(F) Information Given to FIAT Investigators (1947)

Table V, page 38, was submitted by Totzek in response to repeated requests for experimental data and was stated to be based on actual operation, although run numbers and operating conditions were not specified. In addition Totzek furnished the following discussion of efficiency of conversion which he said was indicative of performance which Koppers had obtained experimentally and was willing to guarantee for any new unit.

Material Balances

As a supplemental answer to the questionnaire submitted by FIAT, Totzek furnished the following material balance which he insisted was based on experimental data (not shown) and could surely be realized in commercial operation.

Bituminous Coal Analysis Wt. %

Water	1.95
Ash	8.75
H_2	4.27
C	80.50
S (combustible)	1.80
N_2	1.19
O_2	1.46

Product Gas Analysis Vol. %

CO_2	15
CO	42
H_2	42
N_2	1
Vol. Gas Per Kg Coal	2.3 Nm^3

Carbon Balance: (Basis 1 Kg. Coal)

Introduced as coal	0.805 Kg
Withdrawn as gas	0.705 Kg
Loss	0.100 Kg

In experimental operations carbon losses of 8-14% were observed, the magnitude being largely dependent on the uniformity of fineness of the coal. For the following calculations a carbon loss of 12% was assumed.

TABLE V

DUST GASIFICATION DATA FROM TOTZEK, 1947-

		Bituminous Coal			Lignite		Lignite Coke
Coal Analysis Wt. %							
Water		1.95			13.00		5.00
Ash		8.93			5.95		21.00
Volatile		22.30			51.40		--
Gross Heating Value kcal/kg	Btu/lb.	7744 13,940			5120 9,220		6054 10,900
		Synthesis Gas			Synthesis Gas	Fuel Gas	Fuel Gas
Gas Analysis Vol. %							
CO_2		11.0	15.0	18.0	19	6.0	6.0
CO		54.0	42.0	33.0	35	24.0	26.0
H_2		34.0	42.0	48.0	45	17.0	18.0
N_2		1.0	1.0	1.0	1	52.0	50.0
Net Heating Value kcal/kg	Btu/lb.	2505 4509	2347 4225	2230 4014	2214 3985	1162 2092	1248 2246
Gas Quantity Nm^3/kg	ft.³/lb.	2.10 33.6	2.15 34.4	2.40 38.4	1.84 29.5	2.50 40.0	2.70 43.3
Oxygen Consumption Nm^3/kg	ft.³/lb.	0.57 9.1	0.62 9.9	0.53 8.5	0.38 6.1		
Fuel Gas Consumption kcal/kg	Btu/lb.	415 747	890 1602	1600 2880	579 1042		
CO_2 Consumption Nm^3/kg	ft.³/lb.	0.14					

Hydrogen Balance

Hydrogen in the gas	0.97 Nm^3	15.5 ft^3
Hydrogen from the coal	0.47 Nm^3	7.5 ft^3
Hydrogen from steam	0.50 Nm^3	8.0 ft^3

Oxygen Balance

Oxygen in the gas	0.83 Nm^3	13.3 ft^3
Oxygen from decomposed steam	0.25 Nm^3	4.0 ft^3
Extraneous oxygen required	0.58 Nm^3	9.3 ft^3

(The small quantities of oxygen, nitrogen and sulfur in the coal were neglected).

Extraneous Steam

The quantity of extraneous steam supplied is the amount required to react with the carbon plus the excess needed to attain the desired gas composition in accordance with the water gas equilibrium. Graphs furnished by Koppers for the water gas equilibrium in the presence of, and absence of, carbon are given here as Figures 15 and 16, pages 41 and 42, respectively. In practice it was found that gas composition approached the values for equilibrium in the absence of carbon and these values are used for calculations since they give some margin of safety in the steam requirements. On this basis the excess steam required to attain the desired gas composition at 1200°C. was calculated as 0.86 Nm^3 per Kg coal, making the total steam requirement 1.36 Nm^3 or 1.09 Kg per Kg coal. Deducting 0.02 Kg water in the coal the extraneous steam requirement becomes 1.07 Kg/Kg coal.

Totzek stated that experimental operation on bituminous coal gave ratios of H_2 to CO "ranging from 1.5 to 2.0 with corresponding CO_2 concentrations ranging from 18 to 8%". However the data submitted did not show that a ratio of 2:1 was ever attained directly and the reported CO_2 concentration was higher for higher ratios of H_2:CO. Reactor exit temperatures of 1200°C. were observed experimentally.

Heat Balance, basis 1 Kg raw coal (lb.)

Input

Gross heating value of coal	7700 kcal	13,860 Btu
Preheat of steam to 1200°C.	684 kcal	1,230 Btu
Total	8384 kcal	15,090 Btu

Output

	Btu		
Net heating value of product gas	9720	5400 kcal	64.5%
Carbon loss	1260	700 kcal	9.2%
Sensible heat of wet gas	2610	1450 kcal	17.2%
Radiation and Conduction losses	1380	764 kcal	9.1%
	15,090	8384 kcal	

FIGURE 15

WATER GAS EQUILIBRIUM CONSTANT Kpw
IN THE PRESENCE OF CARBON

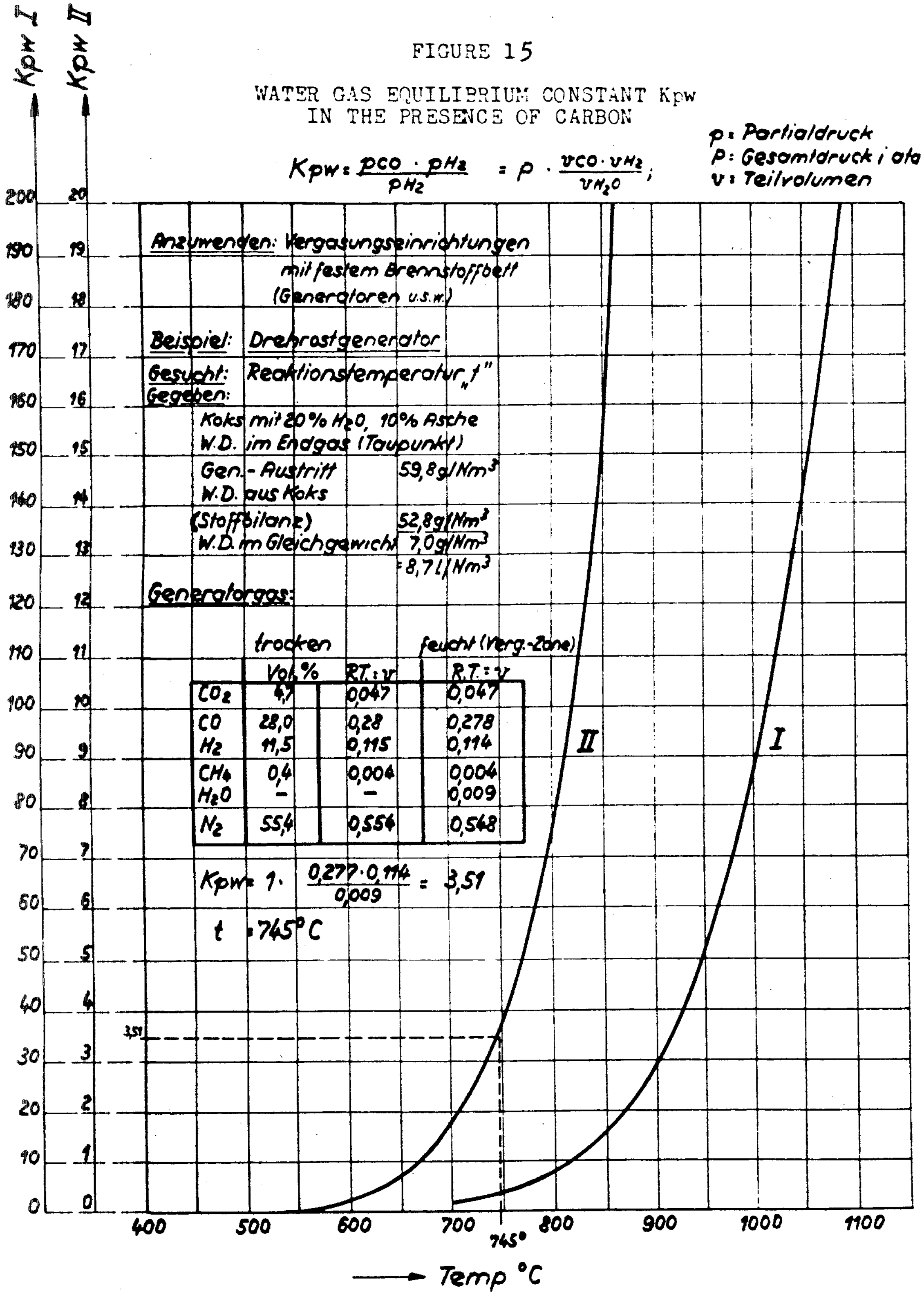
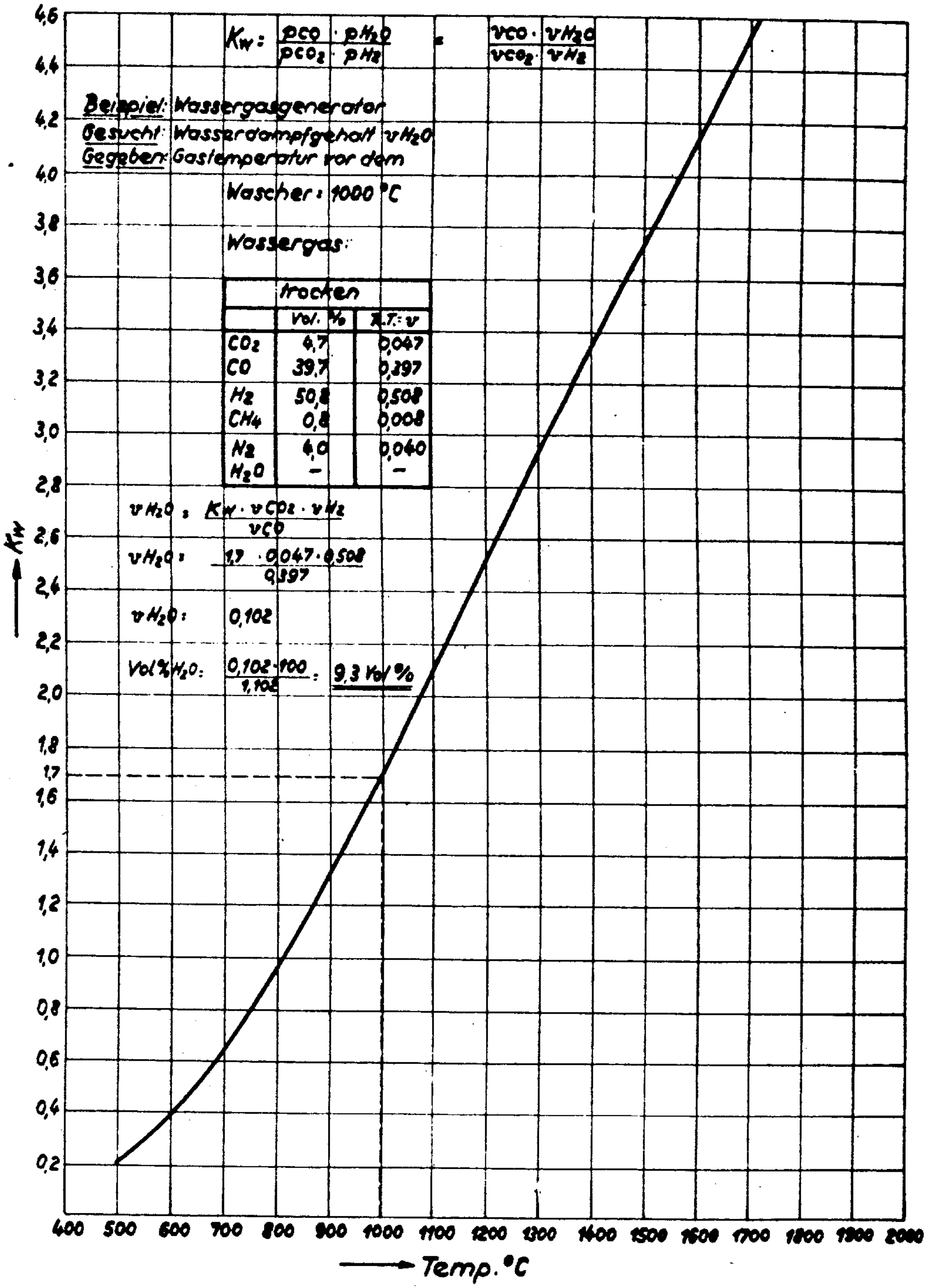


FIGURE 16

WATER GAS EQUILIBRIUM CONSTANT Kw
ONLY IN THE GAS PHASE IN THE
ABSENCE OF CARBON



APPENDIX 1

LIST OF GERMAN PERSONNEL

Dr. Hans H. Koppers, President of H. Koppers G.m.b.H.
Mr. Gapp, Director of H. Koppers G.m.b.H.
Mr. Totzek, Chief Engineer of H. Koppers G.m.b.H.
Mr. H. Kost, Former Head of Steinkohlen Bergwerk Rheinpreussen, Homberg
Dr. Strueven, Chemist, Rheinpreussen Treibstoffwerk, Moers

German Personnel not interviewed but known to have had some connection with Koppers work

Mr. Daniels, Design Engineer, Koppers, Essen
Mr. Schurhoff, Draftsman, Koppers, Essen
Mr. Hahn, Project Engineer, Koppers, Essen

APPENDIX 2

LIST OF TARGETS VISITED

H. Koppers, G.m.b H. 29 Moltke St., Essen (Main Offices)
Steinkohlen Bergwerk Rheinpreussen Shaft IV between Moers-Meerbeek and Homberg. Site of Koppers experimental unit

APPENDIX 3

BIBLIOGRAPHY

(1) FIAT, Fuels and Lubricants Unit

Questionnaire regarding powdered coal gasification, transmitted to Koppers by letter from North German Coal Control dated 12 April 1947.

(2) Koppers G.m.b.H.

Written answers to FIAT questionnaire, transmitted to North German Coal Control by letter from Totzek dated 2 May 1947.

(3) Lowry, H.H. and Rose, H.H.

Coal and Coke Research at H. Koppers G.m.b.H., Essen CIOS File No. XXXI-31 Item 30. (Makes Brief reference to powdered coal gasification system, stating that all records had been previously taken from Koppers by a U. S. Navy Officer).

(4) Newman, L.L.

Oxygen Gasification Processes in Germany A.I.M.M.E. Technical Publication 2116 Class F, Coal Technology November 1946.

(5) Newman, L.L.

Report of Subcommittee on Use of Oxygen in Gas Manufacture. 1946 Report of Gas Production Committee, American Gas Association.

(6) Peck, E. B. and Parker, A.

Report on H. Koppers G.m.b.H., Essen. CIOS Report File No. XXVIII-36, Item 30, 28 June 1945.

(7) Totzek

Arbeiten der Heinr. Koppers G.m.b.H. über restlose Vergasung. Vortag vor dem Energieausschuss 12 June 1942. (Unpublished Address).

(8) U.S. Technical Oil Mission, Microfilm Reel 43

Frames 209 to 278. Documents collected by CIOS investigators Powell, Peck, Parker and Hollings, April 1945.

APPENDIX 3 (CONT'D)

BIBLIOGRAPHY (CONT'D)

(9) U.S. Technical Oil Mission, Microfilm Reel 188

Item 34-U beginning Frame 20951. Documents collected by U.S. Navy Technical Mission in Europe, May-June, 1945.

APPENDIX 4

LIST OF MATERIAL EVACUATED

No equipment was evacuated in connection with this investigation. However prints of a number of drawings were obtained, in addition to the Koppers documents listed in Appendix 3, and the numbers and descriptions of these drawings are given below:

LIST OF KOPPERS DRAWINGS

IOS 92,915	28 July 1938 Dust Gasifier Brabag C 3892
ISO 111,860	7 October 1936 Assembly of the Cowper and Combustion Shaft Brabag V 564
IAK 112,745	Undated Plant Assembly (Brabag) Ruhland Dust Gasification e 3892
IAK 131,928	15 January 1942 300 Ton Dust Gasification Plant Brabag-Zeitz Project
IAK 132,315	17 August 1942 Gas, air, and steam lines for Heater Unit Brabag V 728
IOS 146,506	30 November 1939 Lining of the Dust Gasifier (Rheinpreussen) Dust Gasification C 3939
IOS 146,511	5 September 1940 Schematic Representation of Dust Gasification Rheinpreussen C 3939
IOS 146,520	22 April 1941 Magnesite Lining Rheinpreussen Dust Gasification C 3939
IOS 146,523	5 June 1941 Arrangement of air and gas connections to the feed spiral. Rheinpreussen C 3939

LIST OF KOPPERS DRAWINGS (CONT'D)

IOS 146,531	25 October 1941 Lining of the Dust Gasifier Head Dust inlet Rheinpreussen C 3939
IOS 146,544	15 September 1942 Section and Plot Plan Rheinpreussen C 3939a
IOS 146,551	Undated Assembly Rheinpreussen Dust Gasification C 3939
IOS 178,452	22 December 1942 Lining of the Regenerator and Conduits Rheinpreussen C 3939a
IOS 178,479	Undated (about July 1943) Schematic Representation of the Koppers Coal Dust (Gas) Generator Plant.
IOS 178,480	Undated (About July 1943) Section through the Coal Dust (Gas) Generator

APPENDIX 5

QUESTIONNAIRE ADDRESSED TO KOPPERS BY FIAT, 11 APRIL 1947

Information on the points enumerated below is desired with reference to your process for gasifying powdered coal. Please assemble all available information along these lines including supporting experimental data, drawings, calculations, etc., for discussion with FIAT representatives within about one week. This material is to be incorporated in a detailed report on your process and should be amplified in any way possible to make a complete and accurate report.

1. Record of all forms of apparatus and all methods of operation which were tried, and a discussion of the results obtained in each case. Difficulties encountered as well as success achieved are important.

2. The effect of kind of coal and fineness of grinding on its behavior in gasification unit.

3. Details of equipment for feeding powdered coal to the reactor and operating characteristics of such equipment.

4. Description and drawing of all accessories which you regard as more or less standard equipment, such as preheaters, waste heat boilers, scrubbers, etc. and their operating characteristics.

5. A discussion, theoretical and practical, of the design, construction and operation of the gasification chamber itself.

6. Recommended procedure for starting, running and shutting down such a unit.

7. Safety precautions and devices.

8. Difficulties likely to be encountered because of corrosion or erosion in any part of the system and preventive and remedial measures therefor.

9. Flexibility of the unit with respect to throughput and product gas composition.

10. Exact method of controlling the unit to make gas of any possible composition, particularly of high ratio of H_2 to CO.