U. S. BUREAU OF MINES
HYDRO. DEMON. PLANT DIV.

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KCBraun
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Comparative Costs of CV_2b & DHD
Ludwigshafen, 10.December 1941

To supplement the comparative production costs for auto-, aviation-, and 170-gasoline from bit. coal as feed for DHD, of October 28, 1941, the attached estimate shows the comparative costs of CV_2b and DHD high test fuel from bit. coal.

Two cases are calculated for CV_2b, one for 21% gasification and 0.25 yield, as obtained in Ludwigshafen, and another for 23.5% gasification and 0.19 yield, as obtained in Scholven. In the first case CV_2b is about 1.4 Pf. cheaper than DHD gasoline with a credit of 25 Pf/kg unrefined s-gasoline (heavy), which can be sold as auto gasoline after refining. In the second case CV_2b costs as much as DHD.

(Note:-Detailed figures for case 2 are not reproduced.)

TABLE 1

Estimate of Comparative Costs of CV_2b and DHD-gasoline from Bituminous Coal

Capacity: 34 t/h s-gasol.+M-Oil, corresp. to 250000 t/ann. auto gasoline
Production: 198500 t/ann DHD-gasol, or 191500 t/ann CV_2b +21750 t/ann unref. s-gasol. (185000 t/ann. CV_2b @ Scholven).

21% gasif, 0.25 yield — CV_2b	RM/t gasol.	DHD	RM/t gasol.
Raw Material:			
1.42 t s-gasol + M-Oil @ 200.-	= 284.00	1.37 t @ 200.-	= 274.00
950 m^3 H_2 @ 5.45 Pf.	51.80	1052 m^3 @ 5.45 Pf.	57.50
1850 m^3 Hygas Credit@0.658 Pf.	(12.20)	1750 m^3 @ 0.658 Pf.	(11.52)
156 kg L.F.G. Credit @ 25 Pf.	(39.00)	232 kg @ 25 Pf.	(58.00)
	284.60		261.98
Cat. & Chemicals:			
0.498 Ltr 7019 @ 5.-	= 2.50	0.222 Ltr 5058 @ 12.50	= 2.78
0.171 Ltr 7360 @ 7.-	1.20	0.149 Ltr 6434 @ 4.15	= 0.62
5 kg NaOH @ 15 Pf.	0.75	0.532 Ltr 7360 @ 7.-	= 3.72
	4.15	5 kg NaOH @ 15 Pf.	= 0.75
			7.87
Energy:			
0.42 t HP steam @ 3.-	= 1.26	0.87 t @ 3.-	= 2.60
1.26 t LP " @ 2.60	3.28	0.75 t @ 2.60	1.95
1120 m^3 fuel gas @ 0.658 Pf.	7.37	95 m^3 @ 0.658 Pf.	6.25
124 m^3 water @ 1 Pf.	1.24	116 m^3 @ 1 Pf.	1.16
298 KWH Current @ 2 Pf.	5.96	342 KWH @ 2 Pf.	6.84
	19.11		18.80

TABLE 1 (Cont'd)

	CV_2b		DHD	
	RM/t gasol.			RM/t gasol.
Wages & Salaries:				
80 Men/Shift = 3.68/h@RM 0.85 =	3.13	100 M/Sh = 4.95/h @ 0.85	=	3.78
Added charges 78%	2.44	78%		2.95
Salaries incl. add. ch. 24%	1.34	24%		1.62
Misc. oper. matl. 20%/wages	0.63	20%/wages		0.76
	7.54			9.11
Repairs:				
6.5% of 26.9 Mill. =	9.14	6.5% of 30.15 Mill.	=	9.87
2% of 6.7 "	0.70	2% of 7.55 "		0.76
	9.84			10.63
Amortization & Taxes:				
9% of 33.6 Mill. Amort. =	15.80	9% of 37.7 Mill.	=	17.10
2% " " " Fire Prot & Tax =	3.50	2% " " "	=	3.80
	19.30			20.90
Production Costs	344.84			329.28
General: 2.5% of Prod. Costs =	8.62	2.5%		8.22
Interest: 6% of 38.6 Mill	12.10	6% of 43.3 Mill.		13.10
License:	7.50			7.50
1 t CV_2b-gasol. =	373.46	1 t DHD-gasol. =		358.11
Credit for unref. s-gasol-180° 114 kg @ 25 Pf. =	(28.90)			
1 t CV_2b-gasol. =	344.56			
(358.8: @ Scholven)				

TABLE 2

Operations: Comparing CV_2b and DHD

CV_2b		DHD	
300 atm: (without s-gasol) 21% gasif. 0.25 yield		**300 atm:**	
Injection Pumps	96.0 t/h	Inj. Pumps, 34.0 ± 1.16	t/h
Water "	9.6 t/h	Water " 3.4.	t/h
Oil Wash	93 m³	Gas Circulation, 136000 ± 4600	m³

166 L

CV-2h	DHD
Gas Circulation, 240000 m³	Thruput 0.8-0.85
Yield 0.25	Cat. Vol. 42.5 +1.5 m³
Cat. Vol. 95.5 m³ without ref., 11.7 @ 8.2 m³	Converters 5.2
Converters,	Stalls 1(000) +1(00)
Stalls 4(0000)	C.C.P. Dist. 32.7 +1.10
C.C.P. Dist. 89.0 t/h	Col. Overhead, 10.8 t/h gasol +0.4
Column Overhead, 24.0 t/h-1659	Inj. Pumps, 35.2 +2.2 t/h
Debenzination, 2.4 t/h-light ends	Wat. " 3.5 t/h
L.F.G. Recovery, 3.75 t/h L.F.G.	Gas Circul. 70400 +2400 m³
Gasol. Wash, 24.0 t/h	Yield 0.6
" Stabil. 24.0 t/h	Cat. Vol. 29.5 m³
	Converters 3.6
	Stalls 2(00)
	C.C.P. Dist. 33.8 +1.2 t/h
	Col. Overhead, 20.2 +0.7t/h, containing C₄
	50 atm DHD
H₂-Consumption:	Predist. 31.1 t/h, containing C₄
22800 m³/h	Col. Overhead, 6.1 t/h
	Inj. Pumps, 34.6 t/h
	Wat. " 3.5 t/h
Hy-gas Yield:	Gas Circul. 52000 m³
85.4 x 10⁶ Kcal/h	Thruput 0.4
	Cat. Vol. 86.5 m³
	Stalls 2(00000)
	C.C.P. Dist. 21.8 t/h
	Col. Overhead 20.8 t/h
	Gasol. Stabil. 26.9 t/h
	" Wash 24.8 t/h
	Debenzination, 1.4 +1.5 = 2.9t/h
	L.F.G. Recovery, 3.7 +2.07 = 5.77t/h
	H₂-Consumption: 26100 m³/h
	Hy-gas Yield: 55.3 x 10⁶ Kcal/h
	+ 53.4 x 10⁶ "
	108.7 x 10⁶ Kcal

TABLE 3

PLANT COSTS

CV-2h	DHD
200 atm.	200 atm.
Inj. Pumps & Gas Circul. 2 Mill.	Inj. Pumps & Gas Circul. 2.9 Mill.
Oil Wash 1.4 "	Stalls 4.9 "

TABLE 3 (Cont'd)

CV_2b		DHD	
300 atm.		300 atm.	
Stalls	18.6 Mill.	C.G.P. Dist.	1.6 Mill.
C.G.P. Dist.	1.8 "	Stalls	4.8 "
Debenzination & L.F.G. Recovery	2.4 "	Tankage	1.9 "
Gasol. Wash & Stabil.	0.6 "	Pipe Lines	1.7 "
Pipe Lines	1.8 "	Predist. (50 atm)	0.7 "
Tankage	1.7 "	Inj. Pumps & Gas Circul.	2.8 "
Total	26.9 Mill.	Stalls	4.0 "
		C.G.P. Dist.	0.7 "
		Tankage	0.7 "
		Pipe Lines	0.4 "
		Gasol. Wash & Stabil.	0.65 "
		Debenzination & L.F.G. Recovery	2.4 "
		Total	30.15 Mill.

Cost Calculation for CV_2b

Ludwigshafen, 19 Jan 1942

Let us assume that a hydrogenation plant for producing 250000 t/ann auto gasoline from bituminous coal took up production of CV_2b, as far as this is possible within its capacities and retaining the usual plant reserves.

Let us assume a yield of 0.19 and gasification of 23.5% for CV_2b. Since a CV_2b stall requires a gas [illegible], only [illegible] stall can be used. On the other hand, in order to utilize the prehydrogenation stalls, the auto gasoline production can be replaced only partially by CV_2b. From the above assumptions and consideration of plant capacities and reserves, the following production distribution in the [illegible] phase is derived:

Auto Gasoline	CV_2b	Total	Available capacities
Production, 172000 t/ann (1)	3700 t/ann	209000 t/ann	250000 t/ann
B-middle oil Input, 22.7 t/h	6.8 t/h	29.5 t/h	[illegible] t/h (4)
H_2-Consumpt. 45000 (2) + 16700 m³	136000 (2) + 4800 m³	80100 [illegible]	99000 [illegible]
Inj. Pumps, 43.3 t/h	19.2 t/h	62.5 t/h	61.2 t/h
Gas Circul. [illegible] m³	42000 m³	[illegible] m³	196200 m³
Converters 7	4	[illegible]	10 (3)
Stalls 2(00) + 1(000)	1(000)	[illegible]	[illegible]
C.G.P. Dist. 41.5 t/h	17.2 t/h	[illegible] t/h	61.8 t/h
Debenz. & L.F.G. 1.8 t/h	0.9	2.7 t/h	2.7 t/h

(1) processed together with the CV_2b equivalent of a-gasoline in prehydrogenation
(2) liq. phase
(3) one additional converter must, accordingly, be added
(4) [illegible] 115% of 20.5 or 23.5 [illegible] of [illegible]

156 d

This equation shows that the liquid phase can be utilized only to 66.5% of its capacity. This circumstance increases the cost of s-gasol + H-Oil by 66. But since the H_2-requirement is only 30% of the H_2-plant capacity, the cost of H_2 will also be increased by about 6%. If the ideal figures for auto gasoline and CV_2b are recalculated by using these costs, the cost of auto gasoline is increased from RM. 274.64 to RM. 295.93/t and that of CV_2b from RM. 338.66 to RM. 362.66/t. But if we base our calculation on an auto gasoline price of RM. 310.00/t we get the following prices, recalculated in the proportion of 274.64:310:

auto gasoline/t	RM. 334.00
CV_2b/t	RM. 410.00

Since an increase in the auto gasoline price from 274.64 to 295.93 or from 310.00 to 334.00 does not appear justified, the increased cost must be charged to CV_2b.

With 20.9 t/h of auto gasoline (without s-gasoline equivalent from CV_2b) the additional cost (Hamburg) is 20.9 x 24 (334 - 310 = 24) = 502.00. Therefore, with a production of 4.62 t CV_2b, one ton CV_2b must be charged with 502/4.62 = 108.50. The price of CV_2b is then 410.00 + 108.50 = RM. 518.50/t.

(Note: CV_2b, made over catalyst 70ID, was later discontinued and replaced by CMD)