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INTERIM REPORT

Hydrotreating and Fluid Catalytic Cracking of SRC-II Process Derived Gas Oils

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ABSTRACT

The objective of this work was to evaluate the applicability of commercial UOP hydrotreating and fluid catalytic cracking (FCC) processes to gas oils derived from the SRC-II process. All FCC feedstocks used in these studies were the 400°F$^+$ fractions from the raw and hydrotreated products.

Four different FCC feedstocks, ranging in hydrogen content from 8.66 to 10.59 wt-% were prepared by topping the raw SRC-II gas oil and hydrotreated SRC-II products to remove 400°F$^-$ material. Rerunning the raw SRC-II feed to remove 5.2 wt-% of the bottoms removed most of the heptane insolubles and Conradson carbon precursor. The UOP DCB catalyst was used for hydrotreating the raw SRC-II stock.

Results of fluid catalytic cracking showed that feed hydrogen content is a dominant factor in conversion and yield structure. As the feed hydrogen content increased, both conversion and gasoline yield increased, and carbon deposition decreased. In the range of conditions investigated, gasoline Research octane numbers of 97.5 to 106.7 were obtained. The yields of 650°F minus distillates generated were as high as 93 vol-%.

The yield and quality of alkylate from C_3/C_4 products were estimated to be comparable to those obtained from processing a petroleum derived vacuum gas oil provided the degree of hydrotreatment is sufficient.

It is concluded that SRC-II gas oil, or other coal derived distillate of similar quality, can be processed into high quality gasoline by use of current hydrotreating and FCC technology.

1. INTRODUCTION

The objective of this program was to determine the applicability of commercial UOP conversion processes to coal derived distillate liquids generated by three DOE sponsored processes: H-Coal, Exxon Donor Solvent (EDS) and SRC-II.

Four tasks are identified under this program. Each of these tasks originally comprised coal liquids from the H-Coal and the EDS processes. Task 1 involves two stage continuous hydrocracking of coal distillate liquids boiling in the gas oil range. Task 2 entails processing of these distillates through continuous hydrotreating and fluid catalytic cracking units. Task 3 covers processing of coal derived naphthas through continuous hydrotreating-reforming bench scale units. Task 4 includes all data correlation. SRC-II distillates were subsequently added as feedstocks to be studied under Tasks 2 and 3 only.

Hydrotreating and fluid catalytic cracking of the H-Coal and EDS process derived distillate liquids were covered in Interim Reports FE-2566-20 and FE-2566-30. This report covers work under Task 2 on hydrotreating and fluid catalytic cracking of SRC-II process gas oils. Investigation was carried out on four distinct feedstocks. One was the original SRC-II gas oil. The second was a rerun SRC-II liquid product. The last two were hydrotreated SRC-II gas oils.

For reporting purposes, the experimental conditions employed in this work are expressed in terms of base conditions:

Temperature	T-T(base), °C
Pressure	P-P(base), psi
Space Velocity	LHSV/LHSV(base)
Catalyst Oil Weight Ratio	$\frac{\text{Catalyst/Oil}}{\text{Catalyst/Oil(base)}}$

The base conditions for hydrotreating represent conditions employed commercially for hydrotreating a typical Arabian vacuum gas oil. Similarly, the base conditions for fluid catalytic cracking refer to those conditions used commercially for a typical Arabian gas oil.

2. EQUIPMENT

2.1. Hydrotreating

Hydrotreating of SRC-II gas oil was carried out in continuous research scale units (UOP Research Plants 638 and 505). A simplified flow diagram of a typical hydrotreating plant is shown in Figure 1. Hydrogen and gas oil feed are passed concurrently downflow over a fixed bed of UOP DCB first stage hydrocracking catalyst. The catalyst is a composite of Group VI and Group VIII metals on a high surface area refractory support. Plant 505 was used for hydrotreating process variable studies, while Plant 638 was used in preparative runs to provide hydrogenated feedstocks for the research scale catalytic cracker.

2.2. Fluid Catalytic Cracking

Fluid catalytic cracking of SRC-II derived gas oils was conducted in UOP Research Plant 593, a once-through Quick Quench (all riser) unit, using equilibrium zeolitic catalyst withdrawn from commercial FCC units. Figure 2 is a flow diagram of this plant. It comprises a riser reactor, a catalyst regenerator-hopper system, a catalyst stripper-separator system, and a fractionator. The preheated fresh feed enters the unit at the mixing "Y" where it is mixed with the hot regenerated catalyst which flows down from the regenerator-hopper system through the catalyst transfer line. The catalyst and the vaporized feed travel rapidly through the riser reactor. The cracked oil vapors and the spent catalyst enter the stripper-separator system where the adsorbed hydrocarbons are stripped from the catalyst surface, and the oil vapors are separated from the catalyst. The stripped spent catalyst is charged to a catalyst receiver, and samples are taken to determine carbon content. The hydrocarbon vapors from the separator are sent to the fractionator for separation into gas, gasoline, and cycle oil. The spent catalyst is manually reloaded into the regenerator-hopper system, and is batch regenerated prior to the start of the next test.

In these studies, two sets of conditions were employed:

	Operation A	Operation B
T-T(base), °C	3	33
P-P(base), psi	-10	-10
$\frac{\text{Catalyst/Oil}}{\text{Catalyst/Oil(base)}}$	1	1.4

3. CHARGE STOCKS

3.1. Gas Oil Hydrotreating

Three 55-gallon drums of SRC-II gas oil were received from Pittsburgh and Midway Coal Refining Company, DuPont, Washington, on March 23, 1979. The combined contents were 150 gallons. This was assigned for work under Task 2. Inspections of two drums of this material, identified as 3777-6 and 3777-7, are listed in Table 1. They show high values of steam jet gum, oxygen and nitrogen. The distillation indicated a boiling range from about 350 to 800°F.

Table 2 provides a high resolution mass spectral characterization of the SRC-II gas oil, Drum 1, 3777-6. A report from DOE indicated possible contamination of the SRC-II gas oil with Dowtherm.

The low voltage mass spectrum of this sample was examined in detail. The relative concentrations of compounds at M/C 170.0732 (diphenyl oxide) and M/C 154.0782 (biphenyl) were in the ratio of 64:36. This composition corresponds to that of Dowtherm. The maximum amount of contamination was computed to be approximately 3% of the total sample.

This SRC-II gas oil was used as received to prepare two hydrogenated gas oils for FCC feedstocks.

3.2. Fluid Catalytic Cracking

Fluid catalytic cracking studies were carried out on four different feedstocks: 400°F+ topped gas oil (3777-36); rerun and topped gas oil (3777-38); and two hydrotreated and topped gas oils (3777-34, 3777-41).

Approximately 9 gallons of the raw SRC-II gas oil 3777-7 was fractionated to top off 12.7 wt-% of 400°F- naphtha (3777-35). About 8 gallons (87.3 wt-%) of 400°F+ bottoms (3777-36) was recovered for fluid catalytic cracking studies. Distillation information is given in Table 3. Inspections of the 400°F+ topped gas oil 3777-36 are given in Table 4. Quality of this material is poorer than the original feed, showing higher concentrations of nitrogen, oxygen, heptane insolubles, Conradson carbon, and lower hydrogen.

A 10-gallon sample of raw SRC-II gas 3777-6 was rerun to recover 94.8 wt-% of an IBP-748°F material designated as 3777-19. This material in turn was topped to recover an 81.4 wt-% net yield (based on raw gas oil) of 400°F+ bottoms as feedstock 3777-38. Distillation data are shown in Table 5. Inspections of the rerun product 3777-19 are given in Table 6. The quality of this product is improved as compared to the original feed. Heptane insolubles, Conradson carbon, and steam jet gum were reduced and hydrogen content increased. Inspections of the 400°F+ topped gas oil 3777-38 (derived from the rerun stock 3777-19) are given in Table 7. Removal of the naphtha portion has not appreciably changed the quality of the gas oil when compared to its parent 3777-19. The quality of the 400°F+ rerun and topped gas oil 3777-38 is still better than that of the original feed, 3777-6.

Two gas oils of increased hydrogen content were prepared by hydrotreating and topping the raw SRC-II gas oils 3777-6 and 3777-7. The first, designated as 400°F$^+$ topped gas oil 3777-34, was the naphtha free fraction of the mildly hydrotreated SRC-II gas oil 3777-6. The second, designated as 400°F$^+$ topped gas oil 3777-41, was the naphtha free fraction of the severely hydrogenated SRC-II gas oil 3777-7. Inspections of these two hydrotreated and topped feedstocks are listed in Tables 8 and 9. Figure 3 shows the steps involved in their preparation as well as those for the gas oils 3777-36 and 3777-38.

4. RESULTS AND DISCUSSION

4.1. Gas Oil Hydrotreating

The primary objective in the hydrotreating of coal derived gas oil is to improve the cracking characteristics of the gas oil by reducing nitrogenous poisons and coke precursors, and to provide points of catalytic attack on condensed ring structures by partial saturation of aromatic rings.

4.1.1. Selection of Hydrotreating Catalyst

The UOP-DCB catalyst, a first stage hydrocracking catalyst, was used to upgrade the SRC-II gas oil. Catalysts of this type are sensitive to heptane insolubles, which amount to ∿0.2 wt-% in these charge stocks. It was decided to dispense with rerunning the SRC-II gas oils. Small decreases in catalytic activity noted below can be attributed to this omission.

4.1.2. Hydrotreating Process Variable Studies

A series of four runs were made on Plant 505, Runs 880-883, to determine the process conditions necessary to prepare two feedstocks of increased hydrogen content to be used for FCC studies. The results provided relationships between product hydrogen content and temperature, pressure, and space velocity. The selection of conditions was as follows: base pressure and 500 psi above base; three space velocities, 0.4, 0.8 and 1.2 x base; and four temperatures, 9, 34, 49 and 59°C below base.

Plant 505, Run 880

This run, made at base pressure and at 59°C below base temperature, covered three space velocities in the order of 0.4, 0.8 and 1.2 x base LHSV. A run summary is shown in Table 10. Product samples throughout the run were submitted for carbon and hydrogen analyses to establish when lined out operation had been attained for a given set of conditions and to check for catalyst stability in the run. The catalyst stability check was made by returning to the original starting conditions. Average product hydrogen contents for each of the space velocity tests are tabulated below:

T-T(base)°C = -59

LHSV/LHSV base	Wt-% H (Ave.)
0.4	10.82
0.8	10.13
1.2	9.62
0.4	10.26

The product hydrogen content after 331 hours of operation (10.26 wt-%) indicated a slight catalyst deactivation when compared to the initial average of 10.82 wt-%.

Plant 505, Run 881

This run was made at base pressure, at 0.4, 0.8 and 1.2 x base LHSV, and at two temperature levels, 34°C and 8°C below base. Run summary is given in Table 11. The average hydrogen contents for each of the space velocity tests are tabulated below.

LHSV/LHSV(base)	T-T(base)°C	
	-34	-9
	Wt-% H (Ave.)	
0.4	11.59	11.74
0.8	10.67	10.99
1.2	10.25	10.52
0.4	11.26	11.61

A check on catalyst stability for this run is shown as follows:

LHSV/LHSV(base) = 0.4

T-T(base)°C	Hrs. on Stream	Wt-% H (Ave.)
-34	116-156	11.59
-35	212-242	11.26
-9	292-312	11.74
-8	388-408	11.61

At each temperature level only a slight decrease in hydrogen content was noted.

Plant 505, Run 882

The run was a duplicate of Run 881 except that it was done at 500 psi above base pressure and temperatures of 49°C and 35°C below base temperature. The run summary for this operation is shown in Table 12. The average hydrogen contents for each of the space velocity tests are tabulated below:

LHSV/LHSV(base)	T-T(base)°C	
	-49	-35
	Wt-% H (Ave.)	
0.4	10.88	11.33
0.8	10.60	10.76
1.2	9.89	10.24
0.4	10.87	11.18

The check on stability is also tabulated below:

LHSV/LHSV(base) = 0.4

T-T(base)°C	Hrs. on Stream	Wt-% H (Ave.)
-49	24-54	10.88
-49	130-150	10.87
-35	160-210	11.33
-35	316-346	11.18

The decrease in hydrogen content is within experimental error.

Plant 505, Run 883

This run was made at 500 psi above base pressure. The space velocity sequence was run in reverse. Catalyst stability was checked at 0.8 x base space velocity instead of 0.4. A test at 0.6 x base space velocity was inadvertently made, and the data were not processed. The run summary is shown in Table 13. The average hydrogen contents for each of the space velocity tests are tabulated below:

T-T(base)°C = -9

LHSV/LHSV(base)	Wt-% H (Ave.)
0.8	11.64
1.2	11.02
0.8	11.64
0.4	11.92
0.8	11.46

Again, the decrease in hydrogen content is within experimental error, and indicates no catalyst activity decline over the 331 hours of operation.

Product Distributions

Selected products in each run throughout the variable study were analyzed in order to obtain product distributions at each test condition. These data are presented in Tables 14 through 19.

The hydrogen contents of the liquid products were abstracted from the above tables and used to derive the curves shown in Figures 4 and 5. The curves indicate the hydrogen content of the gas oil product as a function of temperature, for each space velocity, at base pressure and 500 psi above base pressure. The curves are roughly linear over the temperature range covered.

4.1.3. Preparation of Hydrotreated Gas Oils

Two preparative hydrotreating runs were carried out on Plant 638 for the purpose of preparing two feedstocks for FCC studies. Figure 3 is a summary of the basic steps involved, and yield data obtained, in the preparation of these two feedstocks. In this figure, the yield data and hydrogen additions are expressed as weight percent of raw SRC-II gas oils 3777-6 and 3777-7. This figure also shows the preparation and yield data for the two FCC feedstocks prepared by fractionation of the raw SRC-II gas oils.

Plant 638, Run 37

This operation ran for a period of 192 hours, 8 days, to produce about 11 gallons of hydrotreated FCC feed containing 10.38 wt-% hydrogen. The run was made at base pressure, 0.8 x base space velocity, starting at 55°C below base temperature. The temperature was adjusted some 13°C upward to 42°C below base temperature to bring the product up to the desired hydrogen content. The operation and analyses are logged in Table 20.

Table 21 summarizes an overall material balance made for Run 37. Better than 99.4 wt-% of stripper bottoms product was recovered. Losses to C_4 and lighter gases amounted to less than 0.1 wt-% under these mild conditions. Hydrogen consumption amounted to 1230 SCFB. This stripper bottoms product was designated as 3777-21. The hydrogen distribution (Table 22) shows better than 84 wt-% of the hydrogen used to increase the product hydrogen content. Approximately 2 wt-% was consumed in forming light gases, and about 14 wt-% was consumed in desulfurization, denitrification and deoxygenation.

Inspections of the blended liquid product are shown in Table 23. This product was fractionated to recover approximately 8.4 gallons of a 400°F$^+$ topped gas oil designated as 3777-34. Details of the fractionation are given in Table 24. Final yield of FCC feedstock was 78.1 wt-%.

Plant 638, Run 38

This second hydrotreating preparative run was of 292 hours duration. It Produced approximately 12.5 gallons of hydrotreated FCC feed, containing 11.18 wt-% hydrogen. This run was started at 500 psi above base pressure, 0.4 x base space velocity and 36°C below base temperature. After 52 hours of operation, the operating temperature was increased to 28°C below base; and again after 122 hours it was increased to 21°C below base to meet the desired hydrogen specifications. The run summary is given in Table 25.

An overall product distribution made for this run is shown in Table 26. Again, approximately 99.4 wt-% of stripper bottoms was recovered, with only 0.21 wt-% of the feed lost to C_4 and lighter gases. The hydrogen consumption at the more severe conditions amounted to 1790 SCFB. The stripper bottoms product was designated as 3777-28. Table 27 gives the distribution of hydrogen consumption for the run. Approximately 82 wt-% of the hydrogen used remained in the feed. The liquid products were blended and analyzed. The inspections for this severely hydrotreated product blend 3777-28 are shown in Table 28.

The product blend 3777-28 was fractionated to recover approximately 8.4 gallons of 400°F$^+$ topped gas oil designated as 3777-41. Details of this fractionation are shown in Table 24. Final yield of FCC feedstock was 69.4 wt-%.

4.2. Naphtha Characterization

Tables 29 through 32 list the inspections of the IBP-400°F naphtha fractions derived from topping the raw SRC-II gas oil, 3777-7, and the rerun gas oil, 3777-19; and from topping the two hydrogenated products 3777-21 and 3777-28.

The first two naphthas have octane numbers over 100 RON, but will require relatively severe hydrotreatment to remove phenols and heterocyclics. Octane number will drop but can be restored readily by mild reforming to regenerate aromatics. The latter pair of naphthas may also require additional hydrotreatment. Removal of phenols and heterocyclics was incomplete when these naphthas were co-processed with 400°F+ material.

4.3. Fluid Catalytic Cracking of SRC-II Process Derived Gas Oils

Fluid catalytic cracking of the SRC-II process derived gas oils was carried out in Plant 593, described in Paragraph 2.2.

In the current program multiple tests were made at each set of conditions to obtain up to 4 independent sets of experimental data at each condition and to provide sufficient liquid product for fractionation and analysis of the fractions. Octane numbers were obtained in most tests where liquid product was sufficient.

FCC studies were carried out on four 400°F+ feedstocks. One was topped SRC-II gas oil, 3777-36. The second was the topped rerun SRC-II gas oil, 3777-38. The third was the 400°F+ topped mildly hydrotreated gas oil, 3777-34. The final charge stock was the topped severely hydrotreated gas oil 3777-41. The hydrogen contents of these feedstocks were 8.66, 8.89, 9.98 and 10.59 wt-%, respectively (Tables 4, 7, 8 and 9).

All tests were conducted at 10 psi below base pressure. The results are presented in terms of increasing hydrogen content of the feed.

4.3.1. Topped SRC-II Gas Oil 3777-36

Only one acceptable test was obtained at the lower temperature and only two tests were obtained at the higher temperature, due to operational and mechanical difficulties. The results of these tests are summarized in Tables 33 and 34, which lists cracking conditions, product distributions and product inspections.

Some results of these tests are shown below:

Experiment No.	292/3	292/7,9
T-T(base)°C (ave.)	5	32
$\frac{\text{Cat/Oil}}{\text{Cat/Oil(base)}}$ (ave.)	1.07	1.66
Conversion, Vol-%	44.8[a]	50.6[a]
C_5^+ Gasoline, Vol-%	23.9[a]	25.7[a]
Cycle Oil, Vol-%	56.6[a]	51.3[a]
Carbon, Wt-%	11.6	14.4

[a]Adjusted

Carbon production tends to be on the high side for the rather moderate conversion and low C_5^+ gasoline yield. This pattern is to be expected in view of the low hydrogen and high aromatics and nitrogen content of this feed (Table 4).

Throughout this work, the operation of the plant fractionator was not completely satisfactory. This fractionator has been designed to handle 65-85% feed conversions, and gasoline product contents from 35-65 vol-%. It also requires close attention in operation to set the proper gasoline cut point. In addition, the nature of the feed itself differs, making operational changes difficult at times. As a result, the gasoline cut point was not correct and the gasoline fractions were contaminated with cycle oil. To correct for this discrepancy, the observed yields and gravities were adjusted, based on a 380°F temperature at the 90 vol-% point of the Engler distillation.

The numbers shown in the above tabulation are averages of the multiple tests run at each temperature condition.

4.3.2. Topped Rerun SRC-II Gas Oil, 3777-38

This gas oil was prepared by rerunning the raw SRC-II gas oil to take 94.8 vol-% overhead, and then removing the naphtha. The object was to improve the cracking characteristics of the feed by removal of coke precursor material. Both the Conradson carbon and heptane insolubles were markedly reduced. The rerunning did result in a slightly higher hydrogen content gas oil.

Fluid catalytic cracking of gas oil 3777-38 was also conducted at two sets of conditions. The results are summarized in Tables 35 and 36. Each of the tables shows the cracking conditions, product distributions, inspections of the gasoline products, and properties of the gas oils. Table 35 also includes the Research and Motor octane numbers (RON and MON) of the leaded and unleaded gasolines.

Four tests were made at each test condition, and it was necessary to adjust the gasoline, cycle oil yields and their corresponding API and specific gravities due to gasoline fraction contamination with gas oil.

Some results of the tests are shown below:

Experiment No.	299/1,2,4	299/5-8
T-T(base)°C (ave.)	3	28
$\frac{\text{Cat/Oil}}{\text{Cat/Oil(base)}}$ (ave.)	1.01	1.42
Conversion, Vol-%	45.3[a]	51.6[a]
C_5^+ Gasoline, Vol-%	25.1[a]	28.1[a]
Cycle Oil, Vol-%	54.7[a]	48.4[a]
Carbon, Wt-%	12.2	13.9

[a]Adjusted

Conversions for this stock are only slightly higher than that obtained on the raw topped gas oil 3777-36. This reflects the small increased hydrogen content of this gas oil. Yields of gasoline are also slightly higher, while carbon production is essentially the same as that obtained with the gas oil 3777-36.

4.3.3 Topped Mildly Hydrotreated Gas Oil 3777-34

Gas oil 3777-34 was prepared by mild hydrotreatment of the SRC-II gas oil followed by removal of naphtha. The hydrogen content was raised from 8.66 to 9.98 wt-%. The nitrogen content was reduced from 10,200 to 6,000 ppm, approximately 40% in this hydrotreating step. Essentially all of the Conradson carbon and heptane insolubles were removed. The aromatic concentration was high but the condensed ring structures were partially hydrogenated.

The data obtained at the two sets of operating conditions are shown in Tables 37 and 38. The conversion and yield data are abstracted from these tables and shown below.

Experiment No.	294/2,3,10	294/5,6,8
T-T(base)°C (Ave.)	2	28
$\frac{\text{Cat/Oil}}{\text{Cat/Oil(base)}}$ (Ave.)	1.08	1.49
Conversion, Vol-%	49.2	57.3
C_5+ Gasoline, Vol-%	35.3	40.1
Cycle Oil, Vol-%	50.8	42.7
Carbon, Wt-%	7.3	7.3

At the near base condition, this hydrotreated feed showed a lower than anticipated response in conversion. Gasoline yields increased approximately 10-15 vol-% and the carbon make dropped approximately 40% when compared to the untreated stocks.

4.3.4 Topped Severely Hydrotreated Gas Oil 3777-41

The hydrotreated gas oil 3777-41 was prepared by severe hydrotreatment of the SRC-II gas oil, followed by removal of naphtha. The 400°F+ topped hydrotreated fraction represents 69.4 wt-% of the original SRC-II gas oil. This feedstock contained 10.59 wt-% hydrogen. Essentially all of the sulfur has been removed, approximately 80% of the nitrogen and over 50% of the oxygen has been taken out. The aromatic content was still high, 74%. Three tests were conducted at near base conditions and two at the more severe conditions. The data are presented in Tables 39 and 40.

Experiment No.	301/1-3	301/4,6
T-T(base)°C (Ave.)	3	30
$\frac{\text{Cat/Oil}}{\text{Cat/Oil(base)}}$ (Ave.)	1.09	1.50
Conversion, Vol-%	61.9[a]	63.7[a]
C_5+ Gasoline, Vol-%	46.9[a]	43.6[a]
Cycle Oil, Vol-%	38.1[a]	36.3[a]
Carbon, Wt-%	3.9	5.4

[a]Adjusted

A fairly high conversion and gasoline yield, and reduced carbon were obtained at near base conditions. At the more severe conditions the conversion went up slightly, but the gasoline yield went down indicating an increase in secondary cracking of the gasoline. Carbon deposition increased with the increase in secondary cracking. Compared to other hydrotreated distillates (EDS, H-Coal), these hydrotreated SRC-II distillates gave lower carbon yields at comparable hydrogen contents.

4.3.5. Discussion

It was expected that low conversions and high carbon production would result from fluid catalytic cracking of the topped and rerun as received gas oils 3777-36 and 3777-38. The hydrogen contents of these feeds were below 9 wt-%, their nitrogen contents were 10,200 and 9,950 ppm, with aromatic concentrations of 93 vol-%. The Conradson carbon and heptane insoluble contents were not as high as the Exxon Donor solvents and slightly higher than the H-Coal feeds.

Basic nitrogen compounds act as transient poisons to the catalytic acid sites on FCC catalysts. Polynuclear aromatic molecules are known coke formers. They offer few points of catalytic attack to break carbon-carbon bonds and open rings. The heptane insolubles, oxygenates and gum are coke precursors.

Hydrotreatment is necessary to take care of these feedstock deficiencies. The more hydrogen the stock contains, the higher will be the conversion and lower the carbon production. The conversions and yields of the four gas oil stocks are compared below, at the near base condition.

Feed Hydrogen Content, Wt-%	8.66	8.89	9.98	10.59
Conversion, Vol-%	44.8	45.3	49.2	61.9
C_5+ Gasoline, Vol-%	23.9	25.1	35.3	46.9
C_4-, Wt-%	5.3	5.0	8.4	13.5
Carbon, Wt-%	11.6	12.2	7.3	3.9
RON Clear	-	106.7	101.8	97.5

These data are shown in Figure 6 and compared with data plotted from a West Coast refinery feed, hydrotreated to various levels of hydrogen.

Feed Hydrogen Content, Wt-%	11.78	12.46	12.50	13.47
Conversion, Vol-%	67.8	74.6	78.9	87.2
C_5+ Gasoline, Vol-%	50.9	59.0	61.8	71.0
C_4-, Wt-%	15.2	16.5	18.9	21.2
Carbon, Wt-%	7.4	5.7	5.5	4.8

These correlations for the coal and petroleum gas oils do not overlap, but they are reasonably consistent in their general trends.

The Research octane numbers of the coal oil products at base conditions range from 106.7 down to 97.5 for the highest hydrogen content feed. This general trend observed for coal derived gas oils follows the identical trend found for petroleum derived gas oils.

Based on the above data, it is concluded that with proper hydrotreatment, the SRC-II gas oil can be processed via fluid catalytic cracking into a high octane and high quality gasoline.

4.4. Combined FCC and HF Alkylation

The C_3/C_4 stream produced in FCC operations can be used as feedstock to a UOP HF Alkylation unit to make high octane motor fuel. This process combines light olefins (primarily mixtures of propylene and butylenes) with isobutane, producing branched chain paraffins. Estimates of alkylation yield are based on analyses of the C_3/C_4 stream such as contained in Tables 33-40, plus more detailed breakdown of the C_4 olefin portion.

4.4.1. HF Alkylation Feed

A breakdown of the C_3/C_4 FCC product yield from each coal liquid is presented in Table 41. For one of the coal liquids, Topped Severely Hydrotreated Gas Oil, 3777-41, data is presented for two FCC operations at approximately the same conversion, but different operating conditions (Operations A and B). These yields represent what the HF Alkylation unit feed would be in a combined FCC/Alkylation complex using the respective coal liquid feeds. For comparison purposes, a C_3/C_4 yield from a typical petroleum derived FCC operation is also shown. The petroleum feedstock chosen is a 50/50 mixture of Es Sider and Forties vacuum gas oils. Pertinent properties of the petroleum charge are given in Table 42. The processing conditions and conversions for all the FCC operations are shown in Table 43. Since the severely hydrotreated coal liquid would yield the highest C_3/C_4 quantity from a given amount of FCC feed, and since even this case is of questionable viability for a FCC/ Alkylation complex, the subsequent discussion will be limited to this severely hydrotreated operation.

4.4.2. HF Alkylate Properties

In estimating alkylate properties, it is important to consider the distribution of the C_4 olefin isomers and the C_3/C_4 olefin ratio. Table 44 shows that for all practical purposes, the C_4 olefin isomer distribution is the same for the coal derived and petroleum feedstocks, thus C_4 composition is not a factor when comparing petroleum derived and coal derived alkylate quality. However, as is evident from the Table 41 C_3/C_4 yield summary, the propylene quantity exceeds that of the butylene in the coal liquid cases, whereas the reverse is true with petroleum derived feed. Since C_4 olefins produce a higher quality alkylate, higher octane numbers are expected for the petroleum case. Table 45, a summary of C_6+ alkylate properties, confirms this assumption. To produce an alkylate product of equivalent quality from coal liquids, it would be necessary to increase the isobutane/olefin feed ratio beyond that used in the petroleum case.

4.4.3. HF Alkylation Estimated Yields

Alkylation yields have been estimated on both severely hydrotreated cases and on the petroleum case. Results of these estimates are given in Tables 46-48. For comparison purposes, the data have been reported on a nominal 10,000 BPSD charge. The petroleum case, as seen in Table 47, requires less isobutane make-up than the coal derived material. In a commercial operation, the isobutane deficiency would have to be made up via n-butane isomerization or external purchase. The difference is due to the greater inherent quantity of i-C_4 in the petroleum stock. Also, in the petroleum case there is less propane than in the coal cases. Propane gets a free ride through the alkylation unit and has no effect on alkylate quality or quantity.

Overall, the quantity of C_6+ alkylate produced in the coal liquid and petroleum cases is similar if one begins with an equivalent amount of C_3/C_4 feed. Starting with a constant feed to the FCC unit, one would see very different results depending upon the quality of the feed, i.e., hydrogen content of the feed. As shown previously in Table 42, FCC conversion varies from a low of 44.8 vol-% to a high of 62.2 vol-% as compared to the petroleum case of 82.2 vol-%. In the case of the coal liquids these correspond to feed hydrogen contents of 8.66 wt-% and 10.59 wt-%, respectively. Also as seen in Table 41 the quantity of C_3/C_4 material increases from 3.03 wt-% to 12.39 wt-% for the above stated cases. Therefore, depending upon the hydrogen content of the FCC feed, which is a function of the "pre-hydrotreatment" process, it is possible to obtain a widely varying quantity of C_3/C_4 material for alkylation. In addition, FCC feed initial boiling point would be a factor to take into consideration; and this would also affect the C_3/C_4 product yield. Selecting the optimum operating conditions of the FCC unit and the prehydrotreater would require a detailed economic study which is beyond the scope of this evaluation.

In summary it is concluded that for a given quantity of C_3/C_4 FCC product originating from either a 400°F$^+$ severely hydrotreated SRC-II gas oil or a petroleum derived vacuum gas oil, the quantity and quality of C_6+ alkylate will be comparable. The petroleum derived C_6+ alkylate exhibits slightly better quality due to a higher C_4/C_3 ratio. This can, however, be overcome in the coal liquid case by increasing the isobutane/olefin ratio. The basic question of the viability of using an FCC/HF Alkylation complex on a given coal liquid feed will depend on selection of the appropriate feed pretreatment level and feed boiling range (which significantly affect alkylate yield).

Errata:

Report FE-2566-32

Table 5 - Heading should be 94.8%

Table 9 - Chloride, ppm 59

Figure 1 - Blocks to right of word "Rerun" top block 94.8% OH
bottom block 5.2% Botts.

Report FE-2566-36

Tables 15 and 16 - Headings should read:

Fluid Catalytic Cracking of Topped Rerun SRC-II Gas Oil 3777-38
Plant 593, Run 299

Table 1

Inspections of Raw SRC-II Gas Oil[a]

Sample Number	3777-6	3777-7
Drum Number	1	2
°API @ 60°F	9.7	10.1
Sp. Gr. @ 60°F	1.0021	0.9993
Distillation, ASTM D 1160		
IBP, °F	386	335
5%	407	395
10%	417	410
20%	430	425
30%	445	444
40%	465	458
50%	486	472
60%	508	492
70%	535	512
80%	570	571
90%	645	656
95%	711	705
EP	799	810
% Over	99.0	99.0
% Bottoms	1.0	1.0
Hydrogen, Wt-%	8.68	8.72
Carbon, Wt-%	85.83	86.13
Sulfur, Wt-ppm	3300	3815
Nitrogen, Wt-ppm	8100	9040
Oxygen, Wt-ppm	17900	17300
Heptane Insoluble, Wt-%	0.17	0.22
FIA, Vol-%		
Color Band[b]		36.1
A	90.1	54.5
P&N	9.9	9.4
Conradson Carbon, Wt-%	0.38	0.37
Steam Jet Gum mg/100 ml	842	854

[a]Derived from Powhaton No. 5 Mine Coal; contains up to 3% Dowtherm (diphenyl/diphenyl oxide) contaminant.

[b]Highly polar compounds

Table 2

High Resolution Mass Spectral Characterization of SRC-II Gas Oil Drum No. 1 3777-6

Sample Analysis Summary

Compound Type C_nH_{2n-z}	Wt-%	Avg. C No.	Avg. MW	Avg. z No.
Saturated Hydrocarbons (P+N)	8.4	15.5	216	0.7
Aromatic Hydrocarbons	53.8	14.3	186	14.1
Aromatic Nitrogens	7.0	11.7	167	10.8
Aromatic Oxygens	27.6	10.4	153	8.9
Aromatic Sulfurs	1.2	13.7	209	14.6
Aromatic Dioxygenates	1.7	13.1	203	13.5
Aromatic Trioxygenates	0.3	12.5	212	10.8

Elemental Analysis by MS

	Wt-%
Atomic Carbon	87.72
Atomic Hydrogen	8.29
Atomic Nitrogen	0.59
Atomic Oxygen	3.22
Atomic Sulfur	0.18
	100.00

Table 2 (Cont'd.)

High Resolution Mass Spectral Characterization of SRC-II Gas Oil Drum No. 1 3777-6

Hydrocarbon Types Analysis

(C_nH_{2n-z}) z No.	Compound Types	Wt-%	Avg. MW
z=-2	Paraffins	3.6	226
z=0	1 Ring Naphthenes	1.3	224
z=2	2 Ring Naphthenes	1.8	208
z=4	3 Ring Naphthenes	1.3	206
z=6	4 Ring Naphthenes	0.4	190
		8.4	216

z No.	Aromatic Hydrocarbons Compound Types, C_nH_{2n-z}	Wt-%	Avg. MW
z=6	Benzenes	0.9	158
z=8	Indans/Tetralins	10.3	165
z=10	Dinaphthene Benzenes	2.7	185
z=12	Naphthalenes	12.1	159
z=14	Acenaphthenes/Biphenyls	7.5	185
z=16	Fluorenes	4.4	205
z=18	Phenanthrenes	6.7	197
z=20	Aceanthrenes	2.6	227
z=22	Pyrenes	4.7	223
z=24	Chrysenes	0.9	246
z=26	Benzofluoranthenes	0.3	276
z=28	Benzopyrenes	0.6	280
z=30	Dibenzanthracenes	<0.1	292
z=32	Benzoperylenes	T	
z=34	Dibenzopyrenes	T	
z=36	Coronenes	T	
		53.8	186

z No.	Aromatic Oxygens Compound Types, $C_nH_{2n-z}O$	Wt-%	Avg. MW
z=6O	Phenols	14.4	131
z=8O	Naphthenophenols	5.7	154
z=10O	Benzofurans	0.6	183
z=12O	Naphthols	<0.1	180
z=14O	Naphthenonaphthols	3.2	180
z=16O	Dibenzofurans	2.6	202
z=18O	Hydroxyanthracenes	0.3	230
z=20O	Hydroxynaphthenoanthracenes	0.2	233
z=22O	Hydroxypyrenes	0.5	232
z=24O	Hydroxychrysenes	T	
		27.6	153

Suggested compound types

Multiheteroaromatics normalized out of the results

T ≤ 0.05%

High Resolution Mass Spectral Characterization of SRC-II Gas Oil Drum No. 1 3777-6

z No.	Aromatic Dioxygenates Compound Types, $C_nH_{2n-z}O_2$ [a]	Wt-% [a]	Avg. MW
$z=6^{O_2}$	Hydroxyphenols	0.3[b]	120
$z=14^{O_2}$	Hydroxynaphthenonaphthols	0.7[b]	218
$z=16^{O_2}$	Hydroxydibenzofurans	0.5[b]	215
$z=18^{O_2}$	Dihydroxyanthracenes	<0.1[b]	247
$z=20^{O_2}$	Dihydroxynaphthenonanthracenes	<0.1[b]	278
		1.7[b]	203

z No.	Aromatic Trioxygenates Compound Types, $C_nH_{2n-z}O_3$ [a]	Wt-%	Avg. MW
$z=6^{O_3}$	Dihydroxyphenols	<0.1	204
$z=12^{O_3}$	Dihydroxynaphthol	0.2	211
$z=14^{O_3}$	Dihydroxynaphthenonaphthols	T	
		0.3	212

z No.	Aromatic Nitrogens Compound Types, $C_nH_{2n-z}N$ [a]	Wt-%	Avg. MW
$z=5^N$	Pyridines	1.5	130
$z=7^N$	Naphthenopyridines	1.1	153
$z=9^N$	Indoles	0.6	152
$z=11^N$	Quinolines	1.3	156
$z=13^N$	Naphthenoquinolines	0.6	198
$z=15^N$	Carbazoles	0.6	191
$z=17^N$	Acridines	0.6	202
$z=19^N$	Naphthenobenzoquinolines	<0.1	222
$z=21^N$	Benzocarbazoles	0.5	228
$z=23^N$	Benzacridines	<0.1	254
$z=25^N$	Naphthenobenzacridines	T	
$z=27^N$	Dibenzocarbazoles	T	
		7.0	167

z No.	Aromatic Sulfurs Compound Types, $C_nH_{2n-z}S$ [a]	Wt-%	Avg. MW
$z=6^S$	Benzenethiols	T	
$z=8^S$	Dihydrothionaphthenes	0.2	199
$z=10^S$	Benzothiophenes	<0.1	172
$z=12^S$	Naphthenobenzothiophenes	T	
$z=14^S$	Indenothiophenes	T	
$z=16^S$	Dibenzothiophenes	0.6	205
$z=18^S$	Acenaphthenothiophenes	<0.1	239
$z=20^S$	Fluorenothiophenes	T	
$z=22^S$	Tribenzothiophenes	<0.1	250
$z=24^S$	Acephenanthrylenethiophenes	T	
$z=26^S$	Pyrenothiophenes	T	
		1.2	209

[a] Suggested compound types

[b] Estimates due to lack of sensitivity data

T ≤ 0.05%

Table 2 (Cont'd.)

High Resolution Mass Spectral Characterization of
SRC-II Gas Oil Drum No. 1 3777-6

Carbon Number Distribution of Aromatic Hydrocarbons on a 100% Basis

C No. \ z No.	6	8	10	12	14	16	18	20	22	24	26	28	30
8	0.03	0.02											
9	0.12	0.21											
10	0.31	2.12	0.09	2.59									
11	0.42	4.16	0.07	6.72									
12	0.28	4.27	0.47	5.10	2.35								
13	0.28	3.60	1.41	3.45	2.73	0.92							
14	0.23	3.19	1.55	2.61	3.46	1.85	5.00						
15	0.09	1.11	0.75	1.08	2.32	1.03	3.10	0.21					
16	0.05	0.37	0.30	0.40	1.50	1.46	1.74	0.84	3.43				
17			0.30	0.24	0.75	1.27	1.20	1.31	2.14				
18		0.10	0.09	0.10	0.47	0.78	0.87	1.25	1.03	0.54			
19				0.12	0.26	0.52	0.47	0.75	0.92	0.61			
20						0.28	0.21	0.30	0.49	0.37	0.10	0.23	
21								0.12	0.42	0.21	0.14	0.16	
22								0.09	0.10	0.07	0.30	0.24	
23									0.19		0.02	0.16	0.10
24												0.14	
25												0.05	
26												0.03	
	1.81	19.15	5.03	22.41	13.84	8.11	12.59	4.87	8.72	1.80	0.56	1.01	0.10

$\Sigma = 100$

Numbers are shown to two decimal places for normalization purposes only.

Table 2 (Cont'd.)

High Resolution Mass Spectral Characterization of
SRC-II Gas Oil Drum No. 1 3777-6

Carbon Number Distribution of Aromatic Sulfurs on a 100% Basis

C No.	z No. 6^S	8^S	10^S	12^S	14^S	16^S	18^S	20^S	22^S	24^S	26^S	
8	2.34											
9	0.78	1.56	0.78									
10	0.78	3.13	1.56									
11		6.25	3.13									
12		2.34	0.78	0.78		14.06						
13		0.78	0.78			15.63						
14				2.34		9.38						
15				0.78	0.78	4.69	2.34	0.78				
16					0.78	5.47	2.34	0.78	3.13			
17						0.78	1.56	0.78	2.34			
18							0.78		0.78		1.56	
19									0.78	1.56		
	3.90	14.07	7.03	3.90	1.56	50.02	7.03	2.34	7.03	1.56	1.56	$\Sigma = 100$

Numbers are shown for two decimal places for normalization purposes only.

Table 2 (Cont'd.)

High Resolution Mass Characterization of SRC-II Gas Oil Drum No. 1 3777-6

Carbon Number Distribution for Aromatic Nitrogenates on a 100% Basis

C No. z No.	5^N	7^N	9^N	11^N	13^N	15^N	17^N	19^N	21^N	23^N	25^N	27^N
7	5.11											
8	7.14	0.89										
9	4.34	3.18	1.65	3.83								
10	3.44	6.25	2.55	5.23								
11	1.78	3.31	1.91	4.09								
12	0.51	1.66	0.64	3.96	0.64	3.69						
13	0.13	1.15	0.51	1.02	2.55	1.66	1.40					
14		0.38		0.76	1.91	0.25	3.06	0.13				
15		0.25			0.89	0.76	1.91	0.64	0.64			
16				0.64	0.76	2.29	0.64	0.25	1.66			
17					0.13	0.38	0.51	0.38	3.31	0.13		
18					0.38			0.38	0.38	0.13		
19										0.25		
20									0.38	0.25	0.13	0.51
21												0.25
	22.45	17.09	7.27	19.52	7.27	9.05	7.53	1.79	6.38	0.76	0.13	0.76

$\Sigma = 100$

Carbon Number Distribution for Aromatic Oxygenates on a 100% Basis

C No. z No.	6^O	8^O	10^O	12^O	14^O	16^O	18^O	20^O	22^O	24^O
6	1.43									
7	9.25									
8	15.94	0.13								
9	13.17	4.75	0.16							
10	7.30	7.88	0.22	0.16						
11	3.89	4.37	0.19	0.10						
12	1.18	2.36	0.35		7.94	1.37				
13	0.26	0.96	0.48	0.03	0.83	2.14				
14		0.35	0.48	0.03	0.99	1.98				
15		0.03	0.26	0.06	1.24	1.43	0.10			
16			0.10		0.29	1.15	0.54	0.19	0.51	
17				0.06	0.03	0.96	0.29	0.29	0.57	
18					0.10	0.22	0.03	0.16	0.13	
19						0.22	0.10		0.19	
20										0.10
	52.42	20.82	2.23	0.45	11.42	9.47	1.05	0.64	1.40	0.10

$\Sigma = 100$

Numbers are shown to two decimal places for normalization purposes only.

High Resolution Mass Characterization of
SRC-II Gas Oil Drum No. 1 3777-6

Carbon Number Distribution for Aromatic Dioxygenates and Trioxygenates on a 100% Basis

C No.	z No.	$6O_2$	$14O_2$	$16O_2$	$18O_2$	$20O_2$
6		5.54				
7		13.11				
12			3.84			
13			9.38	7.68		
14			13.67	5.54		
15			10.85	8.14		
16			3.95	2.71	2.71	
17			4.29		4.97	
19						3.62
		18.64	45.99	24.07	7.68	3.62

$\Sigma = 100$

C No.	z No.	$6O_3$	$12O_3$	$14O_3$
11		17.65		
12			28.76	
13		7.19	32.03	
14				14.38
		24.84	60.78	14.38

$\Sigma = 100$

Numbers are shown to two decimal places for normalization purposes only.

Table 3

Fractionation of SRC-II Gas Oil 3777-7

Cut Number	Boiling Range, °F	Volume, ml	Volume, %	Weight, g	Wt-%
1 [a]	IBP-400°	4727	13.7	4395	12.7
Botts [b]	400°+	29808	86.3	30324	87.3
		34535	100.0	34719	100.0

[a] Designated as IBP-400°F Naphtha 3777-35

[b] Designated as 400°F+ Topped Gas Oil 3777-36

Table 4

Inspections of 400°F+ Topped Gas Oil from SRC-II Gas Oil 3777-7

Sample Number	3777-36
°API @ 60°F	7.6
Sp. Gr. @ 60°F	1.0173
Distillation, ASTM D 1160	
IBP, °F	400
5%	440
10%	450
20%	460
30%	471
40%	487
50%	501
60%	520
70%	550
80%	606
90%	688
95%	739
EP	820
% Over	99.0
% Bottoms	1.0
Hydrogen, Wt-%	8.66
Carbon, Wt-%	86.72
Sulfur, wt-ppm	3200
Nitrogen, Wt-ppm	10200
Oxygen, Wt-ppm	27200
Heptane Insoluble, Wt-%	0.48
Molecular Weight kg/kmol	173
Pour Point °F	-30
FIA, Vol-%	
Color Band	-
A	93.3
P&N	6.7
Conradson Carbon, Wt-%	0.54
Steam Jet Gum, mg/100 ml	
Viscosity @ 100°F	
SUS	47.9
cSt	6.738

Table 5

Rerunning of SRC-II Gas Oil 3777-6

Cut Number	Boiling Range, °F	Weight, g	Wt-%
1	IBP-748°	34804	94.8
Botts	748°+	1919	5.2
		36723	100.0

Designated as Rerun SRC-II Gas Oil 3777-19

Fractionation of Rerun SRC-II Gas Oil 3777-19

Cut Number	Boiling Range, °F	Volume, ml	Volume, %	Weight, g	Wt-%
1	IBP-400°	4435	14.6	4129	13.6
Botts	400°+	26025	85.4	26137	86.4
		30460	100.0	30266	100.0

Designated as IBP-400°F Naphtha 3777-37

Designated as 400°F+ Topped Gas Oil 3777-38

Table 6

Inspections of 94.8% OH Rerun SRC-II Gas Oil 3777-6

Sample Number	3777-19
°API @ 60°F	10.6
Sp. Gr. @ 60°F	0.9958
Distillation, ASTM D 1160	
IBP, °F	364
5%	391
10%	408
20%	428
30%	444
40%	460
50%	472
60%	489
70%	508
80%	539
90%	609
95%	670
EP	724
% Over	99.0
% Bottoms	1.0
Hydrogen, Wt-%	9.01
Carbon, Wt-%	86.43
Sulfur, Wt-ppm	2750
Nitrogen, Wt-ppm	8570
Oxygen, Wt-ppm	19400
Heptane Insoluble, Wt-%	0.04
FIA, Vol-%	
Color Band[a]	34.0
A	56.3
P&N	9.7
Conradson Carbon, Wt-%	0.10
Steam Jet Gum, mg/100 ml	51.8

[a]Highly polar compounds

Table 7

Inspections of 400°F+ Topped Gas Oil from 3777-19

Sample Number	3777-38
°API @ 60°F	8.7
Sp. Gr. @ 60°F	1.0093
Distillation, ASTM D 1160	
IBP, °F	421
5%	450
10%	452
20%	458
30%	464
40%	478
50%	491
60%	508
70%	529
80%	569
90%	633
95%	672
EP	738
% Over	99.0
% Bottoms	1.0
Hydrogen, Wt-%	8.89
Carbon, Wt-%	86.83
Sulfur, Wt-ppm	2900
Nitrogen, Wt-ppm	9950
Oxygen, Wt-ppm	22800
Heptane Insoluble, Wt-%	0.03
Pour Point, °F	-30
FIA, Vol-%	
Color Band[a]	31.5
A	61.0
P&N	7.5
Conradson Carbon, Wt-%	0.11
Viscosity @ 100°F	
SUS	43.6
cSt	5.388
Molecular Weight, kg/kmol	173

[a]Highly polar compounds

Table 8

Inspections of 400°F+ Topped Gas Oil from 3777-21

Sample Number	3777-34
°API @ 60°F	3.6
Sp. Gr. @ 60°F	0.9752
Distillation, ASTM D 1160	
IBP, °F	418
5%	428
10%	436
20%	450
30%	462
40%	472
50%	487
60%	504
70%	539
80%	582
90%	641
95%	691
EP	790
% Over	99.0
% Bottoms	1.0
Hydrogen, Wt-%	9.98
Carbon, Wt-%	86.84
Sulfur, Wt-ppm	106
Nitrogen, Wt-ppm	6000
Oxygen, Wt-ppm	9800
Heptane Insoluble, Wt-%	0.01
Pour Point, °F	-50
FIA, Vol-%	
Color Band[a]	19.4
A	69.9
P&N	10.7
Conradson Carbon, Wt-%	0.01
Viscosity @ 100°F	
SUS	41.2
cSt	4.628
Molecular Weight, kg/kmol	192

[a]Highly polar compounds

Table 9

Inspections of 400°F+ Topped Gas Oil from 3777-28

Sample Number	3777-41
°API @ 60°F	17.7
Sp. Gr. @ 60°F	0.9484
Distillation, ASTM D 1160	
IBP, °F	408
5%	440
10%	448
20%	455
30%	463
40%	478
50%	490
60%	510
70%	536
80%	570
90%	625
95%	668
EP	748
% Over	99.0
% Bottoms	1.0
Hydrogen, Wt-%	10.59
Carbon, Wt-%	84.86
Sulfur, Wt-ppm	109
Nitrogen, Wt-ppm	1730
Oxygen, Wt-ppm	8300
Heptane Insoluble, Wt-%	0.01
Pour Point, °F	-45
FIA, Vol-%	
Color Band [a]	-
A	73.9
P&N	26.1
Conradson Carbon, Wt-%	0.02
Viscosity @ 100°F	
SUS	37.4
cSt	3.446
Molecular Weight, kg/kmol	193

[a] Highly polar compounds

Table 10

Hydrotreating Raw SRC-II Gas Oil 3777-6

Plant 505, Run 880

Period No.	Hours On Stream	P-P(base) psig	LHSV / LHSV(base)	T-T(base) °C	Product Analysis, Wt-% H	C
2	24-38	0	0.45	-59	10.90	87.59
5	58-68	10	0.44	-59	10.75	87.38
8	89-99	0	0.45	-59	10.84	82.52
10	109-119	0	0.39	-59	11.06	86.45
11	119-129	0	0.37	-61	10.81	86.68
12	129-139	0	0.41	-59	10.54	86.69
14	147-155	0	0.90	-59	10.06	86.38
18	179-187	10	0.79	-59	10.14	86.14
23	219-227	0	0.77	-59	10.19	86.55
24	227-235	-10	0.71	-59	10.14	86.05
29	261-267	0	1.23	-59	9.76	86.36
30	267-273	0	1.30	-59	9.50	85.24
31	273-279	0	1.31	-58	9.52	85.05
32	279-285	-10	1.17	-59	9.69	86.38
37	321-331	15	0.40	-60	10.26	85.70

Table 11

Hydrotreating Raw SRC-II Gas Oil 3777-6

Plant 505, Run 881

Period No	Hours on Stream	P-P(base), psi	LHSV/ LHSV(base)	T-T(base), °C	Product Analysis, Wt-% H	C
3	46-56	0	0.41	-50	11.02	87.81
6	76-86	0	0.39	-45	11.14	86.93
8	96-106	0	0.41	-44	11.07	86.51
9	106-116	0	0.38	-44	11.06	86.94
11	126-136	-5	0.39	-35	11.32	87.19
12	136-146	-10	0.39	-34	11.57	87.44
13	146-156	-10	0.39	-34	11.87	86.54
16	172-180	5	0.81	-34	10.61	87.34
17	180-188	0	0.80	-34	10.73	86.26
20	200-206	5	1.22	-35	10.21	85.84
21	206-212	0	1.18	-35	10.30	85.80
23	222-232	0	0.41	-34	11.34	87.34
24	232-242	10	0.40	-36	11.18	86.69
27	262-272	0	0.40	-10	12.15	86.37
28	272-282	0	0.39	- 8	11.80	86.36
29	282-292	0	0.41	- 9	12.33	86.61
30	292-302	10	0.41	- 9	11.73	86.38
31	302-312	-5	0.39	- 9	11.75	86.91
34	328-336	0	0.83	- 9	11.03	86.75
35	336-344	25	0.82	- 8	10.94	86.91
38	356-362	10	1.22	- 9	10.54	87.58
39	362-368	15	1.18	- 8	10.49	86.85
41	378-388	0	0.48	-16	11.48	88.13
42	388-398	15	0.45	- 7	11.60	87.45
43	398-408	10	0.39	- 9	11.61	87.24

Table 12

Hydrotreating Raw SRC-II Gas Oil 3777-6
Plant 505, Run 882

Period No.	Hrs. on Stream	P-P(base), psi	LHSV/ LHSV(base)	T-T(base), °C	Product Analysis,wt-% H	C
2	24-34	500	0.40	-49	10.54	85.55
3	34-44	500	0.40	-49	11.14	87.38
4	44-54	510	0.41	-49	10.95	87.74
7	70-78	520	0.79	-50	10.48	87.24
8	78-86	500	0.81	-50	10.72	87.42
11	98-104	480	1.18	-47	10.05	86.92
12	104-110	500	1.19	-48	9.72	85.88
14	120-130	500	0.40	-49	10.80	87.65
15	130-140	520	0.40	-49	10.79	87.32
16	140-150	520	0.39	-49	11.01	88.16
18	160-170	500	0.39	-35	11.21	86.60
19	170-180	540	0.40	-34	11.89	88.11
20	180-190	500	0.41	-33	11.42	87.39
21	190-200	530	0.38	-36	12.04	87.90
22	200-210	520	0.40	-35	11.37	87.07
25	226-234	505	0.80	-32	10.76	86.67
26	234-242	500	0.80	-35	10.75	86.51
29	254-260	540	1.18	-35	10.26	86.43
30	260-266	510	1.20	-34	10.22	86.37
33	286-296	510	0.45	-35	11.15	87.26
35	306-316	510	0.39	-35	11.23	86.98
36	316-326	530	0.40	-36	11.28	87.15
38	336-346	520	0.40	-35	11.07	86.88

Table 13

Hydrotreating Raw SRC-II Gas Oil 3777-7
Plant 505, Run 883

Period No.	Hrs. on Stream	P-P(base), psi	LHSV/ LHSV(base)	T-T(base), °C	Product Analysis,wt-% H	C
4	36-44	530	0.84	-9	11.64	87.50
7	55-61	515	1.22	-10	11.02	87.48
8	61-67	550	1.20	-8	11.01	87.35
14	103-111	500	0.81	-7	11.67	86.97
15	111-119	540	0.80	-8	11.60	87.52
20	151-159	500	0.67	-10	11.61	86.68
22	167-175	480	0.57	-9	11.70	86.43
24	183-191	510	0.60	-8	11.66	87.14
25	191-199	480	0.62	-9	11.59	87.52
29	229-239	530	0.40	-9	12.00	87.25
32	259-269	520	0.39	-11	12.07	86.75
35	289-299	500	0.44	-11	11.70	86.87
38	315-323	490	0.79	-10	11.58	87.30
39	323-331	550	0.81	-9	11.33	86.22

Table 14

Hydrotreating SRC-II Gas Oil 3777-6
Plant 505, Run 880

Period No.	Feed	2-12	14-24	29-32
Hours on Stream		24-139	147-235	261-285
Operating Conditions				
P-P (base), psi		0	0	0
T-T (base), °C		-59	-59	-59
LHSV/LHSV (base)		0.45	0.90	1.23
Liquid Product Properties				
°API @ 60°F	9.7	20.6	17.0	14.6
Sp. Gr. @ 60°F	1.0021	0.9303	0.9529	0.9685
Elemental Analysis				
Hydrogen, Wt-%	8.68	10.88	10.16	9.75
Carbon, Wt-%	85.83	86.10	85.51	86.45
Sulfur, Wt-ppm	3300	240	490	470
Nitrogen, Wt-ppm	8100	2700	5100	6800
Oxygen, Wt-ppm	17900	14100	15100	13530
FIA, Vol-%				
Color Band [a]		11.6	19.3	23.9
A	90.1	56.8	60.4	61.4
O	-	-	-	-
P&N	9.9	31.6	20.3	14.7

Product Distribution, % of Feed	Wt-%	Vol-%	Wt-%	Vol-%	Wt-%	Vol-%
C_1-C_4 Fraction	0.13		0.10		0.11	
C_5-C_6 Fraction (in Plant Gas)	0.98	1.51	0.86	1.32	0.30	0.45
C_5+ Fraction	99.70	107.40	99.50	104.53	99.55	103.00
H_2O	0.75		0.62		0.83	
NH_3	0.67		0.36		0.16	
H_2S	0.33		0.30		0.31	
Total	102.56	108.91	101.74	105.85	101.26	103.45
H_2 Consumption, Wt-% of Feed	2.56		1.74		1.26	

[a] Highly polar compounds

Table 15

Hydrotreating SRC-II Gas Oil 3777-6

Plant 505, Run 881

Period No.	Feed	11-13	16-17	20-21
Hours on Stream		126-156	172-188	200-212
Operating Conditions				
P-P(base), psi		-10	5	5
T-T(base), °C		-34	-34	-35
LHSV/LHSV (base)		0.39	0.81	1.20
Liquid Product Properties				
°API @ 60°F	9.7	24.3	19.7	16.8
Sp. Gr. @ 60°F	1.0021	0.9082	0.9358	0.9541
Elemental Analysis				
Hydrogen, Wt-%	8.68	11.29	10.66	10.23
Carbon, Wt-%	85.83	87.58	87.38	86.44
Sulfur, Wt-ppm	3300	130	310	390
Nitrogen, Wt-ppm	8100	600	3100	5970
Oxygen, Wt-ppm	17900	4070	10580	12680
FIA, Vol-%				
Color Band[a]		3.3	12.4	20.2
A	90.1	52.5	59.3	59.9
O	-	-	-	-
P&N	9.9	44.2	28.3	19.9

Product Distribution, % of Feed	11-13 Wt-%	11-13 Vol-%	16-17 Wt-%	16-17 Vol-%	20-21 Wt-%	20-21 Vol-%
C_1-C_4 Fraction	0.24		0.19		0.13	
C_5-C_6 Fraction (in Plant Gas)	1.42	2.18	0.84	1.29	0.43	0.65
C_5+ Fraction	98.21	108.36	99.20	106.23	99.92	104.94
H_2O	1.95		1.17		0.91	
NH_3	0.90		0.61		0.26	
H_2S	0.33		0.32		0.31	
Total	103.05	110.54	102.33	107.52	102.46	105.59
H_2 Consumption, Wt-% of Feed	3.05		2.33		2.46	

[a] Highly polar compounds

Table 16

Hydrotreating SRC-II Gas Oil 3777-6

Plant 505, Run 881

Period No.	Feed	27-31		34-35		38-39	
Hours on Stream		262-312		328-344		356-368	
Operating Conditions							
P-P(base), psi		0		10		10	
T-T(base), °C		-9		-9		-9	
LHSV/LHSV (base)		0.40		0.83		1.20	
Liquid Product Properties							
°API @ 60°F	9.7	26.7		23.3		20.4	
Sp. Gr. @ 60°F	1.0021	0.8944		0.9141		0.9315	
Elemental Analysis							
Hydrogen, Wt-%	8.68	12.00		11.12		10.77	
Carbon, Wt-%	85.83	87.89		88.33		87.35	
Sulfur, Wt-ppm	3300	50		110		210	
Nitrogen, Wt-ppm	8100	230		650		1770	
Oxygen, Wt-ppm	17900	2236		6564		13956	
FIA, Vol-%							
Color Band[a]				5.2		10.6	
A	90.1	42.6		57.1		65.2	
O	-	-		-		-	
P&N	9.9	57.4		37.7		24.2	
Product Distribution, % of Feed		Wt-%	Vol-%	Wt-%	Vol-%	Wt-%	Vol-%
C_1-C_4 Fraction		0.73		0.38		0.31	
C_5-C_6 Fraction (in Plant Gas)		2.23	3.42	1.00	1.53	0.74	1.13
C_5+ Fraction		100.09	111.24	98.47	107.95	98.41	105.87
H_2O		0.68		1.63		1.91	
NH_3		0.70		0.90		0.77	
H_2S		0.35		0.34		0.33	
Total		104.78	114.66	102.72	109.48	102.47	107.00
H_2 Consumption, Wt-% of Feed		4.78		2.72		2.47	

[a]Highly polar compounds

Table 17

Hydrotreating SRC-II Gas Oil 3777-6

Plant 505, Run 882

Period No.	Feed	2-4		7-8		11-12	
Hours on Stream		24-54		70-86		98-110	
Operating Conditions							
P-P(base), psi		505		510		490	
T-T(base), °C		-49		-50		-47	
LHSV/LHSV (base)		0.40		0.80		1.18	
Liquid Product Properties							
°API @ 60°F	9.7	20.2		16.9		14.8	
Sp. Gr. @ 60°F	1.0021	0.9328		0.9535		0.9672	
Elemental Analysis							
Hydrogen, Wt-%	8.68	10.76		10.18		9.84	
Carbon, Wt-%	85.83	86.41		86.03		86.37	
Sulfur, Wt-ppm	3300	61		51		120	
Nitrogen, Wt-ppm	8100	2870		1990		6700	
Oxygen, Wt-ppm	17900	9540		15630		15300	
FIA, Vol-%							
Color Band[a]		13.2		20.2		26.4	
A	90.1	55.7		57.1		57.6	
O	-	-		-		-	
P&N	9.9	31.1		22.7		16.0	
Product Distribution, % of Feed		Wt-%	Vol-%	Wt-%	Vol-%	Wt-%	Vol-%
C_1-C_4 Fraction		0.11		0.13		0.07	
C_5-C_6 Fraction (in Plant Gas)		1.40	2.14	0.73	1.12	0.46	0.71
C_5+ Fraction		98.61	105.94	99.28	104.34	99.70	103.29
H_2O		1.29		0.56		0.59	
NH_3		0.64		0.74		0.17	
H_2S		0.34		0.35		0.34	
Total		102.39	108.08	101.79	105.46	101.33	104.00
H_2 Consumption, Wt-% of Feed		2.39		1.79		1.33	

[a]Highly polar compounds

Table 18

Hydrotreating SRC-II Gas Oil 3777-6

Plant 505, Run 882

Period No.	Feed	20-22		25-26		29-30	
Hours on Stream		180-210		226-242		254-256	
Operating Conditions							
P-P(base), psi		520		505		525	
T-T(base), °C		-35		-34		-35	
LHSV/LHSV(base)		0.40		0.80		1.19	
Liquid Product Properties							
°API @ 60°F	9.7	25.3		21.0		17.9	
Sp. Gr. @ 60°F	1.0021	0.9024		0.9279		0.9471	
Elemental Analysis							
Hydrogen, Wt-%	8.68	11.55		10.77		10.07	
Carbon, Wt-%	85.83	87.25		86.49		86.17	
Sulfur, Wt-ppm	3300	51		36		44	
Nitrogen, Wt-ppm	8100	510		2390		4140	
Oxygen, Wt-ppm	17900	3990		9700		13510	
FIA, Vol-%							
Color Band[a]		4.3		11.7		17.3	
A	90.1	47.6		56.2		57.7	
O	-	-		-		-	
P&N	9.9	48.1		32.1		25.0	
Product Distribution, % of Feed		Wt-%	Vol-%	Wt-%	Vol-%	Wt-%	Vol-%
C_1-C_4 Fraction		0.20		0.19		0.17	
C_5-C_6 Fraction (in Plant Gas)		1.69	2.59	1.01	1.55	0.35	0.53
C_5+ Fraction		98.14	108.98	98.96	106.87	99.48	105.26
H_2O		1.95		1.28		0.84	
NH_3		0.92		0.69		0.45	
H_2S		0.34		0.35		0.35	
Total		103.24	111.57	102.48	108.42	101.64	105.79
H_2 Consumption, Wt-% of Feed		3.24		2.48		1.64	

[a]Highly polar compounds

Table 19

Hydrotreating SRC-II Gas Oil 3777-7
Plant 505, Run 883

Period No.	Feed	7-8	14-15	28-34
Hours on Stream		55-67	103-119	229-289
Operating Conditions				
P-P(base), psi		535	520	520
T-T(base), °C		-9	-8	-10
LHSV/LHSV(base)		1.21	0.80	0.40
Liquid Product Properties				
°API @ 60°F	10.1	24.2	26.1	28.5
Sp. Gr. @ 60°F	0.9993	0.9088	0.8978	0.8894
Elemental Analysis				
Hydrogen, Wt-%	8.72	10.96	11.50	12.43
Carbon, Wt-%	86.13	87.28	87.91	87.48
Sulfur, Wt-ppm	3815	300	130	110
Nitrogen, Wt-ppm	9040	1170	470	170
Oxygen, Wt-ppm	17300	7700	3680	770
FIA, Vol-%				
Color Band[a]	36.1	5.5	2.6	-
A	54.5	53.3	47.7	34.6
O	-	-	-	-
P&N	9.4	41.2	49.7	65.4

Product Distribution, % of Feed	7-8 Wt-%	7-8 Vol-%	14-15 Wt-%	14-15 Vol-%	28-34 Wt-%	28-34 Vol-%
C_1-C_4 Fraction	0.31		0.38		0.43	
C_5-C_6 Fraction (in Plant Gas)	0.91	1.39	1.45	2.22	1.82	2.79
C_5+ Fraction	98.93	108.78	98.36	109.48	98.61	111.42
H_2O	1.21		1.62		1.97	
NH_3	0.87		1.03		1.07	
H_2S	0.37		0.39		0.39	
Total	102.60	110.17	103.23	111.70	104.30	114.21
H_2 Consumption, Wt-% of Feed	2.60		3.23		4.30	

[a]Highly polar compounds

Table 20

Hydrotreating Raw SRC-II Gas Oil 3777-6
Preparative Run No. 1
Plant 638, Run 37

P-P(base) = 0 LHSV/LHSV(base) = 0.8

Period No.	Hrs. on Stream	T-T(base), °C	Product Analysis, wt-% H	C
1	30	-54	10.00	85.89
3	42-52	-55	10.05	85.74
5	62-72	-55	10.06	86.25
7	82-92	-42	10.34	86.07
10	112-122	-45	10.12	86.19
17	182-192	-41	10.27	86.33

Table 21

Hydrotreating SRC-II Gas Oil 3777-6

Overall Product Distribution

Plant 638, Run 37

Product Distribution	Wt-%
C_1	0.01
C_2	0.03
C_3	0.02
C_4	0.03
C_5 and C_6 (in Plant Gas)	0.33
Stripper Bottoms[a]	99.47
H_2O	1.42
H_2S	0.32
NH_3	0.32
Total	101.95
H_2 Consumption, Wt-% of Feed	1.95
H_2 Consumption , SCFB	1230

[a]Designated as Hydrotreated SRC-II Gas Oil 3777-21

Table 22

Hydrotreating SRC-II Gas Oil 3777-6

Distribution of Hydrogen Consumption

Plant 638, Run 37

	Wt-%
C_1-C_4	0.59
C_5-C_6 (in Plant Gas)	1.47
Stripper Bottoms[a]	84.15
H_2O	9.36
H_2S	1.12
NH_3	3.31
Total	100.00
Total Hydrogen Consumption, SCFB	1230

[a]Designated as Hydrotreated SRC-II Gas Oil 3777-21

Table 23

Inspections of Mildly Hydrotreated SRC-II Gas Oil 3777-6

Sample Number	3777-21
°API @ 60°F	17.0
Sp. Gr. @ 60°F	0.9529
Distillation, ASTM D 1160	
IBP, °F	280
5%	350
10%	374
20%	401
30%	422
40%	440
50%	460
60%	481
70%	505
80%	540
90%	611
95%	687
EP	779
% Over	99.0
% Bottoms	1.0
Hydrogen, Wt-%	10.38
Carbon, Wt-%	86.91
Sulfur, Wt-ppm	129
Nitrogen, Wt-ppm	5510
Oxygen, Wt-ppm	10800
Heptane Insoluble, Wt-%	0.01
Pour Point, °F	below -60
FIA, Vol-%	
Color Band[a]	19.7
A	59.1
P&N	21.2
Conradson Carbon, Wt-%	0.04
Viscosity @ 100°F	
SUS	36.4
cSt	3.137
Molecular Weight, kg/kmol	193

[a]Highly polar compounds

Table 24

Fractionation of Mildly Hydrotreated SRC-II Gas Oil 3777-21

Cut Number	Boiling Range, °F	Volume, ml	Volume, %	Weight, g	Weight, %
1[a]	IBP-400°	9699	23.5	8440	21.5
Botts[b]	400°+	31607	76.5	30779	78.5
		41306	100.0	39219	100.0

[a]Designated as IBP-400°F Naphtha 3777-33

[b]Designated as 400°F+ Topped Gas Oil 3777-34

Fractionation of Severely Hydrotreated SRC-II Gas Oil 3777-28

Cut Number	Boiling Range, °F	Volume, ml	Volume, %	Weight, g	Weight, %
1[a]	IBP-400°	15487	32.8	12998	30.2
Botts[b]	400°F+	31665	67.2	29971	69.8
		47152	100.0	42969	100.0

[a]Designated as IBP-400°F Naphtha 3777-40

[b]Designated as 400°F+ Topped Gas Oil 3777-41

Table 25

Hydrotreating Raw SRC-II Gas Oil 3777-7
Preparative Run No. 2
Plant 638, Run 38

P-P(base) = 500   LHSV/LHSV(base) = 0.40

Period No.	Hrs. on Stream	T-T(base), °C	Product Analysis, wt-% H	C
1	22-32	-36	10.97	86.10
3	42-52	-36	10.98	86.22
5	62-72	-28	11.33	86.57
8	92-102	-29	11.35	87.20
10	112-122	-29	11.11	86.58
17	182-192	-21	11.31	86.48
20	212-222	-21	11.43	87.08
22	232-242	-18	11.77	86.92
24	252-262	-17	11.48	86.60
27	282-292	-22	11.17	86.22

Table 26

Hydrotreating SRC-II Gas Oil 3777-7

Overall Product Distribution

Plant 638, Run 38

Product Distribution	Wt-%
C_1	0.04
C_2	0.07
C_3	0.06
C_4	0.04
C_5 and C_6 (in Plant Gas)	0.26
Stripper Bottoms[a]	99.40
H_2O	1.70
H_2S	0.39
NH_3	0.89
Total	102.85
H_2 Consumption, Wt-% of Feed	2.85
H_2 Consumption, SCFB	1790

[a]Designated as Hydrotreated SRC-II Gas Oil 3777-28

Table 27

Hydrotreating SRC-II Gas Oil 3777-7

Distribution of Hydrogen Consumption

Plant 638, Run 38

	Wt-%
C_1-C_4	1.44
C_5-C_6 (in Plant Gas)	1.04
Stripper Bottoms[a]	82.86
H_2O	7.68
H_2S	3.00
NH_3	3.98
Total	100.00
Total Hydrogen Consumption, SCFB	1790

[a]Designated as Hydrotreated SRC-II Gas Oil 3777-28

Table 28

Inspections of Severely Hydrotreated SRC-II Gas Oil 3777-7

Sample Number	3777-28
°API @ 60°F	23.4
Sp. Gr. @ 60°F	0.9135
Distillation, ASTM D 1160	
IBP, °F	234
5%	302
10%	331
20%	372
30%	400
40%	424
50%	446
60%	465
70%	490
80%	521
90%	575
95%	628
EP	724
% Over	99.0
% Bottoms	1.0
Hydrogen, Wt-%	11.18
Carbon, Wt-%	87.17
Sulfur, Wt-ppm	98
Nitrogen, Wt-ppm	1900
Oxygen, Wt-ppm	6700
Heptane Insoluble, Wt-%	<0.01
Pour Point, °F	below -60
FIA, Vol-%	
Color Band[a]	6.3
A	50.8
P&N	42.9
Conradson Carbon, Wt-%	<0.01
Viscosity @ 100°F	
SUS	33.1
cSt	2.144
Molecular Weight, kg/kmol	215

[a]Highly polar compounds

Table 29

Inspections of IBP-400°F Naphtha from Topping SRC-II Gas Oil 3777-7

Sample Number	3777-35
°API @ 60°F	20.8
Sp. Gr. @ 60°F	0.9291
Distillation, ASTM D 1160	
IBP, °F	206
5%	319
10%	331
20%	338
30%	343
40%	344
50%	351
60%	354
70%	358
80%	363
90%	374
95%	382
EP	397
% Over	98.5
% Bottoms	1.5
Hydrogen, Wt-%	9.80
Carbon, Wt-%	83.05
Sulfur, Wt-ppm	1600
Nitrogen, Wt-ppm	4090
Oxygen, Wt-ppm	14100
RON,Clear	105.4
FIA, Vol-%	
Color Band [a]	29.7
A	42.1
P&N	28.2
Steam Jet Gum, mg/100 ml	9.6
Bromine Number	34.2

[a]Highly polar compounds

Table 30

Inspections of IBP-400°F Naphtha from Topping Rerun Gas Oil 3777-19

Sample Number	3777-37
°API @ 60°F	20.5
Sp. Gr. @ 60°F	0.9309
Distillation, ASTM D 86	
IBP, °F	244
5%	330
10%	332
20%	336
30%	339
40%	347
50%	353
60%	357
70%	361
80%	362
90%	372
95%	382
EP	402
% Over	98.5
% Bottoms	1.5
Hydrogen, Wt-%	9.89
Carbon, Wt-%	82.65
Sulfur, Wt-ppm	1650
Nitrogen, Wt-ppm	4350
Oxygen, Wt-ppm	35800
RON, Clear	104.0
FIA, Vol-%	
Color Band[a]	30.7
A	42.2
P&N	27.1
Steam Jet Gum, mg/100 ml	31.3

[a]Highly polar compounds

Table 31

Inspections of IBP-400°F Naphtha Cut from Topping 3777-21

Sample Number	3777-33
°API @ 60°F	30.4
Sp. Gr. @ 60°F	0.8740
Distillation, ASTM D 86[a]	
IBP, °F	174
5%	179
10%	183
20%	300
30%	312
40%	326
50%	336
60%	341
70%	348
80%	361
90%	377
95%	402
EP	495
% Over	99.0
% Bottoms	1.0
Hydrogen, Wt-%	11.60
Carbon, Wt-%	85.32
Sulfur, Wt-ppm	115
Nitrogen, Wt-ppm	4110
Oxygen, Wt-ppm	4700
Chloride, ppm	59
RON, Clear	91.7
FIA, Vol-%	
A	33.5
O	6.4
P&N	60.1
Steam Jet Gum, mg/100 ml	8.1
Bromine Number	22.4

[a] Excessive foaming noted during distillation. Temperatures may be slightly off.

<u>Table 32</u>

<u>Inspections of IBP-400°F Naphtha Topping from 3777-28</u>

Sample Number	3777-40
°API @ 60°F	37.2
Sp. Gr. @ 60°F	0.8388
Distillation, ASTM D 86[a]	
IBP, °F	227
5%	250
10%	263
20%	281
30%	296
40%	311
50%	325
60%	336
70%	345
80%	356
90%	368
95%	376
EP	421
% Over	99.0
% Bottoms	1.0
Hydrogen, Wt-%	12.47
Carbon, Wt-%	85.30
Sulfur, Wt-ppm	66
Nitrogen, Wt-ppm	2030
Oxygen, Wt-ppm	6700
RON,Clear	75.1
FIA, Vol-%	
A	22.3
P&N	77.7
Steam Jet Gum, mg/100 ml	5.0

[a] Dry point observed at 388°F

Table 33

Fluid Catalytic Cracking of the 400°F+ Topped As Received Gas Oil 3777-36

Plant 593, Run 292

Test No.	3
Operating Conditions	
P-P(base), psi	-10
T-T(base), °C	5
[Cat./Oil / Cat./Oil(base)]	1.07
Conversion, Vol-%	44.8[a]
Product Distribution, Wt-%	
C_3-	4.0
C_4	1.3
C_5	} 23.9[a]
C_6-EP Gasoline	
Cycle Oil	56.6[a]
Carbon	11.6
Wt. Recovery	97.4
Products, Vol-%	
C_5-EP Gasoline	26.1[a]
Cycle Oil	55.2[a]
Inspections of C_5-EP Gasoline	
°API @ 60°F	20.5[a]
Sp. Gr. @ 60°F	0.9309[a]
Distillation, ASTM D-86	
IBP, °F	154
5%	189
10	268
50	391
90	419
95	430
EP	450

[a]Adjusted numbers

Table 33 (Cont'd.)

Test No.	3
Properties of Cycle Oil	
°API @ 60°F	4.9[a]
Sp. Gr. @ 60°F	1.0375[a]
Distillation, UOP No. 1	
IBP, °F	476
5%	484
10	490
15	494
% Over at 650°F	84.0
°API of 650°F$^-$ @ 60°F	7.4
Sp. Gr. of 650°F$^-$ @ 60°F	1.0187
°API of 650°F$^+$ @ 60°F	-7.8
Sp. Gr. of 650°F$^+$ @ 60°F	1.1439
C_3-, Mole %	
H_2	51.6
C_1	18.8
C_2 (Total)	14.4
C_3 Olefins	12.6
C_3	2.5
Total	100.0
C_4, Vol-%	
C_4 Olefins	75.5
i-C_4	16.5
n-C_4	8.0
Total	100.0
C_5, Vol-%	
C_5 Olefins	81.4
i-C_5	18.6
n-C_5	0.0
Total	100.0

[a]Adjusted numbers

Table 34

Fluid Catalytic Cracking of the 400°F+ Topped As Received Gas Oil 3777-36
Plant 593, Run 292

Test No.	7	9
Operating Conditions		
P-P(base), psi	-10	-12
T-T(base), °C	33	30
[Cat./Oil / Cat./Oil(base)]	1.51	1.81
Conversion, Vol-%	52.7	48.5
Product Distribution, Wt-%		
C_3-	7.9	0.2
C_4	1.9	0.3
C_5 + C_6-EP Gasoline	24.3[a]	27.1[a]
Cycle Oil	49.0[a]	53.5[a]
Carbon	14.3	14.4
Wt. Recovery	97.3	95.4
Products, Vol-%		
C_5-EP Gasoline	26.7[a]	30.0[a]
Cycle Oil	47.3[a]	51.5[a]
Inspections of C_5-EP Gasoline		
°API @ 60°F	21.5[a]	22.4[a]
Sp. Gr. @ 60°F	0.9248[a]	0.9194[a]
Distillation, ASTM D-86		
IBP, °F	159	159
5%	194	191
10	259	241
50	384	380
90	424	418
95	439	430
EP	472	466
RON, Clear		
RON, 3 ml TEL/Gallon		

[a]Adjusted numbers

Table 34 (Cont'd.)

Test No.	7	9
Properties of Cycle Oil		
°API @ 60°F	2.8[a]	2.5[a]
Sp. Gr. @ 60°F	1.0539[a]	1.0563[a]
Distillation, UOP No. 1		
IBP, °F	476	473
5%	486	482
10	495	489
15	498	494
% Over at 650°F	80.0	82.0
°API of 650°F$^-$ @ 60°F	6.4	6.4
Sp. Gr. of 650°F$^-$ @ 60°F	1.0261	1.0261
°API of 650°F$^+$ @ 60°F	-8.4	-7.9
Sp. Gr. of 650°F$^+$ @ 60°F	1.1495	1.1448
C_3-, Mole %		
H_2	32.9	20.5
C_1	27.5	17.9
C_2 (Total)	20.1	17.9
C_3 Olefins	15.2	35.9
C_3	4.3	7.7
Total	100.0	100.0
C_4, Vol-%		
C_4 Olefins	69.5	91.3
<u>i</u>-C_4	22.8	4.5
<u>n</u>-C_4	7.7	4.3
Total	100.0	100.0
C_5, Vol-%		
C_5 Olefins	77.3	82.0
<u>i</u>-C_5	19.9	10.6
<u>n</u>-C_5	2.8	7.4
Total	100.0	100.0

[a]Adjusted numbers

Table 35

Fluid Catalytic Cracking of 400°F+ Bottoms Gas Oil 3777-38

Plant 593, Run 299

Test No.	1	2	3	4
Operating Conditions				
P-P (base), psig	-9	-10	-10	-10
T-T (base), °C	5	-2	2	5
[Cat./Oil / Cat./Oil (base)]	1.03	0.98	0.97	1.06
Conversion, Vol-%	43.0[a]	46.8[a]	46.5	46.1[a]
Product Distribution, Wt-%				
C_3^-	3.5	2.4	2.8	7.2
C_4	1.3	0.4	0.9	1.4
C_5 / C_6-EP Gasoline	23.4[a]	24.9[a]	31.9	24.4[a]
Cycle Oil	57.7[a]	53.3[a]	54.9	55.2[a]
Carbon	12.5	12.5	11.0	11.5
Wt. Recovery	98.4	94.0	102.2	99.7
Products, Vol-%				
C_5-EP Gasoline	24.6[a]	24.8[a]	35.1	25.8[a]
Cycle Oil	57.0[a]	53.2[a]	53.5	53.9[a]
Inspections of C_5-EP Gasoline				
°API @ 60°F	15.9[a]	7.9[a]	19.9	16.7[a]
Sp. Gr. @ 60°F	0.9600[a]	1.0151[a]	0.9346	0.9548[a]
Distillation, ASTM D 86				
IBP, °F	145	168	b	140
5%	178	194		181
10	263	342		228
50	386	417		380
90	415	473		409
95	428	494		418
EP	463	518		452
RON, Clear	← 106.7 →			
RON, 3 ml TEL/Gallon	← 108.7 →			
MON, Clear	← 94.7 →			
MON, 3 ml TEL/Gallon	← 96.9 →			

[a]Adjusted numbers

[b]Sample lost due to excessive foaming

Table 35 (Cont'd.)

Test No.	1	2	3	4
Properties of Cycle Oil				
°API @ 60°F	7.1[a]	8.4[a]	7.2	5.4[a]
Sp. Gr. @ 60°F	1.0212[a]	1.0109[a]	1.0202	1.0334[a]
Distillation, UOP No. 1				
IBP, °F	469	462	468	472
5%	478	474	478	480
10	482	482	484	485
15	486	496	489	490
% Over at 650°F	88.0	85.0	87.0	86.0
°API of 650°F⁻ @ 60°F	7.6	6.9	7.2	6.6
Sp. Gr. of 650°F⁻ @ 60°F	1.0173	1.0224	1.0202	1.0246
°API of 650°F⁺ @ 60°F	-6.0	-7.0	-7.1	-8.0
Sp. Gr. of 650°F⁺ @ 60°F	1.1275	1.1365	1.1375	1.1457
C_3-, Mole %				
H_2	49.8	49.7	37.1	37.3
C_1	17.7	20.3	26.1	27.5
C_2 (Total)	14.6	15.0	20.0	19.2
C_3 Olefins	14.6	12.2	13.5	12.5
C_3	3.2	2.9	3.2	3.5
Total	100.0	100.0	100.0	100.0
C_4, Vol-%				
C_4 Olefins	68.5	79.6	79.4	78.6
i-C_4	24.6	13.0	11.3	14.3
n-C_4	6.9	7.4	9.3	7.2
Total	100.0	100.0	100.0	100.0
C_5, Vol-%				
C_5 Olefins	86.9	91.4	83.3	91.3
i-C_5	7.1	0.0	6.6	4.4
n-C_5	5.9	8.6	10.0	4.3
Total	100.0	100.0	100.0	100.0

[a]Adjusted numbers

Table 36

Fluid Catalytic Cracking of 400°F+ Bottoms Gas Oil 3777-38

Plant 593, Run 299

Test No.	5	6	7	8
Operating Conditions				
P-P (base), psig	-10	-10.5	-10	-10.5
T-T (base), °C	26	26	30	31
[Cat./Oil / Cat./Oil (base)]	1.41	1.39	1.44	1.42
Conversion, Vol-%	48.1[a]	56.1[a]	50.7[a]	51.6[a]
Product Distribution, Wt-%				
C_3-	4.5	4.1	5.9	5.0
C_4	1.1	1.2	1.3	1.2
C_5 / C_6-EP Gasoline	26.8[a]	32.6[a]	23.8[a]	23.6[a]
Cycle Oil	53.1[a]	43.7[a]	50.5[a]	49.6[a]
Carbon	13.1	15.6	13.0	14.0
Wt. Recovery	98.6	97.2	94.4	93.4
Products, Vol-%				
C_5-EP Gasoline	28.7[a]	32.8[a]	25.5[a]	25.3[a]
Cycle Oil	51.9[a]	43.9[a]	49.3[a]	48.4[a]
Inspections of C_5-EP Gasoline				
°API @ 60°F	18.5[a]	9.3[a]	18.8[a]	19.0[a]
Sp. Gr. @ 60°F	0.9433[a]	1.0050[a]	0.9415[a]	0.9402[a]
Distillation, ASTM D 86				
IBP, °F	128	145	137	130
5%	168	184	166	172
10	209	245	239	232
50	372	410	370	368
90	411	465	417	415
95	424	478	425	426
EP	455	486	465	468

[a]Adjusted numbers

Table 36 (Cont'd.)

Test No.	5	6	7	8
Properties of Cycle Oil				
°API @ 60°F	5.5[a]	9.4[a]	5.4[a]	5.3[a]
Sp. Gr. @ 60°F	1.0324[a]	1.0043[a]	1.0335[a]	1.0341[a]
Distillation, UOP No. 1				
IBP, °F	470	472	470	476
5%	480	486	480	486
10	486	493	486	490
15	490	500	491	496
% Over at 650°F	85.0	82.0	86.0	84.0
°API of $650°F^-$ @ 60°F	6.6	5.7	6.4	6.1
Sp. Gr. of $650°F^-$ @ 60°F	1.0246	1.0313	1.0261	1.0283
°API of $650°F^+$ @ 60°F	-8.2	-8.1	-8.7	-8.3
Sp. Gr. of $650°F^+$ @ 60°F	1.1476	1.1467	1.1523	1.1485
C_3-, Mole %				
H_2	33.0	54.9	35.0	33.3
C_1	29.7	18.0	27.9	29.6
C_2 (Total)	20.5	13.6	18.8	19.6
C_3 Olefins	13.8	10.9	14.2	14.0
C_3	3.0	2.6	4.2	3.5
Total	100.0	100.0	100.0	100.0
C_4, Vol-%				
C_4 Olefins	80.6	81.8	78.8	75.7
i-C_4	11.3	12.0	12.9	14.8
n-C_4	8.1	6.1	8.2	9.5
Total	100.0	100.0	100.0	100.0
C_5, Vol-%				
C_5 Olefins	83.5	87.1	86.2	88.1
i-C_5	10.9	6.5	9.3	6.4
n-C_5	5.4	6.4	4.6	5.5
Total	100.0	100.0	100.0	100.0

[a]Adjusted numbers

Table 37

Fluid Catalytic Cracking of the 400°F+ Topped Mildly Hydrotreated Gas Oil 3777-34

Plant 593, Run 294

Test No.	2	3	10
Operating Conditions			
P-P(base), psi	-11	-10	-10
T-T(base), °C	3	1	2
[Cat./Oil / Cat./Oil(base)]	1.04	1.04	1.16
Conversion, Vol-%	51.3	48.1	48.2
Product Distribution, Wt-%			
C_3-	4.4	6.7	3.9
C_4	3.1	4.4	2.8
C_5	2.0	2.2	1.6
C_6-EP Gasoline	29.8	27.7	29.4
Cycle Oil	50.3	53.3	52.9
Carbon	6.8	6.6	8.6
Wt. Recovery	96.5	100.9	99.1
Products, Vol-%			
C_5-EP Gasoline	36.4	34.2	35.4
Cycle Oil	48.7	51.9	51.8
Inspections of C_5-EP Gasoline			
°API @ 60°F	33.4	32.8	33.8
Sp. Gr. @ 60°F	0.8581	0.8612	0.8560
Distillation, ASTM D-86			
IBP, °F	124	130	129
5%	148	158	158
10	168	186	184
50	300	316	316
90	384	386	390
95	393	395	400
EP	432	440	437
RON, Clear	←	101.8	→
RON, 3 ml TEL/Gallon	←	104.0	→

Table 37 (Cont'd.)

Test No.	2	3	10
Properties of Cycle Oil			
°API @ 60°F	8.9	9.9	10.7
Sp. Gr. @ 60°F	1.0078	1.0007	0.9951
Distillation, UOP No. 1			
IBP, °F	452	438	444
5%	459	455	458
10	464	460	466
15	470	466	470
% Over at 650°F	91.0	91.0	93.0
°API of 650°F$^-$ @ 60°F	10.4	11.7	11.8
Sp. Gr. of 650°F$^-$ @ 60°F	0.9972	0.9881	0.9874
°API of 650°F$^+$ @ 60°F	-6.1	-4.7	-4.1
Sp. Gr. of 650°F$^+$ @ 60°F	1.1284	1.1159	1.1107
C_3-, Mole %			
H_2	31.3	33.0	32.6
C_1	14.2	16.2	10.1
C_2 (Total)	17.1	18.0	15.4
C_3 Olefins	30.0	27.2	34.6
C_3	7.4	5.5	7.3
Total	100.0	100.0	100.0
C_4, Vol-%			
C_4 Olefins	54.4	59.1	58.1
i-C_4	33.6	31.7	31.5
n-C_4	12.1	9.2	10.4
Total	100.0	100.0	100.0
C_5, Vol-%			
C_5 Olefins	50.9	57.5	48.4
i-C_5	44.4	39.8	47.8
n-C_5	4.7	2.6	3.8
Total	100.0	100.0	100.0

Table 38

Fluid Catalytic Cracking of the 400°F+ Topped Mildly Hydrotreated Gas Oil 3777-34

Plant 593, Run 294

Test No.	5	6	8
Operating Conditions			
P-P(base), psi	-10	-12	-9
T-T(base), °C	32	23	30
$\left[\frac{\text{Cat./Oil}}{\text{Cat./Oil(base)}}\right]$	1.54	1.45	1.49
Conversion, Vol-%	57.1	56.3	58.5
Product Distribution, Wt-%			
C_3-	7.1	6.0	7.0
C_4	3.8	3.8	4.5
C_5	2.8	2.6	2.7
C_6-EP Gasoline	33.2	30.9	31.6
Cycle Oil	45.1	45.5	43.5
Carbon	6.1	8.4	7.3
Wt. Recovery	98.0	97.2	96.7
Products, Vol-%			
C_5-EP Gasoline	41.7	38.7	39.8
Cycle Oil	42.9	43.7	41.5
Inspections of C_5-EP Gasoline			
°API @ 60°F	36.8	35.7	35.9
Sp. Gr. @ 60°F	0.8408	0.8463	0.8453
Distillation, ASTM D-86			
IBP, °F	112	116	118
5%	146	148	150
10	169	170	173
50	287	286	284
90	381	382	377
95	398	396	394
EP	436	428	430
RON, Clear	←	101.9	→
RON, 3 ml TEL/Gallon	←	103.9	→

Table 38 (Cont'd.)

Test No.	5	6	8
Properties of Cycle Oil			
°API @ 60°F	6.7	7.9	6.8
Sp. Gr. @ 60°F	1.0239	1.0151	1.0231
Distillation, UOP No. 1			
IBP, °F	432	442	452
5%	458	456	464
10	464	467	470
15	472	468	476
% Over at 650°F	90.0	91.0	89.0
°API of 650°F⁻ @ 60°F	8.7	9.7	8.7
Sp. Gr. of 650°F⁻ @ 60°F	1.0093	1.0021	1.0093
°API of 650°F+ @ 60°F	-7.7	-6.8	-7.0
Sp. Gr. of 650°F+ @ 60°F	1.1430	1.1347	1.1365
C_3-, Mole %			
H_2	22.8	24.2	24.6
C_1	19.4	18.0	16.3
C_2 (Total)	20.6	19.9	18.7
C_3 Olefins	28.3	29.3	30.9
C_3	8.9	8.5	9.4
Total	100.0	100.0	100.0
C_4, Vol-%			
C_4 Olefins	46.9	48.3	46.9
i-C_4	39.6	38.5	38.5
n-C_4	13.5	13.2	14.7
Total	100.0	100.0	100.0
C_5, Vol-%			
C_5 Olefins	37.8	40.9	39.0
i-C_5	57.0	54.0	56.0
n-C_5	5.2	5.2	5.0
Total	100.0	100.0	100.0

Table 39

Fluid Catalytic Cracking of the 400°F+ Topped Severely Hydrotreated Gas Oil 3777-41

Plant 593, Run 301

Test No.	1	2	3
Operating Conditions			
P-P(base), psi	11	10	11.5
T-T(base), °C	6	6	-4
[Cat./Oil / Cat./Oil(base)]	1.31	0.98	0.97
Conversion, Vol-%	61.1[a]	63.0[a]	61.5[a]
Product Distribution, Wt-%			
C_3-	12.3	6.1	5.6
C_4	6.7	5.0	4.9
C_5 / C_6-EP Gasoline	39.0	40.8	40.5[a]
Cycle Oil	41.5[a]	39.8[a]	41.4[a]
Carbon	4.5	2.9	4.3
Wt. Recovery	104.0	94.6	96.7
Products, Vol-%			
C_5-EP Gasoline	45.9[a]	47.7[a]	47.2[a]
Cycle Oil	38.9[a]	37.0[a]	38.5[a]
Inspections of C_5-EP Gasoline			
°API @ 60°F	43.8[a]	43.0[a]	42.3[a]
Sp. Gr. @ 60°F	0.8072[a]	0.8109[a]	0.8142[a]
Distillation, ASTM D 86			
IBP, °F	108	114	110
5%	135	143	145
10%	152	161	163
50%	256	286	292
90%	413	440	440
95%	441	466	458
EP	491	488	483
RON, Clear	←	97.5	→
RON, 3 ml TEL/Gallon	←	103.2	→
MON, Clear	←	83.9	→
MON, 3 ml TEL/Gallon	←	89.6	→
FIA, Vol-%			
A	54.4	55.8	56.7
O	5.8	4.8	5.1
P&N	39.8	39.4	38.2

[a]Adjusted numbers

Table 39 (Cont'd.)

Test No.	1	2	3
Properties of Cycle Oil			
°API @ 60°F	8.4[a]	7.2[a]	7.3[a]
Sp. Gr. @ 60°F	1.0118[a]	1.0203[a]	1.0198[a]
Distillation, UOP No. 1			
IBP, °F	412	440	432
5%	439	456	448
10%	448	464	458
15%	454	470	466
% Over at 650°F	90.0	90.0	90.0
°API of 650°F− @ 60°F	10.3	9.7	10.3
Sp. Gr. of 650°F− @ 60°F	0.9979	0.10021	0.9979
°API of 650°F+ @ 60°F	-4.7	-4.4	-5.8
Sp. Gr. of 650°F+ @ 60°F	1.1159	1.1133	1.1257
C_3-, Mole %			
H_2	26.1	29.9	35.9
C_1	18.7	12.4	13.2
C_2 (Total)	21.4	16.1	14.1
C_3 Olefins	25.3	30.3	27.7
C_3	8.5	11.3	9.0
Total	100.0	100.0	100.0
C_4, Vol-%			
C_4 Olefins	49.8	40.6	44.8
_i_-C_4	36.9	44.3	41.0
_n_-C_4	13.2	15.1	14.2
Total	100.0	100.0	100.0
C_5, Vol-%			
C_5 Olefins	28.8	24.3	30.8
_i_-C_5	65.6	69.8	62.8
_n_-C_5	5.6	5.9	6.4
Total	100.0	100.0	100.0

[a]Adjusted numbers

Table 40

Fluid Catalytic Cracking of the 400°F[+]
Topped Severely Hydrotreated Gas Oil 3777-41

Plant 593, Run 301

Test No.	4	6
Operating Conditions		
P-P(base), psi	10	10
T-T(base), °C	30	30
$\left[\frac{\text{Cat./Oil}}{\text{Cat./Oil(base)}}\right]$	1.54	1.46
Conversion, Vol-%	65.2[a]	62.2[a]
Product Distribution, Wt-%		
C_3-	9.7	10.0
C_4	6.1	6.5
C_5 C_6-EP Gasoline	38.2[a]	37.2[a]
Cycle Oil	37.6[a]	40.5[a]
Carbon	6.3	4.4
Wt. Recovery	97.8	98.6
Products, Vol-%		
C_5-EP Gasoline	43.9[a]	43.2[a]
Cycle Oil	34.8[a]	37.8[a]
Inspections of C_5-EP Gasoline		
°API @ 60°F	39.7[a]	42.1[a]
Sp. Gr. @ 60°F	0.8265[a]	0.8151[a]
Distillation, ASTM D 86		
IBP, °F	123	117
5%	149	139
10%	163	155
50%	267	253
90%	404	397
95%	425	432
EP	448	450
RON, Clear	← 98.9 →	
RON, 3 ml TEL/Gallon	← 104.3 →	
MON, Clear	← 85.1 →	
Mon, 3 ml TEL/Gallon	← 90.0 →	
FIA, Vol-%		
A	62.1	59.2
O	7.0	7.3
P&N	30.9	33.5

[a]Adjusted numbers

Table 40 (Cont'd.)

Test No.	4	6
Properties of Cycle Oil		
°API @ 60°F	6.6 [a]	7.8 [a]
Sp. Gr. @ 60°F	1.0247 [a]	1.0161 [a]
Distillation, UOP No. 1		
IBP, °F	424	424
5%	449	442
10%	456	449
15%	464	457
% Over at 650°F	88.0	90.0
°API of 650°F⁻ @ 60°F	8.8	9.3
Sp. Gr. of 650°F⁻ @ 60°F	1.0086	1.0050
°API of 650°F+ @ 60°F	-8.4	-8.7
Sp. Gr. of 650°F+ @ 60°F	1.1495	1.1523
C_3-, Mole %		
H_2	32.1	29.8
C_1	18.8	19.3
C_2 (Total)	16.0	16.4
C_3 Olefins	24.2	25.3
C_3	8.9	9.2
Total	100.0	100.0
C_4, Vol-%		
C_4 Olefins	46.1	45.2
i-C_4	40.0	40.6
n-C_4	13.8	14.2
Total	100.0	100.0
C_5, Vol-%		
C_5 Olefins	34.6	36.4
i-C_5	59.9	58.3
n-C_5	5.6	5.4
Total	100.0	100.0

[a]Adjusted numbers

Table 41

Composition of HF Alkylation Feed

(Wt-% of FCC Estimated Product)

SRC-II Gas Oil

	As Received Topped 3777-36	Topped & Rerun 3777-38	Mildly Hydrotreated 3777-34	Severely Hydrotreated 3777-41 Operation A 301/1-3	Severely Hydrotreated 3777-41 Operation B 301/4,6	Petroleum Feedstock
$C_3^=$	1.43	0.88	2.32	2.98	4.47	4.94
C_3	0.30	0.22	0.60	1.01	1.72	1.69
$C_4^=$	0.97	0.72	1.44	2.37	2.97	5.86
$\underline{i}$-C_4	0.22	0.10	1.22	2.10	2.40	4.53
$\underline{n}$-C_4	0.11	0.08	0.44	0.73	0.83	1.31
Total	3.03	2.00	8.02	9.19	12.39	18.33

Table 42

Properties of the Petroleum Feedstock

°API @ 60°F	26.0
UOP "K"	11.9
M.W., kg/kmol	370.0
Sulfur, Wt-%	0.49
Conradson Carbon, Wt-%	0.45

Table 43

FCC Operating Conditions and Conversion

SRC-II Gas Oil

	As Received Topped	Topped &Rerun	Mildly Hydrotreated	Severely Hydrotreated Operation A	Severely Hydrotreated Operation B	Petroleum Feedstock
P-P(base), psi	-10	-10	-11	11.5	11	0
T-T(base), °C	5	2	3	-4	30	-11
$\left[\frac{\text{Cat./Oil}}{\text{Cat./Oil(base)}}\right]$	1.07	0.97	1.04	0.97	1.46	0.99
Conversion, Vol-%	44.8	46 .5	51.3	61.5	62.2	82.2

Table 44

C_4= Isomer Distribution from FCC Operation

Feedstock Source ——	SRC-II Coal Liquid 3777-41		Petroleum
Pretreatment ——	Severe Hydrotreatment		——
Operation ——	A	B	——
Composition, LV%			
iC_4 =	48	50	27
$1\text{-}C_4$=			23
$t2\text{-}C_4$=	30	29	29
$c2\text{-}C_4$=	22	21	21

Table 45

Estimated Overall C_6+ Alkylate Properties

Feedstock Source	SRC-II Coal Liquid		Petroleum
Pretreatment	Severe Hydrotreatment		—
Operation	A	B	—
Molecular Weight, kg/kmol	108.2	107.7	109.5
°API @ 60°F	69.9	69.9	69.7
RON, Clear	92.8	92.6	93.3
RON, 3 ml TEL/Gallon	104.5	104.3	105.0
MON, Clear	91.4	91.2	91.8
MON, 3 ml TEL/Gallon	105.6	105.4	106.1
RVP, psi	1.8	1.8	1.7

Table 46

HF Alkylation Estimated Yield

Operation A

Product from FCC Pilot Plant
SRC-II Coal Liquid
(BPSD)

Component	Charge Stock	Isobutane Makeup	Overall Yield
C_3	1,189	--	1,648
$C_3=$	3,401	--	--
$i\text{-}C_4$	2,221	5,427	79
$n\text{-}C_4$	767	--	819
$C_4=$	2,422	--	--
$i\text{-}C_5$	--	--	256
$n\text{-}C_5$	--	--	--
C_6+	--	--	10,079
Tar	--	--	9
Total	10,000	5,427	12,881

Table 47

HF Alkylation Estimated Yield

Operation B

Product from FCC Pilot Plant
SRC-II Coal Liquid
(BPSD)

Component	Charge Stock	Isobutane Makeup	Overall Yield
C_3	1,480	--	1,979
C_3=	3,730	--	--
i-C_4	1,918	5,946	79
n-C_4	657	--	709
C_4=	2,215	--	--
i-C_5	--	--	263
n-C_5	--	--	--
C_6+	--	--	10,928
Tar	--	--	9
Total	10,000	5,946	13,328

Table 48

HF Alkylation Estimated Yield

"Typical" Alkylate Feed Derived from FCC Operation on Petroleum Feedstock (BPSD)

Component	Charge Stock	Isobutane Makeup	Overall Yield
C_3	965	--	1,304
C_3=	2,741	--	--
i-C_4	2,391	5,122	80
n-C_4	692	--	745
C_4=	3,211	--	--
i-C_5	--	--	263
n-C_5	--	--	--
C_6+	--	--	10,070
Tar	--	--	8
Total	10,000	5,122	12,470

FIGURE 1

GAS OIL HYDROTREATING PLANT

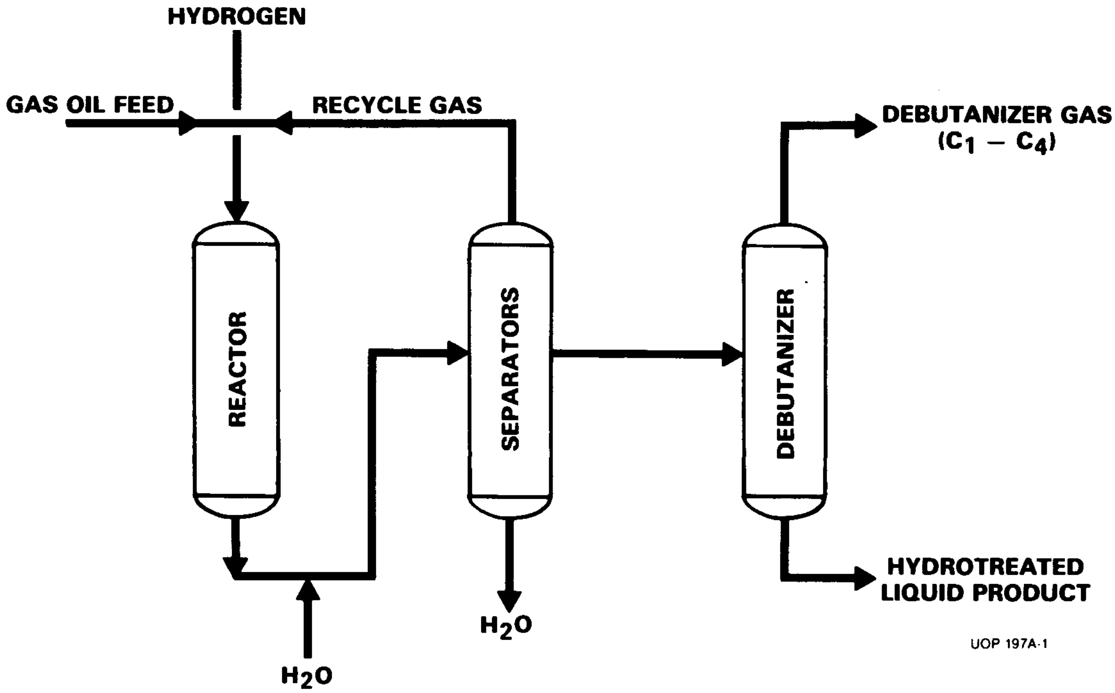
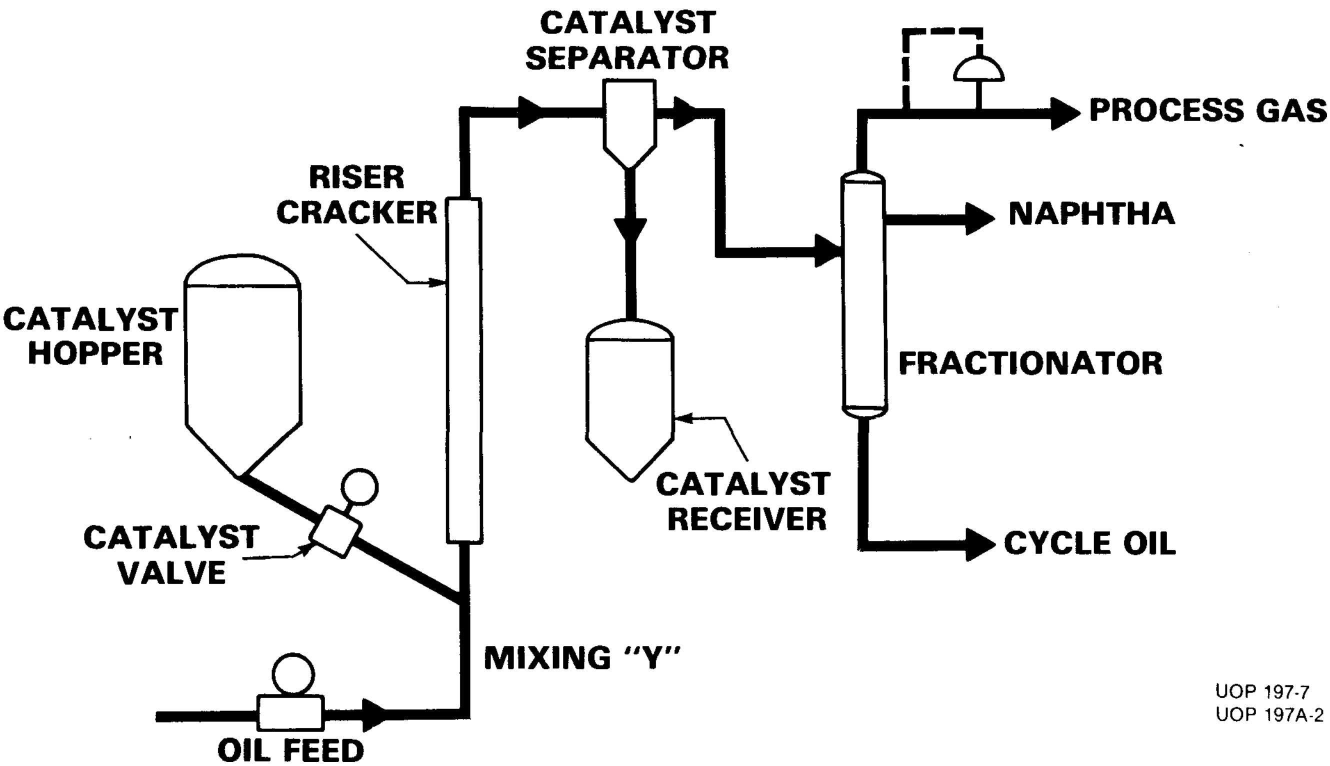


FIGURE 2

SMALL SCALE FLUID CATALYTIC CRACKER



UOP 197-7
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FIGURE 3

FEEDSTOCK DERIVATION

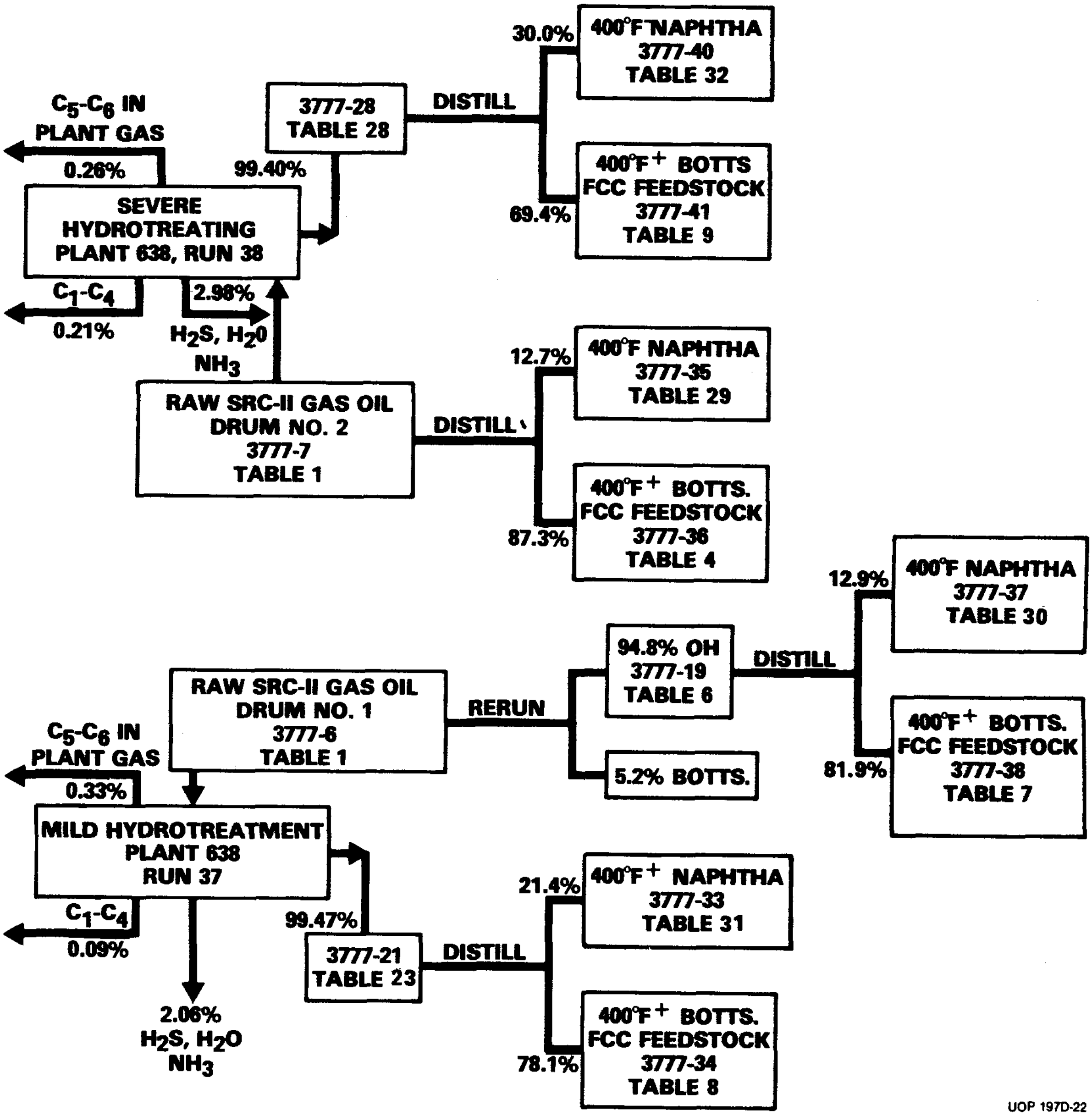

FIGURE 4

HYDROGEN CONTENT OF HYDROGENATED SRC-II GAS OIL vs. TEMPERATURE, °C, AT BASE PRESSURE

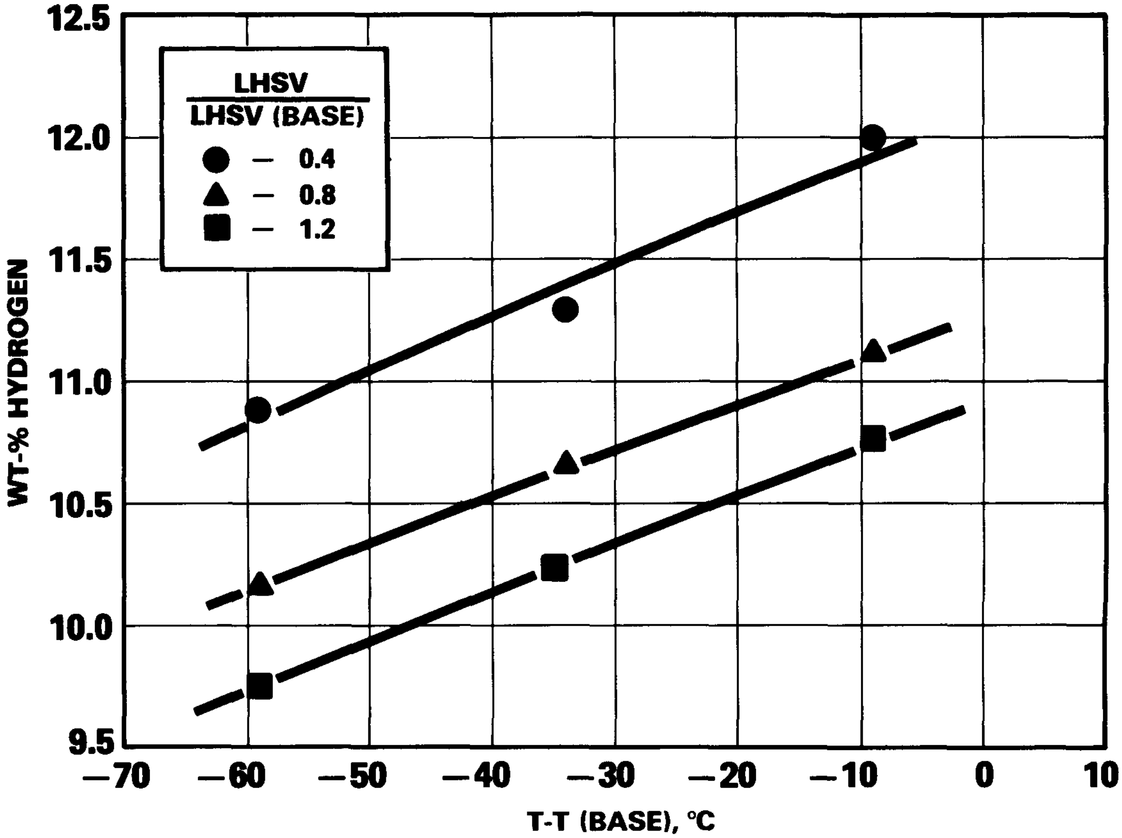

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FIGURE 5

HYDROGEN CONTENT OF HYDROGENATED SRC-II GAS OIL vs. TEMPERATURE, °C, AT 500 PSI ABOVE BASE PRESSURE

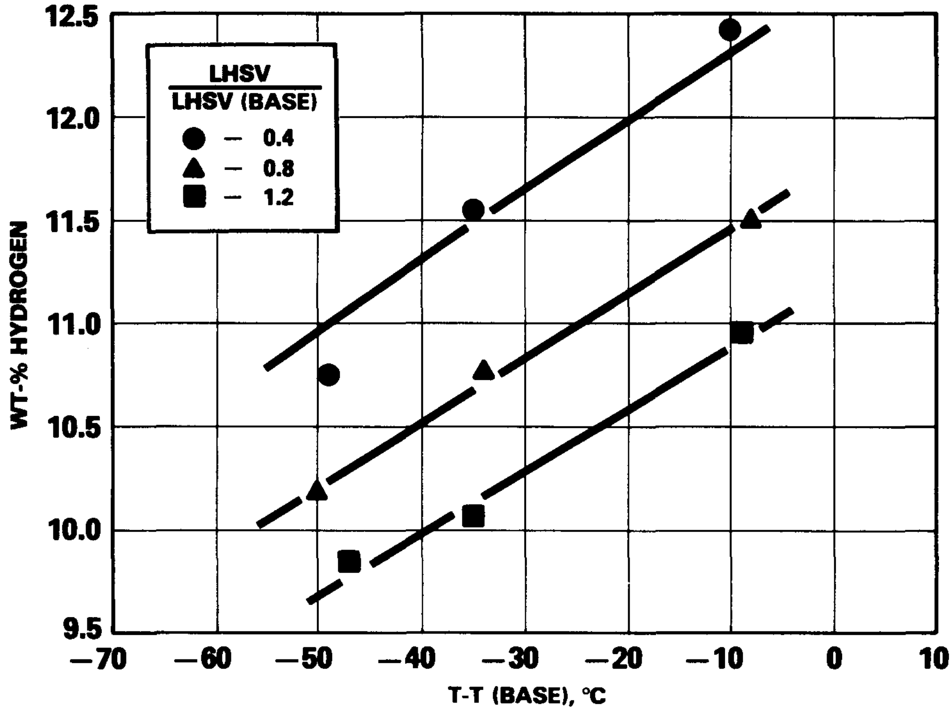

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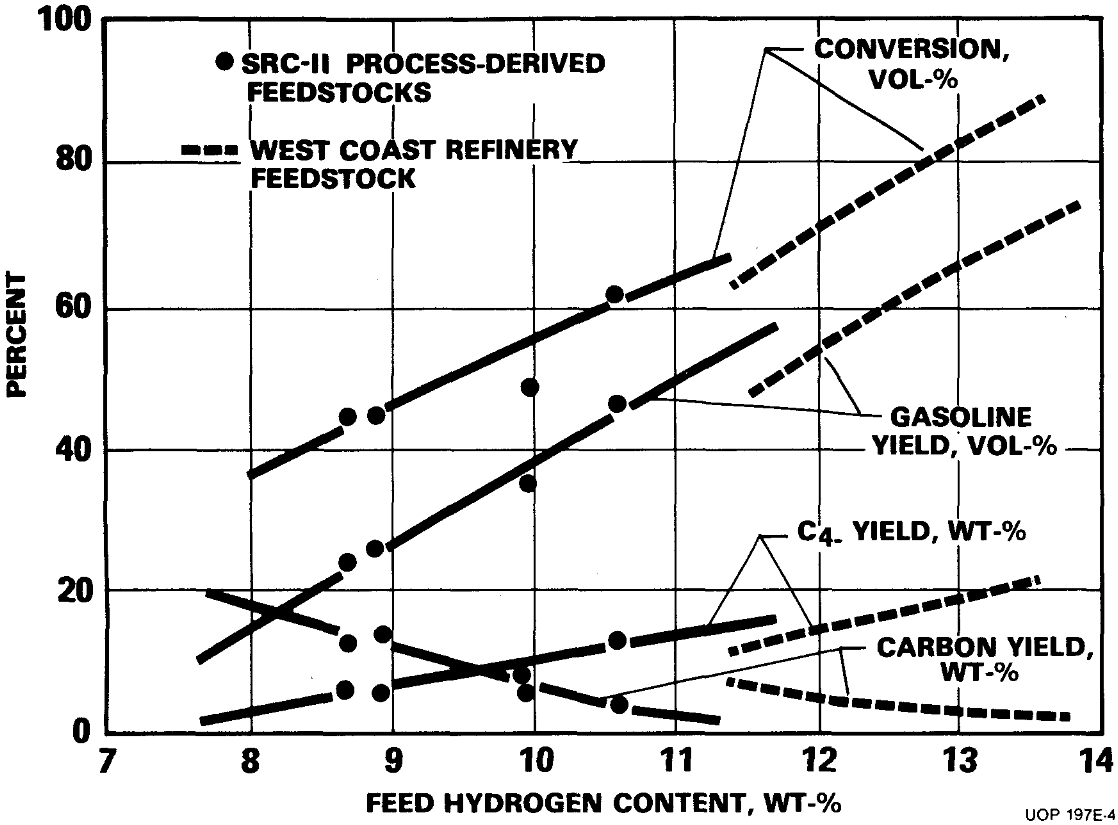
FIGURE 6

EFFECT OF FEEDSTOCK HYDROGEN CONTENT ON RESPONSE TO FLUID CATALYTIC CRACKING



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