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700 or 300 Atm. in the Vapor Phase at Gladbeck

By Dr. Urban, Buer-Scholven, 26 February 1942

1) The question was raised, whether it was better to use 700 atm. in the 5058-6434 vapor phase at Gladbeck, instead of 300 atm., since Blechhammer proposes to use 700 atm. in the vapor phase for its second plant extension.

The following figures serve as a basis for Blechhammer, based on 10 liter experiments with Upper Silesian middle oil.

Small Apparatus at Lu with Mi-Oil alone.	Estimated for Blechhammer with 45% coal gasoline - 200° C and 55% Mi-Oil
Catalyst, 8239	8239
Pressure, 540 atm H_2	550 atm
Thruput, 1.1	1.4
Gas load, 1500 m^3/t oil	1500 m^3 + 1000 m^3 cold gas
Temp, 23-24 mV/40° basis	23.5 mV/heat of reaction abt. 250-300 Kcal/kg
Gasol. yield - 165°C = 0.44	0.55 total yield, incl. coal gasol.
Gasol. Concentr. in C. Catchpot= 43%	50% - 155° C gasoline
C-gasification = 13.1%	10.5%
O.N. 74, with Pb 89.	H_2 reqmt = 500 m^3/t gasol. & Mi-Oil input = 550 m^3/t gasol.

The small experiments with Scholven 40 part coal gasoline and 60 part middle oil mixture gave the following results with recycling of the B-oil:

Gasoline - 155° C
Density @ 15° C = 0.762
Aniline Point I = +26.4° C
Iodine Number = 1.0
Vapor Pressure = 0.45
Aromatics = 28.5%/wt.
Unsaturated = 1.0%/wt.

Naphthenes = 42.5%/wt.
Paraffin = 28%/wt.
Octane Number = 75, (with 0.12 Pb = 91)
Boiling - 70°C = 7.5%
" 100 = 74%
" 150 = 92%
End Point = 163° C.

The total yield = 89 kg gasoline from 100 kg of above mixture of coal gasoline and middle oil, i.e. C-gasification = 9%, gasoline concentration in cold catch pot = 65%/vol. with a thruput of 1.5 @ 24 mV/40°.

Middle oil benzinated alone gave a gasoline of the following quality:

Spec. Grav. @ 15° C	= 0.772
Aniline Point	= + 17° C
Iodine Number	= 2.0
Vapor Pressure	= 0.45
Aromatics	= 37%/wt.
Unsaturated	= 1%/wt.
Naphthene	= 37%
Paraffin	= 25%
C-gasification	= 13%
Octane Number	= 77 (with 0.12 Pb = 90)

Properly, the coal gasoline should not be benzinated together with the middle oil, but cut off at 170° C and then refined in a 50 atm DHD stall.

Raw Coal Gasoline	DHD @ 26 mV	DHD @ 28 mV
Spec.G. = 0.776 A.P. = 23.3 Initial boil = 69°C -80°C, 1.5% -100 , 26.5 -150 , 88.5 E.P. = 170°C Aromatics = 36.5%/wt	4% gasification 39% aromatics	14% gasification 59% aromatics O.N. 79-80, with Pb.89-90 = CV_2b quality.

When applied to Gladbeck, the following changes result:

To be benzinated in Case VIa	= Oper. Meth. 35:65,
Coal gasoline - 200°C	= 11.3 t/h
Middle oil 200-325°C	= 25.6 t/h
Total	= 36.9 t/h
Required catalyst volume, 700 atm	= 58 m^3
@ 0.55 gasoline yield	= 8.3 Converters @ 7 m^3
& 87%/wt. total yield	= 3 Stalls (triple converters)

In Case VIb	= Operating Method 50:50
Coal gasoline	= 11.4 t
Coal middle oil	= 18.3 t
Total	= 29.7 t/h corresponding to 87% yield = 25.9 t gasoline.
required catalyst volume	= 47 m^3
	= 6.7 converters
	= 3 stalls, 2 double & 1 triple.

If, however, the coal gasoline is cut off at 170°C instead of 200°C and separately refined at 50 atm DHD, the following picture results:

instead of 11.4 t - 200° C = 9 t - 170° C, gasification 14% = 7.75 t gasoline yield with 59% aromatics, residual gasoline 170-200° C = 2.4 t to middle oil,

instead of 25.6 t middle oil and 2.4 t residual gasoline = 28 t 170-375° C, gasification 15% = 23.8 t gasoline with 37% aromatics.

This gasoline can be brought up to an aromatic content of at least 55-60% under mild conditions with little loss in the DHD process because of its great naphthene content.

a) required for DHD @ a load of 0.3 =
30 m^3 catalyst volume & 1 DHD system.

b) required middle oil benzination 0.44 =
54 m^3 catalyst volume
2 triple systems
1 double system

In any case, three 700 atm stalls are required, instead of at least 4 with 5058-6434 combination and probably 5 stalls at 300 atm.

Blechhammer calculated additional capital requirements of about RM. 3,500,000.- @ 700 atm, compared with 300 atm vapor phase which can be saved in one year by the lower gasification, in spite of higher aromatic content.

Gasoline yield @ 300 atm from 30 t gasoline and middle oil x 82% = 24.6 t/h = 197000 t/ann (aromatics 10-15%).

Gasoline yield @ 700 atm from 30 t gasoline and middle oil x 87% = 26.1 t/h = 209000 t/ann (aromatics 25-30%).

An additional yield of about 12000 t/ann x RM. 400.- = abt. RM. 5,000,000.--.

In addition, the saving of H_2 @ 700 atm vapor phase is considerable. Differences exist in the quantities of H_2 in our flow sheet MaGl-2 Ho, since I. G. calculates:

with VIa liquid phase 91000 m^3/h,
instead of 108000 m^3,

with VIa vapor phase 24000 m^3/h,
instead of 29000 m^3,

with VIb liquid phase 85000 m^3/h,
instead of 100000 m^3,

with VIb vapor phase 18500 m^3/h,
instead of 22500 m^3.

Compared to these figures, the H_2 consumption in 700 atm vapor phase:

Case VIa = $\frac{31.0 \text{ t} \times 87}{82}$ = 32.8 t gasoline x 575 m^3
= reduced to 19000 m^3/h

Case VIb = $\frac{24.8 \times 87}{82}$ = 26.3 t gasoline x 575 m^3
= reduced to 15500 m^3/h.

2) By eliminating the 6434 catalysts, the iso-butane yield at Gladbeck is reduced to about 50%.

According to large scale experiments at Ludwigshafen, only about 17% C_4 hydrocarbons with about 10% iso-C_4 in the butane can be expected in 700 atm liquid phase. At abt. 19.5 t hydrocarbon gasification this corresponds to 0.3 t/h iso-butane. (Figured with a pure coal input of 80 t/h @ 21% C-gasification to 75 t converted C = 15.8 t gasified C = 19.5 t hydrocarbons = 3.3 t butane and iso-butane/h).

In the 700 atm vapor phase gasification contains abt. 45% C_4 hydrocarbons with abt. 40% iso-C_4 in the butane @ abt. 4.3 t hydrocarbon gasification, corresponding to 0.7 t/h iso-butane, i.e. total butane = 1 t/h by analysis = 8000 t/ann. iso-butane. (Figured with a mean gasoline production of 29 t/h @ 12% oil gasification = 4 t/h oil = 4.3 t hydrocarbons, of which 1.9 t butane and iso-butane/h)

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