Wiley

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
OFFICE OF SYNTHETIC LIQUID FUEL
LOUISIANA, MISSOURI

1425

From Dr. Pier's File

T -430

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Dec. 31, 1947

High Pressure Experiments In Politz 10/4/41, Wch.
Ludwigshafen, 558

ESTIMATION OF THE COSTS OF AVIATION GASOLINE (TYPE O.Z. 87) FROM UPPER SILESIAN BITUMINOUS COAL

The estimates are based on tests run in Ludwigshafen Oppau with the Upper Silesian bituminous coal (the Beuthen and Heinitz mines). The following data are used as the basis of estimates, with the expectation, that the gasification will be further reduced in the gas phase in large scale operations by 1 - 2 percent.

700 atm Liquid Phase:

Utilization	96 percent
Production (referred to avail. oil production)	0.26 kg/li/h
Gasification (referred to avail. oil product. + gasif.)	24

	300 atm prelim. hydrogenation	300 atm benzin
Thruput, or output, kg/li/h	0.8	0.45
Gasification (to gasoline + middle oil + gasif.)	3.5	20
Concentration (percent gasoline in catchpot)	35	60

The operations are conducted by hydrogenating coal in the four stalls of four converters each (141 cbm reaction volume) in Pölitz. On the basis of the figures given, 535,000 te/year of coal (with 5 percent ash and 10 percent water) can produce 295,000 te/year of liquid phase middle oil + gasoline.

In the two stalls for the preliminary hydrogenation (46 cbm reaction volume) + 2 benzination stalls (42 cbm reaction volume) the above amount is converted into 244,000 te/year of aviation gasoline (O.N. 87, with lead).

In addition to the 244,000 te/year = 30.5 te/h of aviation gasoline, there are produced hydrogenation off-gases with a heating value of 230 x 10^6 h.u./h*.

It is planned, in accordance with the Pölitz practice, that only the rich part of the off-gas, with a total content of about 80.5 percent propane-butane, is used for the production of pitch gas. It is further assumed that in the distillation in the column the yield consists of 95 percent of the available propane and butane. With these assumptions, the production of power gas will be

71,000 te/year = 8.9 te/h.

The remaining hydrogen-rich off-gas is used in the preparation of hydrogen; 80,000 cbm H_2/h can be obtained after [illegible]. The total requirements of hydrogen [illegible] 80,000 cbm H_2/h, and the hydrogenation [illegible] 30 percent of the hydrogen consumed. [illegible], 56,000 cbm H_2/h are produced from coke.

The [illegible] requirements, again in accordance with the [illegible] requirements, are covered by the output of [illegible] gasboard. The fuel gas requirements [illegible] hydrogenation are estimated at

$$\frac{84 \times 10^6 \text{ h.u./h}}{170 \times 10^6} = \text{[illegible]}$$

of hydrogenation [illegible] building.

* Based on [illegible] yield of the hydrogenation of off-gases, checked by calculation.

Of this amount, the residual water gas proportion of the coke gas producers furnish

$$\frac{25 \times 10^6}{115 \times 10^6} \text{ h.u./h}$$

and the fuel gas installation must produce

The electric power requirements are assumed, in accordance with the Politz data, to be 200 x 10^6 kw from outside sources, which are best supplied by a power plant.

Whenever known, the prices for coal, coke and power were those in Politz. A small part of the prices, in particular the cost of steam, has been roughly estimated. Credit for the power gas, as well as for the production of fuel gas, have been conservatively evaluated: the power gas at 150 Mk/te, the tar at 55 Mk/te.

The installation costs were recalculated to a 244,000 te/year aviation gasoline installation from the data here available for the installation costs. The total installation costs were figured to 234 million mark, i.e. slightly below 1000 Mk/te/year of gasoline.

The repair costs were calculated from the installation costs as follows:

In the hydrogenation proper and the hydrogen production at	6.5 percent/year
Power production	2.0 " "
Fuel gas production	5.0 " "
Other installations	2.0 " "

The number of operators is obtained by dividing the sum of the above by 3.40 RM/h mechanics' work.

The interest charges were figured on a stock

capital of	110,000.000 RM at 5 percent
the balance	124,000.000 RM " 6 "

From these figures, the average interest rate is figures to 5.53 percent.

The general costs were roughly estimated at 2.5 percent of the operating costs (without the interest on the capital investment).

These assumptions were used for arriving at:

1. an estimate of the operating costs of hydrogenation (including the balance, course of operations and power).

2. an estimate of the basic costs (including the estimated installation costs)

1. ESTIMATED OPERATING COSTS OF HYDROGENATION OF UPPER SILESIAN BITUMINOUS COAL TO AVIATION GASOLINE (O.W. 87) IN PÖLITZ

Part 2.

	RM/to aviat. gasol.	
Raw materials:		
2.18 to dry coal, 10, 5 percent ash, at 22.50 M/to	49.--	
3135 cbm hydrogen, at 5.45 Pf/cbm	171.--	
4390 cbm credit for hydrogenation gas with 1803 h.u., at 0.[illegible] per 1000 h.u.	28.90	
290 kg power gas, at 15 M/to, credit	43.50	147.60
Auxiliary materials:		
24 kg 1181, at 1.65 pf/kg	0.40	
31.6 kg Bayer mass, at 1.8 pf/kg	0.57	
6.0 kg sulfigran, at 30 pf/kg	1.80	
0.189 li 5058, at 12.50 " "	2.36	
0.173 li 6434, at 4.15 " "	0.72	
5 li caustic soda solution, at 0.15 pf/li	0.75	6.60
Costs:		
Power:		
0.79 to high pressure steam, at 3.0 M/to	2.37	
3.16 to low pressure steam, at 2.60 M/to	8.21	
2730 cbm fuel gas, 1000 h.u., at 0.658 pf/1000 h.u.	18.--	
232 cbm water, 1 pf/cbm	2.32	
1170 kw electric power, at 2 pf/kwh	23.40	54.30

	RM/to aviat. gasol	
Wages:		
303 man/shift = 11.0 hrs/to gasoline, at 0.85	9.35	
Overhead, 78 percent of wages	7.30	
Salaries, including overhead, 24 percent of wages + overhead	3.98	
Work material, 20 percent of wages	1.87	22.50
Repairs:		
6.5 percent of 78.8 mill RM for hydrogenation	21.--	
2 percent of 19.7 mill RM for auxiliary installations	1.62	22.62
Amortization and taxes:		
9 percent of 98.5 mill. RM for hydrogenation and auxiliary installations	35.40	
2 percent of 98.5 mill. RM for hydrogenation and auxiliary installations	8.08	44.48
		298.10
General Expense:		
2.5 percent of 298.10 mill. RM installation costs	7.45	
Interest:		
5.53 percent on 113.3 mill. f. hydrogen. + auxiliary installation + 15 percent other capital req.	25.75	
Licenses:		
for gasoline 7.55 RM; for power gas 1.30 RM/to aviation gasoline	8.65	41.85
		339.95

Operations

Liquid Phase, 700 atm:

Preliminary crushing of coal	67.0	te/h raw coal
Drying, 10→2 percent water	67.0	" " "
Catalyst 1181	0.74	"
	67.74	"
Grinding the paste	62.24	te/h dry coal + cat. 1181
	0.92	" cat. 6512
	0.18	" cat. 6709
	74.7	" paste oil + glide oil
	6.29	" cold HOLD return
Pumping the paste	144.33	"
Pumping the flushing oil	3.14	"
Pumping the water	3.5	"
Gas circulation	230,000	m³
Compression 300→700 atm	69,100	"
Oil scrubbing	173	"
Performance	0.26	
Reaction space	141	m³
Converter systems	16	converters, 15/18 m long, 1,000 mm diameter
Stalls	4	(coal stalls)
Centrifuging	85.8	te/h
Kilning	18.6	"
Catchpot distillation	78.7	"
distillate from column	9.5	" gasoline - 200°
	27.18	" middle oil - 325°

Vapor Phase, 300 atm:

Preliminary hydrogenation:		
Injection pumps	36.68	te/h + gasoline + m.o.
Water pumps	3.4	"
Gas circulation	148,000	m³
thruput	0.8	
catalyst volume	46	m³
converter systems	5.6	converters, 18 m long, 1,000 mm internal diam.
Stalls	2 (000)	
Catchpot distillation	36.0	te/h
distillate from column	11.5	" gasoline - 150°
Remination:		
Injection pumps	23.25	te/h recycle m.o.
	12.47	" middle oil
	35.72	"
Water pumps	3.5	
Gas circulation	71,500	m³
Performance	0.45	
Catalyst volume	42.5	m³
converter systems	5.15	converters
Stalls	1 (000) + 1 (00)	

Catchpot distillation	31.8 to/h	
distillate from column	19.1 "	gasoline - 150°
Gasoline recovery and power gas production	8.9 "	$C_3 + C_4$
+ about	2.5 "	C_5
Gasoline stabilization	30.6 "	
Gasoline washing	30.6 "	

H_2 Consumption:

Liquid phase	69,100	m^3
Vapor phase	26,700	"
	95,800	"

Hydrogenation gas production:

Liquid phase	162×10^6	h.u./h
Vapor phase	70×10^6	h.u./h
	232×10^6	h.u./h

Power Table for Aviation Gasoline from Upper Silesian Coal.

	Amount	High Compr.	Low Compr.	Gas	Water	High voltage kw	Low voltage kw	Men/ shift
Liquid Phase, 700 atm								
Crushing	67	-	0.63	-	-	448	111	5
Drying	67.7	-	0.45	9,000	-	575	76	7
Grinding of paste	144.3	2.52	3.32	-	5	2,630	263	7
Pumping of paste	144.3	-	3.75	-	-	9,450	100	23
Water and flushing oil pump	6.6	-	-	-	-	264	1	4
Gas circulation	230,000	-	-	-	-	1,370	23	9
Compression	69,100	-	-	-	208	4,850	-	10
Stalls	147	1.47	25.0	31,500	1,660	1,850	413	28
Oil scrubbing	173	-	17.3	-	58	1,120	190	12
Centrifuging	65.8	3.02	1.56	-	2	-	243	15
Kilning	18.6	1.12	0.86	8,700	240	740	2	40
Catchpot distillation	78.7	-	5.1	17,400	1,080	-	244	12
Vapour Phase, 200 atm								
Reaction								
Injection pumps	26.7	-	-	-	-	468	8	6
Water pumps	3.4	0.52	-	-	4	-	71	3
Gas circulation	148,000	-	0.53	-	-	735	12	6
Stalls	26.7	-	0.7	-	400	565	42	14
Catchpot distillation	35.0	-	1.77	6,950	500	-	140	5
Separation:								
Injection pumps	35.7	-	-	-	-	455	6	6
Water pumps	3.6	0.6	-	-	1	-	72	3
Gas circulation	715,00	-	0.25	-	-	360	5	4
Stalls	35.7	-	0.66	3,580	386	550	41	14
Catchpot distillation	31.0	-	1.54	6,050	452	-	127	5
Gasoline recovery and power gas	11.1	5.7	1.9	-	620	2,120	-	20
Stabilization	39.6	4.95	0.87	-	263	-	61	4
Washing	20.6	-	0.59	-	9	-	23	3
Separation to tank farm	20.6	3.4	6.8	-	-	-	430	12
Air fans								4
Refrigeration								
Absorber	30.6	9.92	6.1	306	218	31	250	2
Grinder, lubrmnt.								20
Auxiliary distill.	-	-	15.0	-	1,000	4,000	-	
	-	24.22	96.75	89,586	7,106	32,581	3,230	303
						35,811		
Power/ton/shift, gasol	-	0.79	3.16	2,730	232	1,170 kw/t		

2. ESTIMATED BASIC COSTS OF PRODUCTION OF 244,000 TE AVIATION GASOLINE (O.N. 87) FROM THE UPPER SILESIAN BITUMINOUS COAL IN POLITZ

Part 3.

	RM/year	RM/to aviat. gasol.	
A). Hydrogenation Coal:			
Coal for hydrogenation: 535,000 to/year, at 22.50 M/to	12,050,000.-		49.30
B). Operating Sources:			
Coke: 267,000 to/year, at 30.-M/to	8,010,000.-	32.80	
Coal for power: 389,000 to/year at 13.80 M/to	5,370,000.-	22.--	
Coal for fuel gas: 184,000 to/year at 18.80 M/to	3,460,000.-	14.15	
Outside power: 200×10^6 kw/year at 2 Pf/kWh	4,000,000.-	16.40	85.35
Auxiliary substances:			
For hydrogenation	1,608,000.-	6.59	
For H_2 production			
Catalysts I - III for splitting	147,000.-	-.61	
Catalysts for conversion	154,000.-	-.63	7.83
Wages:			
1790 men x 8 x 365 at 0.85 RM/h	4,450,000.-	18.20	
Overhead at 76 percent	3,500,000.-	14.30	
Salaries including overhead 24 percent of wages + overhead	1,900,000.-	7.75	
Operation materials, 20 percent of wages	890,000.-	3.65	43.90
Repairs: 970 mechanics x 8 x 365 at 3.40 RM/h	9,640.000.-		39.30
			225.68
C). Capital corrdinge:			
Amortisation 9 percent of 203.5 mill.RM	18,300.000.-	75.--	
Fire protection and insurance: 2 percent of 203.5 mill.RM	4,070,000.-	16.65	
Interest: 5.55 percent of .234 mill.RM	13,000,000.-	53.20	144.85
			370.53

D). General Expense and License:		RM/year	RM/to aviat. gasol.	
General expense 2.5 percent of production costs without interest = 317.13		1,930,000.-	7.90	
License for gasoline 200,000 to				
at 7.50	1,500,000.-	44,000 to		
at 6.75	297,000.-	1,797,000.-	7.35	
License for fuel gas				
56,000 to at 4.50	252,000.-	316,500.-	1.30	
15,000 to at 4.30	64,500.-			16.55
				387.08

E). Credits:				
Tar from fuel gas production 15,000 to/year at 55.-RM/to		825,000.-	3.38	
Power gas 71,000 to/year at 150.-RM/to		10,650,000.-	43.50	46.88
				340.20

Installation Costs

		Mill. RM
Hydrogenation proper:		
Liquid Phase	56.8	
Vapor Phase	22.0	78.8
Hydrogen production 95,200 m^3/h		39.0
Power production (including water)		36.0
Fuel gas production		9.0
		162.8
Auxiliary installations 25 percent		40.7
Other capital requirements 15 percent		30.5
		234.0

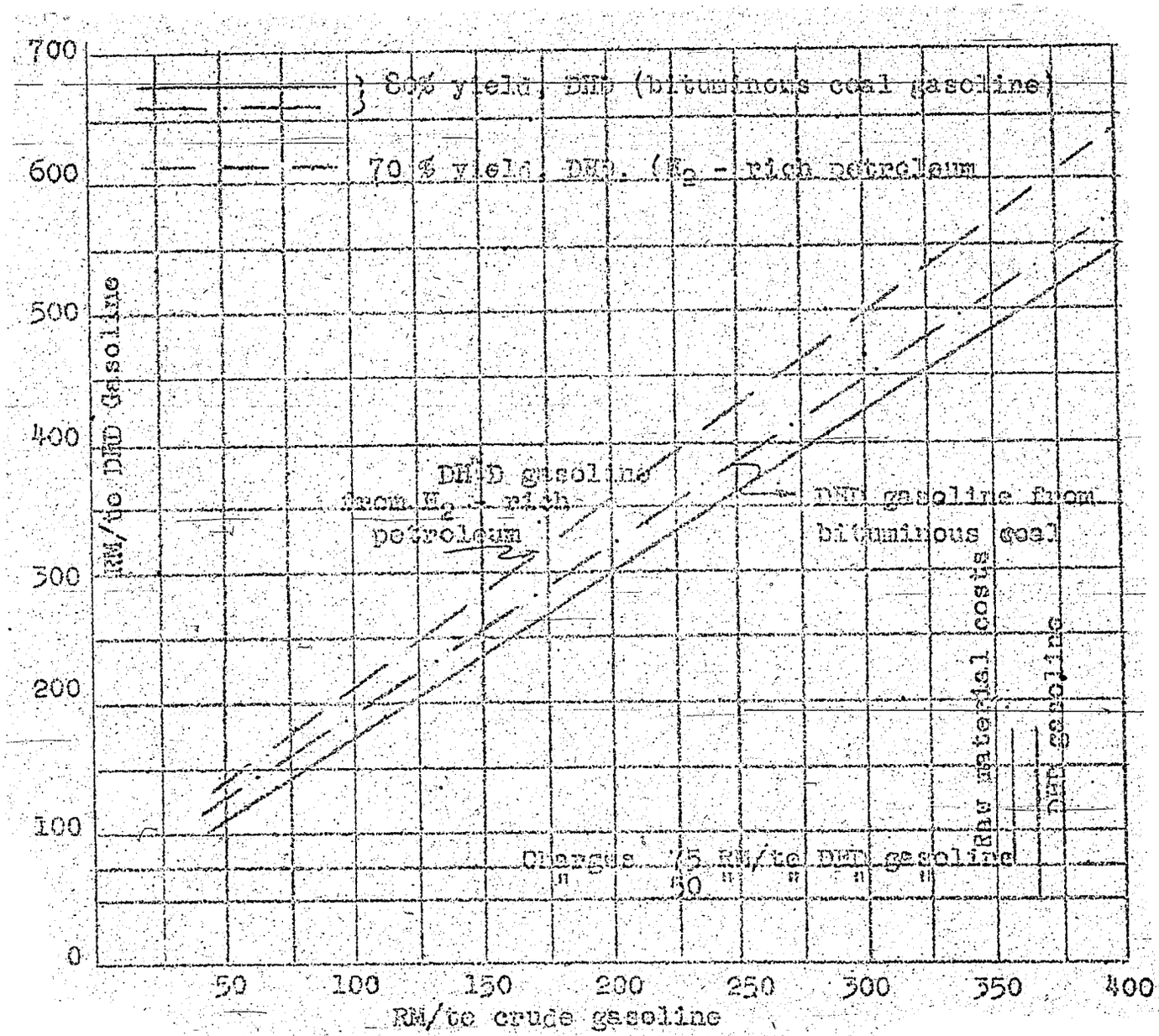
Supplement

General Estimation Cost of the DHD Gasoline

With a general price of 340.-RM/to for aviation gasoline (O.N. 87) the starting fraction for the preparation of DHD gasoline will figure to about 320 RM/to.

The prices of the DHD gasoline can be read off from the chart. Two cases are assumed for the dehydrogenation of bituminous coal gasoline: in one case the operating costs (including amortization, general expense and profit) are set very conservatively at 74.-RM/to in the other case at 50 RM/to of DHD gasoline.

For the sake of comparison the cost of the DHD gasoline from H_2 - rich petroleum gasolines will have to carry conversion costs of 75.-RM/to.



Costs per To DHD Gasoline

in Relation to Cost of Crude Gasoline