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ENCLOSURE (B) 7

EFFECT OF REACTION PRESSURE ON HYDROGENATION OF COAL

by

NAVAL CHEM. ENG. T. OGAWA

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SUMMARY

The effect of hydrogen pressure on the hydrogenation of Fushun Oyama coal was studied, using low-temperature tar as Paste Oil and a ferric oxide catalyst. It was shown that at least 200 atmospheres of pressure was needed for the hydrogenation reaction to proceed smoothly. At pressures lower than 200 atmospheres the hydrogenation of coal was not only incomplete, but a part of the hydrogenated product was converted to coke and gas.

I. INTRODUCTION

The reaction pressure is an important factor in the hydrogenation of coal. Up to the time of this study, many experiments had been made on this subject, and it was concluded that, in general, the higher the pressure, the higher the yield of oil and the lower the solid residue.

In this study the hydrogenation of Fushun Oyama coal was investigated at different hydrogen pressures and with other reaction conditions constant (reaction temperature, 455°C, reaction time, 1 hour).

II. DETAILED DESCRIPTION

The test apparatus and procedure were the same as described in previous reports of this series. The following feed stocks were used:

Coal	:	Fushun Oyama coal crushed to under 20 mesh size.
Tar	:	Light oil fraction from Shinbara low-temperature tar obtained by Davidson Retort and 30% topped.
Catalyst	:	Ferric oxide
H_2	:	Obtained from electrolysis of water, purity above 99.5%.

These materials were used in the following amounts: coal, 100 grams; tar, 40 grams; ferric oxide, 5 grams. The H_2 pressure was varied on each run as shown in Table I(B)7.

The reaction pressure was the only variable in these runs and other conditions were kept as constant as possible. Experimental conditions and results are as shown in Table II(B)7.

III. CONCLUSIONS

The higher the hydrogen pressure, the greater the yield of oil products and the smaller the coke formation. From the results of the gas analysis, it was found that decreasing hydrogen pressure resulted in more saturated hydrocarbon gases being formed and more of the hydrogen being converted into gas than into liquid and solid products, as shown by the following Table IV(B)7.

Thus, higher pressure of hydrogen resulted in more complete hydrogenation of coal, and reduced gas formation and secondary cracking of produced oil.

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Table I(B)7
HYDROGEN REACTION PRESSURES

	Run Number			
	76	47	307	308
Reaction Press. (atm.)	205	225	200	175
Weight of H_2 (gm.)	19.8	18.3	15.4	13.0
H_2/coal (wt. %)	19.8	18.3	15.4	13.0

Table II(B)7
COAL HYDROGENATION EXPERIMENTAL RESULTS

		Run Number			
		76	47	307	308
Reaction Conditions	Reaction Conditions (atm.)	250	225	200	175
	Reaction Temperature (°C)	455	455	455	455
	Initial Pressure (atm.)	101	93.5	79	66
	Pressure Drop (atm.)	19	17	17	16
	Reaction Time (hr.-min.)	1-0	1-0	1-0	1-0
	Preheating Time (hr.-min.)	2.15	1-55	2-45	2-55
Reaction Products (gm.)	Gas	33.6	36.6	35.7	34.3
	H_2O	17.4	16.9	16.8	15.8
	Oil	85.9	79.2	60.8	59.3
	Residue	24.9	27.4	40.0	41.3
Gas Analysis (vol.%)	CO_2	0.2	0.5	0.7	0.6
	C_nH_n	0.2	0.1	0.2	0.3
	CO	0.7	0.5	0.7	0.8
	H_2	88.8	88.3	70.8	80.6
	C_nH_{2n+2}	10.1	10.6	28.6	17.7
	n	1.3	1.7	1.3	1.5
Distillation of Oil (wt.%)	~180°C	12.4	12.8	18.7	15.5
	180~230°C	6.8	7.7	16.1	13.2
	230~360°C	42.0	42.1	40.8	44.2
	Pitch	38.8	37.4	24.4	26.1
Analysis of Solid Residue (gm.)	Benzene Soluble	0.2	0.1	5.4	5.6
	Organic Solid Residue	12.0	15.1	27.4	28.7
	Ash	12.9	12.3	12.6	12.4

Table III(B)7
ABSORPTION OF HYDROGEN

	Run Number			
	76	47	307	308
Reaction Pressure (atm.)	250	225	200	175
Hydrogen Adsorption Total (gm.)	5.5	5.1	5.8	4.3
Hydrogen in Hydrocarbon Gas (gm.)	3.7	4.3	5.1	4.9
H_2 in Absorbed in Liquid and Solid (gm.)	1.8	0.8	0.7	0.6