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The Joint Chiefs of Staff,
by Col. E. W. Gruhn.

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H. KOPPERS G.M.B.H., ESSEN

Peck, E. B.

RESTRICTED

COMBINED INTELLIGENCE OBJECTIVES
SUB - COMMITTEE

(2)

RESTRICTED

REPORT ON

H. KOPPERS G.m.b.H. ESSEN

Reported by:

Dr. E. B. Peck

on behalf of

United States Technical Industrial Intelligence Committee.

and

Dr. A. Parker

on behalf of

British Ministry of Fuel and Power

CIOS TARGET No. 30/11.11 (also 30/6.12)

Fuels and Lubricants

28 June 1945

COMBINED INTELLIGENCE OBJECTIVES SUB-COMMITTEE
G-2 Division, SHAEF (Rear) APO 413

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7 p. diagrs.

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Personnel of Team

Dr. A. R. Powell, - U.S. Petroleum Administration for War
Dr. E. B. Peck, - U.S. Petroleum Administration for War
Dr. A. Parker, - Brit. Ministry of Fuel and Power
Dr. H. Hollings, - Brit. Ministry of Fuel and Power

Target visited on

15 April 1945

H. KOPPERS, B. m. b. H., ESSEN

Object of Visit:

This company is well known as designers of coke ovens and gas equipment. The present investigation was directed to those activities that relate to synthetic oils, i.e., the low temperature carbonization of coal and the gasification of coal to make synthesis gas.

Sources of Information:

The interrogation of Dr. Hans H. Koppers, son of the founder of the company, and a preliminary examination of confiscated documents.

Information Obtained:

The Koppers process for low temperature carbonization of coal was well known before the war and there have been no new developments since the war.

The process has been developed for the partial combustion of low grade coals with oxygen to produce synthesis gas ($CO + H_2$). The importance of using brown coal fines for producing synthesis gas is shown by the value put on various grades of fuel by the Brabag Company (Braunkohle Benzin A. G.) at the Schwarzheide, synthetic oil plant:

	RM/Metric Ton
Dry fine coke (brown coal)	2.00
Dry Brown coal coke	20.00
Dry hard coke (bituminous coal)	30.00
Power per KW hr.	0.02
Oxygen Nm^3 95%	0.025

The files revealed an estimate prepared by Koppers for Brabag of which the essential features are:

(1) Brabag (letter of 17 May 1943) required a plant to produce 100,000 Nm^3/hr. of synthesis gas (CO/H_2 = 1.65/1) (8000 hr/year) from upper Silesian coal or low-temperature coke for medium pressure Fischer synthesis over an iron catalyst. The coal and coke specifications were not given except that it would be ground so that 75% would pass through a 49000 mesh sieve. The finished gas must be free of condensible hydrocarbons and the sulphur removal must present

no difficulties (such as are caused by pressure of dust or condensible tar or hydrocarbons).

Koppers submitted the following proposal:

For a coal dust of analysis H_2O 1.95%, ash 8.75%, volatiles 22.3%, residue 77.7%, and heating value 7650 WE/kg., there would be produced a gas meeting the above Brabag requirements and with composition: CO_2 - 11.0%; CO = 54.0% H_2 = 34.0%; N_2 1.0% (conc. of CO + H_2 = 88%); lower heating value of gas 2505 WE/Nm^3.

The consumption of materials per Nm^3 of synthesis gas would be:

Coal dust	Kg/Nm^3	of	syn.	gas	0.475
Oxygen	Nm^3/Nm^3	"	"	"	0.27
CO_2	Nm^3/Nm^3	"	"	"	0.066
Steam @ 2 atm.	Kg/Nm^3	"	"	"	0.19
Heating gas	WE/Nm^3	"	"	"	167.0
Steam recovered at 16 ats. and 350°C.	Kg/Nm^3	"	"	"	0.339

For the production of 100,000 Nm^3 of synthesis gas for 8000 hours per year Koppers would build six (6) units (one reserve) each costing 2.7 million R.M. or a total cost of 16.2 million R.M. It was estimated that the gas would cost 1.7 pfg. per Nm^3 (@ 5.2 R.M./$ this would be 9.27¢/MCR). The unit costs used for this estimate were as follows:

	RM
1 ton fine coal in bunker	14.00
1 Nm^3 of 95% oxygen	0.025
Labor 1 man shift (8 hrs.)	10.00
Power 1 Kwhr	0.02
Fresh water 1 M^3	0.025
Recycle cooling water 1 M^3	0.025
Treated boiler feed water 1 M^3	0.025
Heating gas 1 x 10^6 Kcal	4.75
Steam at 16 ats 1 ton	3.00
Steam at 3 ats 1 ton	1.50
Amortization and interest	12%
Maintenance and repairs	2%

A comparison of the powdered coal gasification using air instead of oxygen and producing a heating as of 1250 Kcal/Nm^3 (140 BUT/C F) is estimated for three cases for a daily production of 700,000 Nm^3 or 875,000,000 Kcal:

Capital Cost

	R.M.
A. Coal Dust or Fine Coke	6,000,000
B. Hard Coke, rotating-grate producers, 12 units 2.6 m. in diameter	2,100,000
C. Brown Coal Coke, rotating-grate producers, 12 units 2.6 m. in diameter.	2,400,000

The operating costs for each case are estimated as follows:

A. 300 t. fine coke @ R.M. 2 ($0.385/ton)	600 R.M.
1200 KWhr @ 0.02 R.M.	240
30 Man shifts @ 12 R.M.	360
Supervision 20% of labor	72
Repairs 5% of investment	860
Amortization and Interest 15%	2,570
	4,702

Cost per 1000 Kcal. 039 pfg.

ø per MMBTU* 19.0

B. Hard Coke.

184 t. coke @ 30 R.M. ($5.77/ton)	5,520
1200 KWhr @ 0.02 R.M.	240
24 shifts @ 12 R.M.	288
Supervision 20% of labor	58
Repairs 5% of investment	286
Amortization and Interest 15%	860
	7,252
Credit for 74 tons L.P. steam @ 2.50 R.M.	184
	7,068

Cost per 1000 Kcal 0.81 pfg.

ø per MMBTU* 39.3

*5.2 R.M./$.

	Capital Cost. R.M.
C. Brown Coal Coke (Grude).	
200 tons @ 20 R.M. ($3.85/ton)	4,000
1200 KWhr @ 0.02	240
Labor 30 men shifts @ 12 R.M.	360
Supervision 20% of labor	72
Repairs 5% of plant cost	330
Amorization and Interest	990
	5,992
Credit 74 tons of L.P. steam	184
	5,808
Cost per 1000 Kcal 0.66 pfg.	
ø per MMBTU* 32	

Dr. Koppers produced detailed information on two other processes: (a) conversion of coke oven gas to synthesis gas (CO + H2), and (b) low temperature carbonization of bituminous coal with gasification of the semi-coke in the form of flow sheets, copies of which are attached to this report as Fig. 1 (process a) and Fig. 2 (process b).

E. B. PECK
A. PARKER

*5.2 R.M./$.

Electricity Consumption: ca 370 Kwh
= ca 38.5 KW/1000 Nm^3 Coke-Oven Gas
Fresh Water Consumption: ca 25 m^3/hr.
(Make-up Water) = ca 2.6 m^3/1000 Nm^3
Coke-Oven Gas

Refactories:				
	Silica	1360 ≠ 80	= 1440	Tons
	Fire Clay	1180 ≠ 160	= 1440	"
	Insul. Mat.	600 ≠ 100	= 700	"
			3580	"

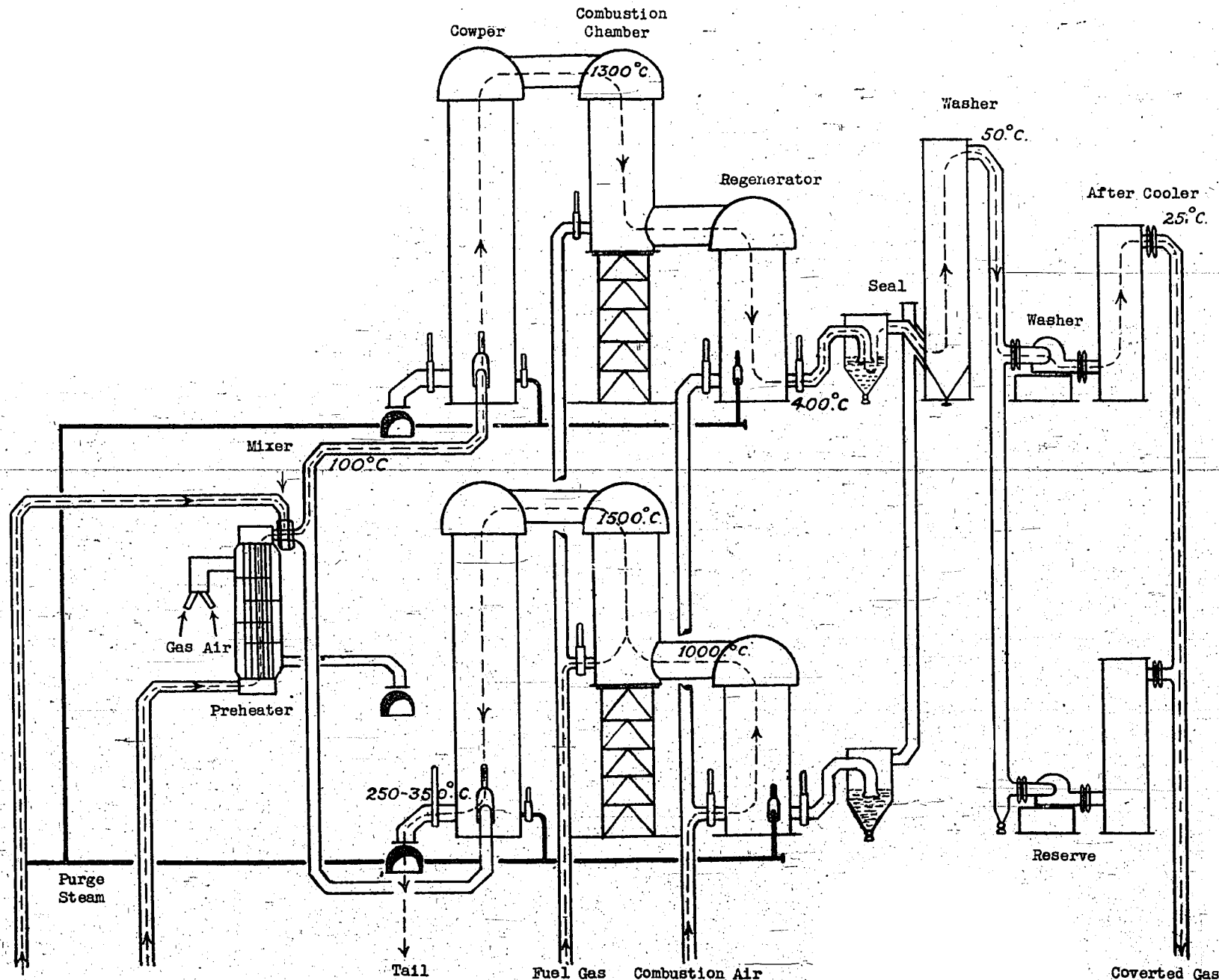


FIG. 1

CONVERSION OF COKE-OVEN GAS TO SYNTHESIS GAS

Steam
2.5 ATS.
8200 Kg/hr.
incl.
Purge Steam
(0.85 Kg/Nm^3
Coke-Oven Gas)

Coke-Oven Gas

CO_2	6.8%
Cn Hm	2.5%
O_2	0.2%
CO	11.5%
H_2	46.5%
CH_4	24.0%
N_2	8.5%

9600 Nm^3/hr.

Fuel Gas
2500 Kcal (Lower Heating Value)
Residual Synthesis Gas
Heating Gas Input:
14,700,000 Kcal
(Lower Heating Value)
/hr. - 1515 Kcal
(Lower Heating Value)
/Nm^3 Coke-Oven Gas
(Of this about 3% for Preheater)

Combustion Air
30,000 Nm^3/hr.

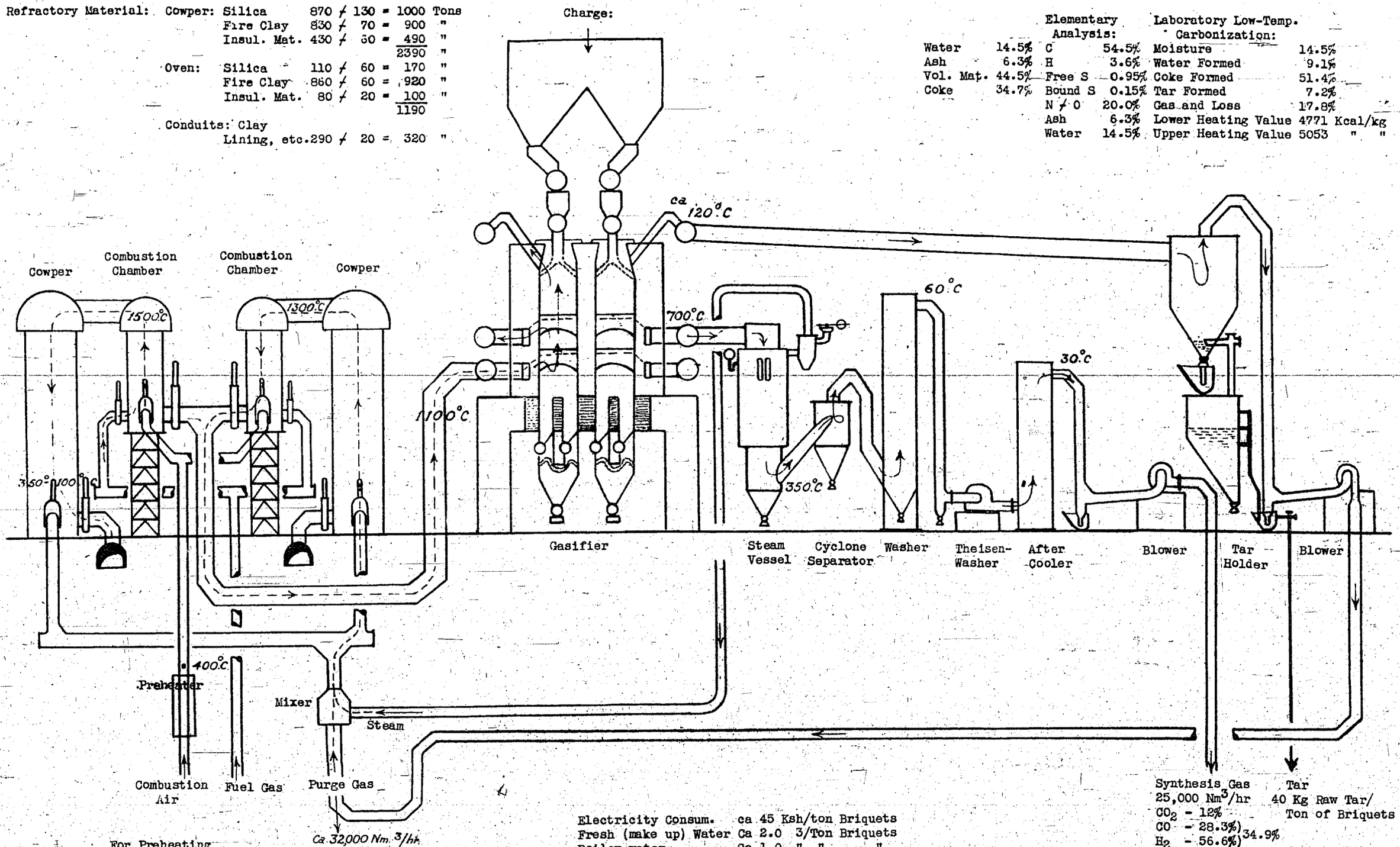
Coverted Gas
CO_2 5.1%
CO 19.7%
H_2 69.1%
88.8%; CO:H_2 - 1.5.5
Ch_4 1.0%
N_2 5.1%

17,700 Nm^3/hr.
(From 1 Nm^3 Coke-Oven Gas
1.85 Nm^3 Synthesis Gas)
Dust Content: 30 mg/Nm^3

Refractory Material:

Cowper:	Silica	870	/ 130	= 1000	Tons
	Fire Clay	830	/ 70	= 900	"
	Insul. Mat.	430	/ 60	= 490	"
				2390	"
Oven:	Silica	110	/ 60	= 170	"
	Fire Clay	860	/ 60	= 920	"
	Insul. Mat.	80	/ 20	= 100	"
				1190	
Conduits:	Clay				
	Lining, etc.	290	/ 20	= 320	"

		Elementary Analysis:		Laboratory Low-Temp. Carbonization:	
Water	14.5%	C	54.5%	Moisture	14.5%
Ash	6.3%	H	3.6%	Water Formed	9.1%
Vol. Mat.	44.5%	Free S	0.95%	Coke Formed	51.4%
Coke	34.7%	Bound S	0.15%	Tar Formed	7.2%
		N / O	20.0%	Gas and Loss	17.8%
		Ash	6.3%	Lower Heating Value	4771 Kcal/kg
		Water	14.5%	Upper Heating Value	5053 " "



For Preheating
1300 Kcal. (Lower Heating Value) per Kg. Briquets
- 1200 Kcal. (L.H.V.) per Nm^3 Synt. Gas
As Fuel Gas-Generator Gas from Res. Coke
Fuel Gas Heating Value: 1300 Kcal/Nm^3

Electricity Consum. ca 45 Ksh/ton Briquets
Fresh (make up) Water Ca 2.0 3/Ton Briquets
Boiler water Ca 1.0 " " "
Steam Requirements Produced in Plant.

FIG. 2
SYNTHESIS GAS PRODUCTION
FROM BROWN COAL BRIQUETS

Synthesis Gas 25,000 Nm^3/hr
CO_2 - 12%
CO - 28.3%
H_2 - 56.6% } 34.9%
CH_4 - 1.0%
N_2 - 2.1%
Dust Content: 20 mg/Nm^3
Synt. Gas free from Tar & Oil Vapors
" " " " Resins, etc.
Synt. Gas Yield: 1200 Nm^3/Ton Briquets

Tar
40 Kg Raw Tar/ Ton of Briquets