawn through line 15 and preferably combined with the 230–325° F. fraction from fractionator 9 and passed to suitable reforming means. A 230–325° F. fraction is withdrawn from fractionator 14 through line 16 and is combined with the C_6–230° F. fraction from fractionator 9 to give the final high octane number gasoline in accordance with the present invention. The bottoms are withdrawn from fractionator 14 through line 17 and preferably combined with the bottoms withdrawn from fractionator 9 through line 12 and recycled through line 18 back into reactor along with fresh feed supplied through line 5.

The following example is illustrative of the present invention:

Example

A refinery light mixed gas oil (364° F. to 700° F.) was cracked in a fluid catalyst cracking unit in contact with silica-alumina catalyst at 820° F., (8.3 catalyst/oil and 1.4 w./hr./w.) and at 48.6 volume per cent conversion (400° F. E. P.). The resultant product was fractionated and a C_6 to 230° F. fraction was taken.

A heavy coastal gas oil boiling between 500° F. and 900° F. was cracked in a fluid catalyst cracking unit in contact with silica-alumina catalyst at 975° F. (4.5 catalyst/oil and 1.0 w./hr./w.) and at 81.7 volume per cent conversion (400° F. E. P.). This product was fractionated and a cut taken boiling between 230 and 325° F.

The C_6–230° F. fraction from the light gas oil cracking and the 230–325° F. fraction from the heavy gas oil cracking were blended (in production proportions) and sufficient isopentane was added to attain a Reid vapor pressure of 7 pounds. The following table compares the inspections of the two cracked gasolines (with isopentane added to each to attain a Reid vapor pressure of 7 lbs.) with this blend.

Sample	(1) Cracked Gasoline from Light Gas Oil	(2) Cracked Gasoline from Heavy Gas Oil	Blend of C_6 230° F. of (1) and 230–325° F. of (2)
Gravity	63.4	56.4	56.7
Aniline Point, ° F	103	53	66
Acid Heat, ° F	62	88	50
ASRM Octane Number	79.5		82.6
ASTM Av.+4 cc. TEL	92.9	91.1	93.9
3-C Rich, Peak	96.5 (S in M)	S+0.34 (*a*), S+0.50 [1] (*a*)	S+1.17 (*a*)
3-C Rich, AFR	96.5 (S in M)	S+0.34 (*a*), S+0.50 [1] (*a*)	S+1.17 (*a*)

(*a*) cc. tetraethyl lead per gallon. S is a reference fuel (iso-octane or its equivalent) having a 100 octane number and M is a low octane number reference fuel (equivalent to 95% by volume of 2,2,4-trimethyl pentane and 5% by volume of n-heptane). (S in M) is dilution of reference fuel of 100 O. N. with low O. N. reference fuel necessary to match knocking tendency of fuel of unknown O. N. Where fuel of unknown O. N. is higher than 100 O. N., its rating is given as equivalent to S fuel plus the cc. of tetraethyl lead required per gallon to match the knocking tendency of the fuel of the unknown O. N.

[1] Duplicate determinations.

It may be readily seen from the foregoing inspection that the blend produced in accordance with the present invention has an extremely low acid heat, a higher ASTM Octane Number than either of the straight cracked gasolines, the 3C rich mixture performance being particularly outstanding.

The foregoing description contains a limited number of embodiments of this invention. It will be understood, however, that numerous variations are possible without departing from the scope of the following claims.

What I claim and desire to secure by Letters Patent is:

1. The process of producing high octane number gasolines which comprises catalytically cracking light gas oil at temperatures of about 800–850° F. and at conversions of from 45–55 volume per cent, catalytically cracking heavy gas oil at temperatures of 950–1000° F. and at conversions of from 55–85 volume per cent, taking a C_6–230° F. cut from the reaction product of the light gas oil cracking step and a 230–325° F. cut from the reaction product of the heavy gas oil cracking step, and blending these cuts to produce a high octane number aviation gasoline.

2. The process of producing high octane number gasolines which comprises catalytically cracking light gas oil at temperatures of about 800–850° F. and at conversions of from 45–55 volume per cent, catalytically cracking heavy gas oil at temperatures of 950–1000° F. and at conversions of from 55–85 volume per cent, taking a C_6–230° F. and a 230–325° F. cut from the reaction product of the light gas oil cracking step, taking a C_6–230° F. and a 230–325° F. cut from the heavy gas oil cracking step and blending the C_6–230° F. cut from the cracked light gas oil with the 230–325° F. cut from the cracked heavy

gas oil to produce a high octane number aviation gasoline, and blending the 230–325° F. cut from the cracked light gas oil with the C_6–230° F. cut from the cracked heavy gas oil, and subjecting this mixture to a reforming operation.

3. The process of producing high octane number gasolines which comprises catalytically cracking light gas oil at temperatures of about 800–850° F. and at conversions of from 45–55 volume per cent, catalytically cracking heavy gas oil at temperatures of 950–1000° F. and at conversions of from 55–85 volume per cent, taking a C_6–230° F. cut from the reaction product of the light gas oil cracking step and a 230–325° F. cut from the reaction product of the heavy gas oil cracking step, blending these cuts to produce a high octane number aviation gasoline and combining the bottoms from both fractionations with fresh heavy gas oil feed.

4. The process of producing high octane number gasolines which comprises catalytically cracking light gas oil at temperatures of about 800–850° F. and at conversions of from 45–55 volume per cent catalytically cracking heavy gas oil at temperatures of 950–1000° F. and at conversions of from 55–85 volume per cent, taking a C_6–230° F. and a 230–325° F. cut from the reaction product of the light gas oil cracking step, taking a C_6–230° F. and a 230–325° F. cut from the heavy gas oil cracking step, blending the C_6–230° F. cut from the cracked light gas oil, with the 230–325° F. cut from the cracked heavy gas oil to produce a high octane number aviation gasoline, blending the 230–325° F. cut from the cracked light gas oil with the C_6–230° F. cut from the cracked heavy gas oil, subjecting this mixture to a reforming operation and combining the bottoms from both fractionations with fresh heavy gas oil feed.

KENNETH M. PURDY.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,235,133	Zimmerman	Mar. 18, 1941
2,257,723	Arveson	Oct. 7, 1941
2,289,716	Marschner	July 14, 1942
2,303,107	Benedict	Nov. 24, 1942
2,341,269	Day et al.	Feb. 8, 1944
2,423,637	Chandler	July 8, 1947
2,432,912	Loeb	Dec. 16, 1947