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ITEM NO. 30.

FILE NO. XXXIII-30

STICKSTOFFWERK - HIBERNIA

WANNE - EICKEL - RUHR

Recovery of Hydrocarbons from Coke-Oven Gas

Bardgett, H.

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**COMBINED INTELLIGENCE OBJECTIVES
SUB-COMMITTEE**

REF'D. *JUL* 1946

LONDON: H.M. STATIONERY OFFICE

STICKSTOFFWERK - HIBERNIA

WANNE-EICKEL - RUHR

Recovery of Hydrocarbons from Coke-Oven Gas

Reported by

H. BARDGETT (British)

on behalf of

British Ministry of Fuel and Power

and

U.S. Technical Industrial Intelligence Committee.

C.I.O.S. Target No. C30/380.

COMBINED INTELLIGENCE OBJECTIVES SUB-COMMITTEE

G - 2 Division, S.H.A.E.F. (Rear) A.P.O.413.

(1945)

8 p. diagr

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Personnel of Team.

H. BARDGETT, British.	Ministry of Fuel & Power
F.H. REED, U.S.	Bureau of Mines.
L.D. SCHMIDT, U.S.	Bureau of Mines.

Stickstoffwerk - Hibernia

Wanne-Eickel - Ruhr

Personnel interrogated: Dr. E. Rindtorff, Director.
Dr. H. Benneissen.

Date of visit: 30th July, 1945.

Condition of target: Twenty-five per cent. destroyed and not
in operation at the time of the visit.

Description of process.

The visit was made to obtain information relating to the recovery of hydrocarbons from coke-oven gas.

The Company operate a process for the recovery of hydrocarbons from coke-oven gas by liquefaction and for the production of synthetic ammonia and ammonium fertilizers. The plant was designed and erected by the firm Uhde of Dortmund, from whom it was said full details could be obtained. The plant has a capacity for treating about 800,000 Nm³ of coke-oven gas per day, and can fix about 150 tons of nitrogen per day, including nitrogen from air separation.

A flow sheet of the process is shown in the attached diagram.

Coke-oven gas taken from the grid is passed first to a 20,000 Nm³ holder, and is then compressed to a pressure of 12 atmospheres in 3-stage reciprocating type compressors of capacity 5300 and 8000 Nm³ per hour. The compressed gas passes to a Linde liquefaction plant where all the constituents other than nitrogen and hydrogen are liquefied at a temperature of minus 200°C.

Air for separation is first dried by cooling with liquid ammonia to minus 35°C. at atmospheric pressure. This is accomplished by passing the air through vessels containing nests of tubes of 5 mm. internal diameter in which the water is frozen out. Particles of ice carried forward in the air are removed by means of wire gauze filters of aperture 0.001 mm., which also remove other solid material and oil. The dry air compressed to 120-150 atmospheres is separated in a series of ten Linde separators, seven of which are normally used each of capacity 10,000 Nm³ per hour. The oxygen is bottled and sold. The separated nitrogen compressed to 150 atmospheres is fed to the coke-oven gas liquefiers and provides the additional source of cooling, and together with nitrogen and hydrogen from the coke-oven gas provides the mixture for ammonia synthesis. Residual gas from the coke-oven gas liquefiers amounting to about 40 per cent. of the total is returned for heating coke ovens.

Purification of gas

The coke oven gas is purified from CO₂ and H₂S prior to liquefaction. The H₂S is removed by an iron hydroxide process described by Gluud and Schonfelder in Stahl u. Eisen 1927, p.453, but the management considered this process to be not very satisfactory. The CO₂ is reduced from 2 to 0.25 per cent. by water washing under a pressure of 12 atmospheres, and the remaining CO₂ is then removed by washing with caustic soda lye.

Ammonia synthesis

Ammonia is synthesised by passing the mixed nitrogen and hydrogen through a contact oven containing a catalyst of magnetite of size 2 - 12 mm., activated with traces of vanadium oxide. The magnetite was said to be obtained from Norway and to be similar to that used in America.

Products.

The products from the liquefaction process are as follows:-

1. Ruhrgasol - This is recovered at - 110°C. (12 atmospheres), is bottled at 6 - 8 atmospheres and sold as motor fuel.
2. Ethylene product - Recovered at minus 145 - 150°C. (12 atmospheres); is used for synthesis of Buna rubber. This product is piped at relatively low pressure to I.G. and Buna rubber producers.
3. Methane product - This is of somewhat similar composition to the ethylene product. It is compressed to 20 atmospheres in bottles and sold for motor fuel.

In addition to the above products the Company bottle and sell the oxygen from the separation of air, and bottle hydrogenation gases purchased from Hydinerwerke-Scholven (Hibernia). The latter gas produced by liquefaction consists approximately of 90 per cent. propane and 10 per cent. butane, and is sold as bottled gas for household purposes. The amount of gas taken from H-S, is about 150 tonnes per month.

Data for a typical working day.

Coke-oven gas received:

Quantity	Nm ³	735,000					
Density	gm./Nm ³	505					
Analysis	%	CO ₂	2.0	O ₂	1.0	CH ₄	19.6
		H ₂ S	0.5	CO	6.0	C ₂ H ₆	4.9
		C ₂ H ₄ + C ₃ H ₆	2.0	H ₂	54.0	N ₂	10.0

Products.

Ruhrgasol:

Quantity	tonnes	1.0					
Analysis	%	C ₂ H ₆	6	C ₃ H ₆	34	C ₅ H ₁₀	6
		C ₂ H ₄	14	C ₄ H ₁₀	8	CH ₄	3
		C ₃ H ₈	11	C ₄ H ₈	18		
Selling price		380 RM per tonne					

Ethylene product:

Quantity	tonnes	10					
Analysis	%	O ₂	2.0	C ₂ H ₆	19.5	N ₂	5.0
		CO	3.0	C ₂ H ₄		33.0	
		H ₂	1.6	CH ₄		35.9	
Selling price		70 RM per tonne					

Methane product:

Quantity	tonnes	13					
Analysis	%	0.2	1.8	H ₂	4.4	C ₂ H ₄	27.8
		CO	6.0	CH ₄	53.4	N ₂	6.6
Selling price		340 RM per tonne					

Rest Gas:

Quantity	Nm ³	320,000					
Analysis	%	CO ₂	3.0	CO	13.0	N ₂	22.0
		C ₂ H ₄	3.2	H ₂	9.4		
		O ₂	1.4	CH ₄	48.0		
Density	gm./Nm ³	909					
Selling price		0.027 RM per Nm ³					

Oxygen (unpurified)

Quantity Nm³ 40,000 = 57 tonnes
Purity % O₂ 92
Selling price 0.019 RM per Nm³

Oxygen (purified)

Quantity Nm³ 1,200 = 1.7 = 1.7 tonnes
Purity % O₂ 99.2
Selling price 0.37 RM per Nm³

Power for gas compression

Coke-oven gas	93,000	KWH.
Air	40,800	"
Nitrogen	79,000	"
Mixed gas (3H ₂ + N ₂)	66,000	"
Methane for cylinders	3,400	"
Oxygen " "	310	"

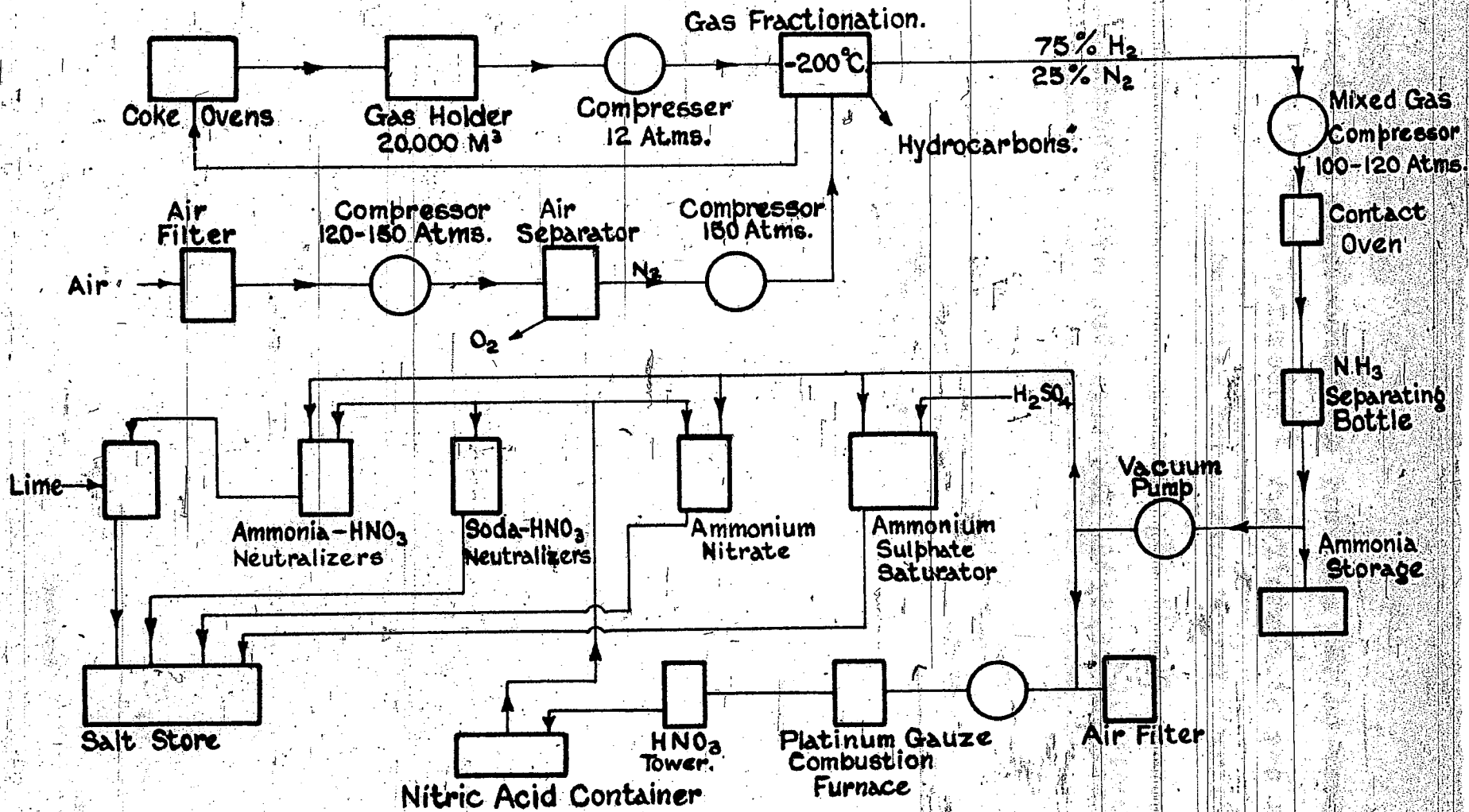
Cost of Power 0.023 RM per KWH.

Labour employed in above operations 120 men (24 hours).

Average wage 0.88 RM. per hour.

List of Documents Obtained from
Stickstoffwerk - Hibernia, Wanne-Eickel.

1. Questions on the recovery of Hydrocarbons from Coke-Oven Gas.
2. Schema des Stickstoffwerk - Hibernia.
3. Temperatur - Druck Kurven von Reingasol.
4. Fließschema für die NH_3 Synthese aus Loksofen gas + Luft.
5. Reingasol vom 18/5/36. Destillation nach Podbielniak.



**FLOW SHEET OF PROCESS-HYDROCARBON RECOVERY AND PRODUCTION OF FERTILIZERS
AT STICKSTOFFWERK - HIBERNIA.**