ENCLOSURE (B) 16

PART II

STUDIES ON HYDROCRACKING OF LOW TEMPERATURE COAL TAR

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Research Period: Aug. 1941 to May 1942

SUMMARY

The object of these experiments was to study the preparation of aviation gasoline from low temperature coal tar by high pressure hydrocracking.

MoS_3 was found to be the best catalyst, and under reaction conditions of 200 kg/cm^2, and 410 to 430°C, a 40 to 60 vol% yield of aviation gasoline with octane number (0.1% T.E.L.) of 87 to 89 was obtained.

I. INTRODUCTION

At the time of this investigation low temperature carbonization of coal had been recognized as an important source of supply of oil in Japan. In this connection plans were being made to develop hydrocracking of the tar on industrial scale. Research at the First Naval Fuel Depot was directed at determining the best catalyst and optimum conditions for the hydrocracking reaction. Key research personnel working on project were:

Chem. Eng. Lt.-Comdr.	K. MITSUI
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II. DETAILED DESCRIPTION

A. Test Apparatus

Tests were first made in an autoclave, and then in a continuous pilot plant. The equipment used was the same as that described in the report "Studies on Hydrocracking of High Temperature Tar."

B. Experimental Results

1. Raw materials

a. Low temperature tar oils

Middle oil and heavy oil No. 1 fractions from crude tar produced by low temperature carbonization of UBE coal at the UBE Nitrogen Works, were used. Properties of these oils are given in Table XVI(B)16.

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b. Catalyst

Catalysts used in these experiments are summarized in Table XX(B)16.

c. Hydrogen

Hydrogen was prepared by electrolysis of water with purity of 99.5%.

2. Autoclave tests

a. Effect of reaction temperature

200 gm of middle oil with 10 gm of MoO_3 were put in the 2.4lit autoclave, and H_2 pumped in until a pressure of 100 kg/cm^2 at 0°C was reached. The autoclave was heated at rate of 2.5°C/min and held at the reaction temperature for 60 minutes. Results are given in Tables XVII(B)16 through XIX(B)16.

b. Catalyst studies

A number of catalysts were tested in the autoclave under the following conditions:

Feed Stock	Middle oil
Amount of Feed Stock	200 gm
Amount of Catalyst	10 gm
H_2 Pressure at 0°C	100 kg/cm^2

Experimental results are given in Table XXI(B)16.

From the standpoint of yield of aviation gasoline, MoS_3 was best, MoS_3·NiS(3:1) and MoO_3 on active clay (1:1) were next best. From tests on effect of different catalyst carriers with MoO_3 catalyst, it was concluded that active clay or Al_2O_3 was more effective than acid clay or silica gel.

3. Experiments in continuous hydrocracking pilot plant

a. Hydrocracking with MoO_3 on active clay (1:1)

In this experiment, middle oil was hydrocracked using MoO_3 on active clay (ratio 1:1 by weight) tablets 6mm in diameter and 6mm in height as the catalyst. 9.5 lit (11.8 kg) of this catalyst was packed into each reaction chamber.

Test results are given in Tables XXII(B)16-a through XXII(B)16-d.

These tests gave poorer results than the autoclave tests and it is believed that contact time in the pilot plant catalyst zone was too short.

b. Hydrocracking with MoS_3 catalyst

Tablets of MoS_3 (height 6mm and diameter 6mm) were employed as catalyst. Eight lit of tablets were packed into each reaction chamber.

Reaction conditions and results are given in Tables XXIII(B)16-a through XXIII(B)16-d.

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III. CONCLUSIONS

In this research, MoS_3 was the best catalyst. It showed good activity and long life.

By hydrocracking of middle oil from low temperature tar using MoS_3 catalyst, a good aviation gasoline of 87 to 89 octane number (0.1% lead) can be obtained in yield of 40 to 60 vol%.

Table XVI(B)16
PROPERTIES OF LOW TEMPERATURE TAR

		Middle oil	Heavy oil No. 1	Recycle oil
d_4^{20}		.9681	.9740	.9371
First Drop °C		101	101	102
Engler Distillation	10% °C	195	220	210.5
	20% °C	204	226	223
	30% °C	212	234	233
	40% °C	220.5	245	242
	50% °C	239.5	255	253.5
	60% °C	242	266	263
	70% °C	258	280	278
	80% °C	275	299	294
	90% °C	300	323	325
Dry Point °C		260	330.5	336
Total Distilled Vol %		97	98.5	95
Analysis (Vol %)	Phenols	46.0	42.0	24.0
	Bases	3.5	4.5	2.5
	Neutral oil	50.5	53.5	73.5
Ultimate Analysis (Wt.%)	C	75.25		
	H	10.94	9.25	15.77
	O	12.82	10.12	6.01
	S	.58	.57	.35
	N	.41	.45	.31

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Table XVII(B)16
EFFECT OF REACTION TEMPERATURE
(Autoclave Test)

Reaction Conditions

Exp. No.	Reaction Temp. (°C)	Initial Press. of H_2 at 0°C (Kg/cm^2)	Max. Press. at Temp. (Kg/cm^2)	Final Press. at 0°C (Kg/cm^2)	Press. Drop. (Kg/cm^2)
1	350	100.8	220	73.6	27.2
2	400	100.8	224	66.0	34.8
3	410	99.5	220	62.4	37.1
4	430	99.3	238	59.3	40.0
5	450	96.5	225	52.0	44.5

Table XVIII(B)16
EFFECT OF REACTION TEMPERATURE
(Autoclave Test)

Analysis of Residual Gas (Vol %)

Exp. No.	CO_2	O_2	C_nH_{2n}	CO	H_2	C_nH_{2n+2}	N_2	n
1	0.4	0.2	1.0	0.6	95.4	1.4	1.0	1.8
2	0.2		0.6	0.3	93.9	5.0		1.3
3	0.2		0.3	0.3	90.3	7.0	1.9	1.1
4	0.2	0.2	0.6	0.4	88.2	10.4		1.2
5			0.4	0.8	68.2	28.4	2.2	1.5

Table XIX(B)16
EFFECT OF REACTION TEMPERATURE
(Autoclave Test)

Yields and Properties of Product

Exp. No.	Yield (wt.%)	d_4^{15}	First Drop (°C)	10% (°C)	50% (°C)	90% (°C)	Dry Point (°C)	Fraction Boiling F.D.-150°C (vol. % per raw material)	Fraction Boiling F.D.-150°C (wt.% per product)
1	98.50	0.8669	84.5	128.5	210.5	297	341	21	46.0
2	97.00	0.8270	82.5	112.5	177.0	266	303	37.8	61.8
3	89.95	0.8214	70.5	109.0	170.0	261	297	41.5	64.0
4	78.45	0.8173	65.0	103.0	162.0	250.5	292	46.7	69.0
5	52.75	0.8103	49.0	78.5	118.5	194.5	241	75.5	91.5

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Table XX(B)16
CATALYST TESTS IN AUTOCLAVE
REACTION CONDITIONS

Exp. No.	Catalyst	Reaction Condition			H_2 Consumption		Analysis of Residual Gases (vol %)							
		Temp. (°C)	Max. Press. (kg/cm^2)	Time (hr)	Press. Drop (kg/cm^2)	(wt%)	CO_2	O_2	C_nH_{2n}	CO	H_2	C_nH_{2n+2}	N_2	n
1	MoO_3	450	225	60	44.5	6.04			0.4	0.8	68.2	28.4	2.2	1.5
9	WO_3	450	243	60	40.4	5.11		0.2		0.6	71.4	24.2	3.6	1.5
10	MoO_3:ZnO (3:1)	450	230	60	38.7	4.86		0.2	1.6	1.0	82.0	14.0	1.2	2.0
11	MoO_3:ZnO (9:1)	450	228	60	40.4	5.15	0.2		0.6	0.8	80.0	14.7	4.7	2.4
12	MoO_3:NiO:Active Clay (3:1:3)	450	232	60	42.2	5.49	0.2	0.2	0.8	0.8	77.1	17.6	3.3	1.8
13	$3(NH_4)_2OP_2O_5 \cdot 24MoO_3$	450	231	60	41.5	5.28	0.3	0.2	0.8	1.0	80.0	13.1	4.6	2.0
14	$2(NH_4)_2O\ SiO_2 \cdot 12MoO_3$	450	220	60	39.4	4.95			0.6	0.6	81.4	17.0	0.4	1.1
15	$(NH_4)_3H_6(CrMoO_4)_6$	450	231	60	40.7	5.43	0.2	0.2	0.4	0.6	76.5	22.1		1.0
16	MoO_3:ZnO (9.5:0.5)	450	232	60	41.8	5.24	0.2	0.2	0.4	0.4	81.2	16.8	0.8	1.2
17	MoO_3	450	212	60	40.0	4.16	0.2		0.3	0.3	86.6	12.4	0.2	0.9
18	MoO_3:Cr_2O_3 (9.5:0.5)	450	225	60	44.6	5.44	0.2	0.1	0.7	0.8	77.3	20.6	0.3	1.5
19	H_2MoO_4	450	231	60	41.1	6.10	0.2	0.2	0.4	0.4	76.6	22.0	0.2	1.3
20	MoO_3:Acid Clay (1:1)	450	228	60	48.0	4.38	0.2	0.1	0.6	0.6	75.6	22.0	0.9	1.6
21	$CuCrO_4$	450	240	60	40.0	6.75	0.8		0.6	0.8	93.0	5.2	0.2	2.0
22	MoS_3	450	221	60	50.7	5.69	0.2		0.6		63.2	34.2	2.8	1.0
23	MoS_3	450	233	10	45.9	5.12	0.2	0.2	0.6	0.2	88.5	9.9	0.4	1.0
24	MoO_3:NiO:ZnO (3:1:0.05)	450	233	60	47.2	6.15	0.2		0.8	0.6	71.8	26.0	0.6	0.9
25	MoO_3:FeO (3:1)	450	238	60	44.9	5.78		0.2	0.4	0.2	75.4	21.0	2.8	1.1
26	MoO_3:NiO:CuO (3:1:0.5)	450	238	60	45.1	5.70			0.8	0.2	77.0	21.7	0.3	1.3
27	MoO_3:Active Clay (1:1)	450	230	60	47.4	5.98			0.6	0.2	72.4	26.0	0.8	0.9
28	MoO_3:SiO_2 (1:1)	450	238	60	44.3	5.03	0.3	0.1	0.4		84.6	14.6	0.1	1.0
29	MoO_3:Al-Silicate (1:1)	450	238	60	43.6	5.25	0.4	0.2	1.2	0.2	83.3	14.5	0.7	1.8
30	MoO_3:Al_2O_3 (1:1)	450	230	60	51.8	6.06	0.2	0.2	0.2		80.5	14.0	0.4	1.7
31	MoS_3:Sn_3 (3:1)	450	238	60	40.9	5.04	0.2	0.1	1.1	0.2	76.1	18.5	0.4	1.9
32	MoS_3:NiS (3:1)	450	225	60	56.3	6.78	0.4	0.2	0.8		74.5	21.9	2.2	1.9
33	$(NH_4)_2\ MoS_4$	450	220	60	42.8	5.28	0.4		0.3	0.1	79.3	21.9	0.1	1.8
34	H_2WO_3	450	225	60	40.8	4.79	0.4	0.2	0.6		86.9	19.8	0.1	2.7
35	MoS_3	450	223	60	46.2	5.76	0.2	0.1	0.5		78.1	11.8	0.3	1.3
36	H_2WO_4:NiO:Acid Clay (3:1:3)	450	230	60	41.8	5.11	0.4	0.2	0.8	0.1	82.7	20.8	0.1	2.2
38	$(NH_4)_2\ WO_4$	450	227	60	39.8	4.26	0.2	0.1	0.5		80.6	15.7	0.7	1.9
39	$(NH_4)_2\ MoO_4$	450	231	60	44.1	5.60	0.2	0.2	0.4		78.5	17.9	0.1	1.4
40	Al-Methylate	450	255	60	23.0	3.63	0.1	0.2	1.1	0.2	83.9	20.6	0.1	2.0
41	MoS_3:Sn_3 (3:1)	450	230	10	40.0	5.18	0.1	0.1	0.4		79.5	14.4	1.0	1.8
42	MoS_3:Sn_3 (3:1)	430	228	60	40.0	4.85	0.1		0.7	0.2	85.0	18.9	0.1	1.4
43	MoS_3:Al_2O_3 (1:1)	450	220	60	52.2	6.35	0.2		0.8	0.4	76.2	22.0	0.4	1.0
44	MoS_3:Cr3 (3:1)	450	230	60	49.1	5.42	0.1	0.2	0.8	0.3	79.7	18.7	0.3	1.2

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Table XXI(B)16
PRODUCT YIELDS AND INSPECTIONS

Exp. No.	Yield of Product Vol.%	Yield of Product Wt.%	Density 15/4 °C	I.B.P.	10%	50%	90%	FBP	Fraction boiling up to 150°C Vol% Product	Fraction boiling up to 150°C Vol% Raw Mat.	Fraction boiling up to 200°C Vol% Product	Fraction boiling up to 200°C Vol% Raw Mat.	H_2O Produced (Wt%) Raw
1	64.65	52.75	0.8103	45	78.5	118.5	194.5	241.0	75.5	48.8	91.5	59.2	8.1
9	63.50	51.85	0.8140	50	82.5	120.0	204.5	253.5	71.5	45.4	89.0	56.5	10.1
10	80.00	64.60	0.8127	47.5	80.5	105.0	210.0	254.0	68.8	55.0	88.0	70.4	7.9
11	78.25	63.10	0.8116	50	83.5	124.5	178.0	259.0	67.8	53.1	87.0	68.1	8.9
12	72.50	57.50	0.8075	45.5	81.0	121.0	199.5	251.0	71.5	51.8	90.9	65.5	7.0
13	77.50	63.25	0.8175	53	88.0	130.0	217.0	271.0	64.5	50.0	85.0	65.9	7.6
14	89.50	72.35	0.8132	50	82.5	135.0	223.0	397.0	58.7	52.5	82.7	74.0	8.9
15	89.00	71.45	0.8101	52	86.0	131.0	219.0	270.0	61.8	55.0	85.0	75.7	8.9
16	82.00	67.50	0.8009	47.5	81.0	122.0	223.0	248.0	70.0	57.4	89.9	73.7	6.8
17	91.50	70.55	0.8197	52	90.5	142.5	230.0	265.5	55.3	50.4	79.9	73.1	7.9
18	82.90	66.10	0.8030	45	80.0	124.5	208.5	250.0	67.8	56.2	88.3	73.2	7.4
19	85.50	67.85	0.8056	44.5	79.0	122.0	201.5	240.0	71.0	60.7	89.9	76.8	8.6
20	77.50	61.50	0.7954	44	75.0	116.0	185.5	241.5	78.9	61.2	97.4	75.5	8.1
21	86.50	84.50	0.8095	61	97.5	147.5	238.0	289.0	51.5	44.6	75.7	65.5	8.5
22	57.75	45.60	0.7936	38.5	68.5	104.0	168.5	218.0	84.2	48.6	95.0	54.9	9.6
23	97.55	77.90	0.7987	55	87.0	135.5	221.0	266.5	60.9	59.4	84.4	82.3	7.5
24	82.00	64.95	0.7896	41	72.5	114.0	186.5	241.0	79.1	64.9	97.1	79.6	8.0
25	93.75	72.05	0.7965	47	81.0	125.0	208.5	262.0	70.0	65.6	88.2	82.7	7.7
26	80.90	64.10	0.7911	45	77.5	117.5	188.5	247.0	74.8	60.5	92.7	75.0	9.4
27	80.00	62.50	0.7846	43.5	71.5	110.0	180.0	247.5	81.9	65.5	97.0	77.5	7.9
28	85.00	67.75	0.7966	40.5	76.0	120.5	201.5	254.0	71.9	61.1	89.7	77.1	7.1
29	80.00	64.15	0.7975	44	74.5	120.5	193.5	254.5	73.5	58.8	91.9	73.5	7.2
30	79.10	61.70	0.7797	27	65.0	108.5	173.5	226.0	81.3	64.3	95.0	75.2	6.2
31	64.00	53.80	0.8332	28	65.0	128.5	210.0	281.0	64.9	41.5	88.0	56.3	9.0
32	61.00	47.99	0.7861	31.5	59.3	102.5	185.0	265.0	81.2	49.5	92.8	56.6	9.8
33	78.50	62.75	0.7898	30.5	65.0	118.0	217.0	277.0	71.0	55.7	87.7	68.9	9.5
34	70.00	58.00	0.8368	37.5	78.5	131.5	232.0	305.0	62.7	43.9	82.5	57.8	7.8
35	70.90	56.00	0.7895	30	61.5	110.0	187.0	261.0	78.0	55.3	92.0	65.2	7.5
36	75.00	60.86	0.8072	33.5	71.0	124.0	213.5	276.5	67.1	50.3	87.5	65.6	9.5
38	86.50	75.00	0.8673	41	72.5	148.5	221.0	298.0	51.5	44.5	81.5	70.5	7.8
39	75.00	59.05	0.7950	38.5	71.0	116.5	192.5	240.0	74.8	56.9	92.0	69.0	7.3
40	86.00	66.25	0.8913	37	67.5	172.5	240.0	310.0	39.0	28.9	71.8	53.1	3.1
41	90.50	76.00	0.8544	43	76.0	164.0	235.0	297.0	42.5	38.5	76.5	69.2	7.5
42	94.00	78.30	0.8311	39.5	82.0	152.5	231.0	289.0	49.5	46.5	79.5	74.7	6.0
43	80.75	62.90	0.7790	42	71.0	110.0	173.5	231.0	82.0	66.2	95.5	77.1	9.0
44	86.12	69.20	0.8060	41	70.0	126.0	181.0	236.0	69.0	58.9	81.0	69.7	8.7

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Table XXII(B)16-a
HYDROCRACKING MIDDLE OIL IN CONTINUOUS PILOT PLANT
(MoS_3 ACID CLAY CATALYST)

Reaction Condition

	1	2	3	4
Temp. of Reaction chamber No. 1 (°C)	350	350	350	350
No. 2 (°C)	410	430	450	450
Reaction Pressure (kg/cm^2)	200	200	200	200
Run Period (hr)	6	6	6	6
SV. oil charged/cat.vol.	0.44	0.52	0,53	1.06
Total oil charged (lit)	25.00	27.55	30.25	60.10
Mean Value (lit/hr)	4.17	4.95	5.04	10.1
Total of Product (lit)	29.47	28.58	32.20	63.73
Yield of Product (vol%)	117.8	103.6	106.5	104.0
Total H_2 Charged (m^3)	26.8	32.60	33.2	60.1
Mean Value (m^3/Hr)	4.47	5.43	5.53	10.0
Total Residual Gas (m^3)	17.1	18.25	17.9	41.6
H_2 Consumption (wt%)	5.1	5.2	4.9	4.6
Residual Gas analysis (%)				
CO_2	0	0	0	0.7
O_2	0.1	0.3	0.1	0
C_nH_{2n}	0.1	0.6	0.2	1.8
CO	0.7	0.8	0.6	1.8
H_2	93.8	92.4	93.2	71.6
C_nH_{2n+2}	5.3	1.3	4.3	15.5
N_2	0	4.6	1.6	9.6
n	1.8	3.0	1.1	3.6

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Table XXII(B)16-b
HYDROCRACKING MIDDLE OIL IN
CONTINUOUS PILOT PLANT
(MoS_3 ACID CLAY CATALYST)

Product Inspection

d_4^{20}	0.9190	0.8249	0.8252	0.8549
I.B.P. (°C)	77	55	60	63
10 "	118	98	105	113
20 "	157	112	120.5	134
30 "	176	128	131	153
40 "	192	140	145	175
50 "	208	160	168	194
60 "	221	181	191	213.5
70 "	241	203	208	227
80 "	259	232	232	247
90 "	280.5	264	262	280
97 "	344	335	315	323.5
F.B.P. "	355	337.5	330	336.5
Total distilled %	98.0	97.5	98	98
Residue	1.7	1.0	0.8	0.8
Loss	0.3	1.5	1.2	1.2
Fraction boiling I.B.P. 150°(Vol%)	18.0	45.5	43.5	28.5
Fraction boiling I.B.P. 200°(Vol%)	45.0	69.0	66.0	58.0
Yield of Aviation Gasoline (Vol%)	21.7	35.3	34.0	22.6

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Table XXII(B)16-c
HYDROCRACKING MIDDLE OIL IN
CONTINUOUS PILOT PLANT
(MoS_3 ACID CLAY CATALYST)

Aviation Gasoline

	1	2	3	4
d_4^{20}	0.7658	0.7625	0.7610	0.7628
I.B.P. (°C)	76	62	59	62
10% (°C)	95	82	80	66
20 (°C)	99	91	88	92
30 (°C)	104	96	95	99
40 (°C)	107	101	101	102
50 (°C)	110	105	104	107
60 (°C)	115	110	110	113
70 (°C)	120	117	118	117
80 (°C)	127	125	123	127
90 (°C)	139	138	137	138
97 (°C)	157	165	158	164
F.B.P. (°C)	177	165.5	168	178.5
Total distilled (%)	99	98.5	99	99
Residue (%)	0.5	0.7	0.7	0.4
Loss (%)	0.5	0.8	0.3	0.6
Sum of 10% 50% 90% Point (°C)	344	325	321	311
Analysis				
Unsat H.C. (Vol%)	1.5	2.5	2.5	3.5
Aromat. H.C. (Vol%)	18.7	29.3	27.3	26.1
Naph. H.C. (Vol%)	57.2	39.8	43.3	43.4
Para. H.C. (Vol%)	22.6	28.4	26.9	27.0
Octane Value Clear	68.7	74.9	72.6	71.8
Leaded 0.1%	85.7	89.0	88.5	87.0
Vapor Pressure (kg/cm^2)	0.28	0.39	0.40	0.39

ENCLOSURE (B)16

Table XXII(B)16-d
HYDROCRACKING MIDDLE OIL IN
CONTINUOUS PILOT PLANT
(MoS_3 ACID CLAY CATALYST)

Topped Oil Inspection

d_4^{20}		0.8975	0.8750	0.8750	0.9004
I.B.P.	(°C)	163	151	154	151.5
10%	(°C)	192.5	175	176	180
20	(°C)	199.5	182	183	188
30	(°C)	211	190.5	191	196
40	(°C)	217.5	203.5	200.5	204
50	(°C)	228	214	211	212
60	(°C)	241	224.5	221	224.5
70	(°C)	255	241	237	238.5
80	(°C)	270.5	255.5	252	257
90	(°C)	295.5	279	278	286
97	(°C)	344	348	320	329
F.B.P.	(°C)	348.5	350	341	350.5
Total distilled	(%)	99.0	98.5	98.5	98.5
Residue	(%)	0.6	0.3	0.2	
Loss	(%)	0.4	1.2	0.3	
Aniline Point	(°C)	32.5	28.5	28.5	26.5

ENCLOSURE (B)16

Table XXIII(B)16-a
HYDROCRACKING OIL IN CONTINUOUS PILOT PLANT
(MoS_3 CATALYST)

Reaction Condition

Run No.		1	2	15	16	17	18	19
Raw Material		Middle oil	Middle oil	Middle oil	Heavy oil No.1	Heavy oil No.1	Recycle oil	Heavy oil No.1
Temp. of Preheater (°C)		300	300	300	300	300	300	300
Temp. of Reaction chamber No.1		380	380	380	380	390	390	390
Temp. of Reaction chamber No.2		420	420	420	420	430	430	450
Reaction Pressure (kg/cm^2)		200	200	200	200	200	200	200
CS_2 added (cc/lit oil)		3	0	3	3	0.5	3	3
Run Period (Hrs.)		6	12	6	6	6	6	6
S.V. of Oil oil charged/hr Vol		0.50	0.98	0.50	0.50	1.0	0.46	0.49
Time passed from start (Hrs)		18-24	28-40	368-374	387-393	398-404	410 416	422 428
Total oil charged	(lit)	24.00	94.00	23.75	24.20	48.00	23.55	23.60
	(kg)	23.20	91.18	23.05	23.40	46.80	22.10	23.00
Mean Value	(lit/Hr)	4.0	7.8	3.96	4.03	8.00	3.93	3.93
Total Product	(lit)	22.86	104.76	20.59	25.68	51.84	21.25	18.36
	(kg)	21.43	89.35	17.95	21.64	43.22	17.18	14.77
Mean Value	lit/hr	3.8	8.7	3.43	4.28	8.64	3.54	3.13
Residual Gas Analysis (%)								
CO_2		0	0.2	0.2	0.3	0	0.3	70.2
O_2		0.3	0	0.4	0.2	0.1	0.1	0.2
C_nH_{2n}		0.3	0.4	1.0	0.6	0.3	0.9	1.5
CO		0.6	0.4	0.4	0.4	0.2	0.4	0.4
H_2		82.3	92.4	75.1	83.5	86.1	85.8	86.0
C_nH_{2n+2}		14.8	6.6	20.5	14.4	12.9	12.4	10.7
N_2		1.7	0	2.4	0.6	0.4	0.1	1.0
n		1.4	1.1.0	1.3	1.0	1.0	1.6	1.9

Table XXIII(B)16-b
HYDROCRACKING OIL IN CONTINUOUS
PILOT PLANT
(MoS_3 CATALYST)

Yield of Product

Run No.	1	2	15	16	17	18	19
Raw Material	Middle oil	Middle oil	Middle oil	Heavy oil No.1	Heavy oil No.1	Recycle oil	Heavy oil No.
Vol %	95.0	111.5	86.6	106.2	108.0	90.1	79.6
Wt %	92.2	98.0	77.9	92.6	92.3	77.9	65.3
Total H_2 Charged (m^3)	26.2	106.7	27.2	27.6	52.70	26.20	26.80
Mean Value (m^3/Hr)	4.4	8.9	4.5	4.6	8.7	4.37	4.47
Total Residual Gas (m^3)	12.4	48.0	12.3	10.3	27.70	14.00	13.40
Mean Value (m^3/Hr)	2.7	4.0	2.5	1.7	4.6	2.33	2.23
H_2 Consumption (Wt% per product)	5.0	6.2	6.0	9.3	5.5	5.7	5.9

ENCLOSURE (B)16

Table XXIII(B)16-o
HYDROCRACKING OIL IN CONTINUOUS PILOT PLANT
(MoS_3 CATALYST)

Aviation Gasoline

	1	2	15	16	17	18	19
d^{20}_4	0.7556	0.7597	0.7601	0.7545	0.7540	0.7616	0.7489
I.B.P. (°C)	38.0	64.5	55.0	59.0	61.0	54.5	55.0
10%	77.5	84.0	80.0	83.5	85.0	77.5	79.5
20	85.5	91.0	87.5	92.0	93.5	86.0	86.5
30	92.0	98.0	93.0	98.0	99.0	92.0	93.0
40	97.0	102.0	98.0	103.5	104.0	97.5	99.0
50	102.0	106.0	102.5	109.0	107.5	103.0	104.5
60	106.5	110.5	108.0	114.0	114.0	108.5	110;5
70	113.0	112.5	113.5	119.5	119.5	115.0	117.5
80	124.0	125.0	121.0	129.0	127.0	124.5	127.0
90	133.0	135.0	132.5	138.0	140.0	138.0	143.0
97	152.5	155.0	151.5	161.5	162.0	165.0	168.0
F.B.P.	161.5	170.0	163.0	181.0	184.0	178.0	181.0
Total Distilled %	98.5	98.5	98.0	98.5	99.0	98.5	99.0
Residue	0.6	0.7	0.7	0.4	0.3	0.4	0.6
Loss	0.9	0.8	1.3	1.1	0.7	1.1	0.4
Vapor Pressure kg/cm^2	0.45	0.39	0.42	0.40	0.42	0.42	0.33
Constituent Analysis							
Unsat. H.C. vol%	1.5	0.7	1.5	2.0	3.0	5.0	2.0
Arom. H.C. "	25.6	20.9	21.7	20.6	19.4	20.0	16.7
Naph. H.C. "	49.6	55.4	53.0	50.3	51.7	53.8	50.1
Para. H.C. "	23.3	23.0	23.8	27.1	25.9	21.2	31.2
Octane Value not leaded	73.5	171.2	73.3	69.3	67.8	74.4	68.5
Leaded 0.1%	88.8	86.7	87.4	86.2	85.8	88.5	84.9

Table XXIII(B)16-d
HYDROCRACKING OIL IN CONTINUOUS
PILOT PLANT
(MoS_3 CATALYST)

Topped Oil Inspection

	1	2	15	16	17	18	19
d_4^{20}	0.8319	0.8297	0.8698	0.8522	0.8564	0.8429	0.8441
I.B.P. (°C)	153	154	160	154.5	162	159	156
10%	166	174.5	180.5	181.5	185	178	175
20	174	180.5	187.0	190	196	187	181
30	181.5	189.5	198	202	205	195	190
40	190	201.0	208	212	215	206	197
50	200.5	211.5	216.5	222	232	215	206
60	212	223	227.5	234	242	224	216
70	225	237.5	242	258	254.5	235	226.5
80	241	257.5	257	264.5	272	250	246
90	269	294	290	294.5	299	276	268
97	311	325	350	335	345	320	313
F.B.P.	323	337	360	355	362	342	343
Total Distilled %	98.0	98.0	98.0	99.0	98.5	98.5	99.0
Residue	0.9	1.4	1.4	0.7	1.1	0.9	0.7
Loss	1.3	0.6	0.6	1.3	0.4	0.6	0.3
Aniline Point °C	42.0	48.5	38.5	43.0	41.5	46.0	40.0