ENCLOSURE (B) 5

EFFECT OF FERRIC OXIDE ON COAL HYDROGENATION

by

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SUMMARY

Autoclave experiments were made to determine the effect of ferric oxide as a catalyst in the high-pressure hydrogenation of coal. The results indicated that the yield of oil was increased, and the solid residue decreased when ferric oxide was used.

I. DETAILED DESCRIPTION

The test apparatus and procedure were the same as described in Enclosure (B)3.

Fushun coal, sized below 20 mesh, and heavy oil made by topping 30% of the light oil from the low-temperature tar from Shinbara coal, were used as charge stocks.

Ferric oxide, commercial grade, was used as a catalyst, and hydrogen of 99% purity was employed.

These materials were mixed in the following proportions.

Coal	100grams
Tar	50grams
Ferric oxide	5grams
Hydrogen	19grams (100atm at 0°C).

Experimental results are summarized in the tables below.

Some water should be produced by the reduction of Fe_2O_3, but the difference is not apparent from this table. It is not understood why this is so.

Although some difference of yield was caused by the reaction temperature, in general, when Fe_2O_3 was used, the yield of oil product was greater.

II. CONCLUSIONS

When Fe_2O_3 was used in the high-pressure hydrogenation of coal, the consumption of hydrogen, the volume of saturated hydrocarbons in the produced gas and the yield of oil were greater than when Fe_2O_3 was not present.

When no Fe_2O_3 was used, solid substances often stuck to the inside of the autoclave and a large percentage of organic residue was contained in the solid residue.

It was concluded that Fe_2O_3 had a favorable effect on the hydrogenation of coal.

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Table I(B)5
REACTION CONDITIONS AND YIELDS OF PRODUCTS

Run Number	28	27	61	65	62	66	64	13
React.conditions:								
Catalyst	Fe_2O_3	None	Fe_2O_3	Fe_2O_3	None	None	Fe_2O_3	Fe_2O_3
React.Temp.(°C)	430-450			450-455			470-480	
Initial Press. (atm)	99	98	101	100	100	100	100	100
Pressure Drop. (atm)	17	12	19	20	10	12	21	14
Preheating Time (hr)	1-0	1-30	1-45	1-40	1-40	1-40	1-45	1-50
Reaction Time (hr)	2-0	2-10	1-0	1-0	1-0	1-0	1-0	1-0
Yield of Products (gm):								
Gas	35.2	22.6	35.5	35.2	30.6	29.4	38.1	39.4
Water	15.0	10.0	14.0	14.8	15.4	10.3	16.3	13.0
Oil	76.0	71.6	88.9	80.5	67.8	67.3	68.9	62.0
Residue	22.4	40.5	29.8	30.0	51.8	47.3	37.0	36.7
Total	148.6	144.9	168.0	160.5	165.6	154.6	160.3	151.1

Table II(B)5
GAS ANALYSES (VOL %)

Run Number	28	27	61	65	62	66	64	13
Co_2	0.4	0.4	0.5	0.3	0.5	0.2	0.2	0.8
Cn H_{2n}			0.1		0.1		0.1	0.4
O_2	1.6	1.6	0.3	0.2	0.5	0.3	0.2	1.0
CO	0.8	0.4	0.6	0.5	0.6	0.3	0.6	0.8
H_2	82.5	89.7	85.5	84.4	88.5	89.2	82.4	84.7
C_nH_{2n+2}	9.8	2.9	12.5	11.2	7.9	5.5	14.9	7.7
N_2	4.9	5.0	0.5	3.3	1.9	4.6	0.8	4.6
n	1.4		1.2	1.4	1.0	1.5	1.3	1.8

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Table III(B)5
YIELDS OF CRUDE OIL AND WATER.

Run Number	28	27	61	65	62	66	64	13
Yield of Crude Oil (gm)								
Crude Oil "A"	117.5	65.0	84.0	105.0	53.0	40.0	108.0 14.2	59.0
Crude Oil "B"	*	57.1	48.5	20.3	82.0	85.2	*	52.7
Total	*	122.1	132.5	125.3	135.0	125.2	122.2	111.7
Yield of Water (gm)								
Crude Oil "A"	13.0	10.0	11.5	13.5	13.0	5.5	14.5	13.0
Crude Oil "B"	2.0	Trace	2.5	1.3	2.4	4.8	1.8	
Total	15.0	10.0	14.0	14.8	15.4	10.3	16.3	13.0

*Part of sample lost.

Table IV(B)5
DISTILLATION OF TOTAL OIL (gm)

Run Number	28	27	61	65	62	66	64	13
-180°C	11.0	6.8	8.9	11.5	6.5	3.6	12.3	5.7
180-230°C	6.5	3.7						5.6
230-280°C	15.7	13.4	80.0	69.0	59.0	64.0	56.1	14.1
280-360°C	17.2	22.5						16.6
Pitch	23.7	25.0					*	17.2
Total	74.1	71.4	88.9	80.5	65.5	67.6	68.4	59.2

*Part of sample lost in distillation

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Table V(B)5
YIELD OF RESIDUE AND ITS PROPERTIES

Run Number	28	27	61	65	62	66	64	13
Yield of Residue (gm)								
Crude Oil "A"	19.0	11.2	8.8	18.0	8.1	3.4	18.3	39.5
Crude Oil "B"	5.3	29.5	20.8	12.0	44.4	43.9	19.2	
Total	24.3	40.7	29.6	30.0	52.5	47.3	37.5	39.5
Properties of Residue, (gm)								
Soluble in Benzene	1.9	0.2			0.7		0.5	2.8
Organic Residue	11.0	32.4	17.5	17.8	43.4	39.0	21.9	29.6
Ash	11.4	8.1	12.1	12.2	8.4	8.3	15.1	7.1
Total	24.3	40.7	29.6	30.0	52.5	47.3	37.5	39.5