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Two Short Papers on Dr. Duftschmid's Oil Circulation Process

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W. M. Sternberg
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I. DISCUSSION OF CARBON MONOXIDE-HYDROGEN SYNTHESIS IN BERLIN, JUNE 1, 1941

Dr. Mach has discovered the fused iron catalyst in 1927 to 1928. At that time deposition of carbon caused difficulties when operating under high pressure in the vapor phase.

Experiments in the liquid phase were begun in 1934 and resulted in the development of the oil circulation processes, in which oil and gas were led concurrently over a stool bed catalyst. It is important here that operations be conducted in the boiling phase, produced by the return of the relatively low boiling oil-constituents. The work was originally conducted at 100 atm, and subsequently at middle pressures in two stages.

With a 260°C reactor inlet temperature and 230°C reactor outlet, a total of 150 grams of primary products (liquid and gasol) were obtained in the two stages per cbm of the ideal gas, with a 50% conversion in each stage. The composition of the primary products was:

40% primary gasoline, o.n. 62-68
o.n. with 0.1% lead was 85
2% oxygen content, removable by washing with water.

20% middle oil — cetane No. 78
20% hard paraffin — m.p. 95°C
15% gasol (no C_3) — with 85% olefines
5% alcohols — with 25% methanol, 50% ethanol, 25% higher alcohols, acetaldehyde, acetone, etc.

The space-time yield was

30 g/l cat/h = 0.7 g/l cat/day.

Experiments at 25, 100, 150 and 200 atm. have shown that the oxygen content rises with increasing pressure, and at 150 atm. very much low boiling alcohols and very little higher alcohols are obtained.

The process can be used for alcohol production when operating with a low conversion and with a hydrogen-rich synthesis gas.

With a CO:H_2 ratio of 1:1, at 150 atm. and 200-250°C, with a 20-30% conversion, 45.5% alcohols was found in the total liquid formed which consisted of

8.5% methanol
21.0% ethanol
10.0% propanol
5.5% C_4-C_{11} alcohols
2.5% higher alcohols.

The 32.5% hydrocarbons consisted of

26.5% gasoline
3.5% middle oil
3.5% over 300°C.

The 18% fatty acids consisted of:

11% water solubles
5% C_5-C_{11}
2% C_{12}-C_{20}.

The alcohols disappear in the liquid fraction

(a) when the conversion is high,
(b) when carbon is deposited upon the catalyst.

TOM Reel 13, Bag 3043, Item 2, p. 150

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II. DISCUSSION OF JULY, 1942

The process is practically identical with Michael's foam process with the exception that the catalyst is arranged in a fixed bed making the separation of the catalyst unnecessary.

Maximum reactor capacity	At present up to 1.5 cbm
Space time yield	0.[illegible] kg/cbm/hr catalyst
Conversion	87% in two stages
Oil circulation considerably smaller than in Michael's	CO_2 formation quite predominate over the formation of water
Composition of products	150 gram total products of which 40% gasoline 20% gas oil 20% hard paraffin wax 15% gasol 10% alcohols

(It is assumed that the water formed amounts to 10% of the above and the total amount of liquid formed adds then up to 110%.)

THE COMPOSITION OF HYDROCARBONS

	C No.	Per Cent by Wt. in 150 grams	Per Cent Olefines*
	C_3	8.6%	75-80%
	C_4	7.4	75-80
20-50°C	C_5	6.8	60-75
50-75	C_6	6.6	60-70
75-100	C_7	6.5	55-60
100-125	C_8	6.2	50-55
125-150	C_9	5.0	50-55
150-175	C_{10}	3.7	40-50
175-200	C_{11}	3.2	35-40
200-225		3.1	35-40
225-250		3.6	
250-275		1.9	
275-300		[illegible]	
>300		11.4	
Hard Paraffin Wax		20.0	
Alcohols		5.7	

*The olefines: 50% branched, 50% straight chain