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8/14/47

THE WINKLER METHOD OF GASIFICATION.

(BAMAG-MEGUIN Aktiengesellschaft)

I. Theory.

A number of finely powdered brown coal and bituminous coal, as well as the l.t.c. cokes produced from them, especially if high in ash, can be gasified only with difficulty in the usual gas producers, or even not at all. These fuels, considered as inferior in the past, are however particularly attractive for this kind of use for the manifold requirements of modern gasification, because of their low price.

Dr. Fritz Winkler of the I.G. Farbenindustrie A.G. has succeeded in a satisfactory solution of this problem by inventing the gasification process known under his name, and which permits the gasification of the above mentioned fuels with the maximum efficiency.

The particular characteristics of the Winkler process consist in blowing mixture of steam with air or oxygen into a layer of fuel on a grate in a shaft, which causes the glowing fuel through the whole thickness of the layer to become violently agitated, like a boiling solution, and kept in a state of violent motion. This results in an exceptionally intimate mixing of the fuel particles with the gasification agent, with a rapid and lasting temperature equalization between the solid and gaseous reaction participants, while the high temperature required for gasification remains very uniform.

This gasification process characteristic for the Winkler process requires a certain minimum amount of the gasification agent, but the gasification yield is extraordinarily increased by exceeding this minimum amount. This change from a minimum load can be produced in the briefest time, and is another characteristic and valuable property of the Winkler process.

The hourly gasification production by the Winkler process amounts to 1000 to 4000 m^3 per square meter of the cross section of the shaft, when using the above mentioned fuels of low value, and frequently ungasifiable by the usual methods. This so-called specific gas production ($m^3/m^2/h$) amounts at most to 800-1000 m^3 in the modern rotating grate gas producers, operating on brown coal briquettes or on coke, i.e. on chemically and physically high grade fuels. The progress achieved by the Winkler process becomes the more striking when comparing with the specific gas production obtained with lump, or at least not too finely ground raw brown coal in the former types of gas producers, where it amounted at most to 50-150 m^3.

The small size unwashed, ash-rich bituminous coal can also be gasified by this process. The ready slagging used to cause much difficulties, but has been completely overcome by modifying the gasifying conditions in comparison with those for the brown coal. In this way various domestic and

foreign grades of coal, such as the lean coal fines, fat coal fines, flame coal fines, etc., could be gasified in an experimental gasifier with a shaft cross section of 1 m^2 with a production of 2000 m^3 per hour, producing either water gas or synthetic gas.

The Winkler process has a specific advantage of permitting the production of various gases, depending on the choice of the gasifying agent and the operations (cf table 2).

Low BTU gas is produced when the gasification is done with air as the only gasifying agent.

Water gas, such as used in large amount for the preparation of hydrogen in hydrogenating plants is obtained in a continuous process by simultaneous introduction of oxygen and steam in definite proportion. The low nitrogen content is very remarkable.

Mixed gas, - hydrogen enriched with nitrogen for the synthesis of ammonia, - is obtained by blowing a properly proportioned mixture of air, steam and oxygen. The proportion of air must be measured to obtain the proper proportion of H_2 to N_2 (3:1) for the ammonia synthesis, after the conversion of the CO and the removal of CO_2.

Synthesis gas with a definite proportion of CO and H_2, required, i.e. for the synthesis of gasoline or methanol, can be obtained by corresponding changes in the methods of operation. It is possible in such cases to use different hydrocarbon-containing gases, such as coke oven gas, l.t.s.c. gas, off-gas of the hudrogenation, etc., if desired, and convert them directly without the need of any special arrangements.

II. Development of the Process.

The Winkler method was developed primarily to obtain a method to gasify efficiently small size higher ash grades of fuel. The finely ground raw gasification material is served to the gasifier has a particle size between 0 and 6 mm, and with a low moisture content, preferably not exceeding 8% (of tables 1a and 1b). When the fuel contains more water it is preferably first dried, while lump fuel or coarser grained must first be ground.

In the accompanying sketch the major parts of the Winkler producer unit are shown, omitting all the equipment needed for the preliminary or subsequent treatment.

The finely ground fuel, stored in a bin is fed by a worm drive to the bottom of the producer. The producer proper is in most cases a walled-in cylindrical shaft, the bottom connection of which is used for the introduction of the gasifying agent. The usually horizontal grate secures the same thickness of the fuel bed and the same resistance at every point. Regulation of the amount of fuel supplied by the screw conveyor will affect the height of the layer and therefore also the loss of pressure in the fuel layer. A regularly

rotating water-cooled stirrer is located close to the grate, and brings to the ash removal opening all small particles remaining on the grate, and the residue is carried out by a second screw conveyor to the de-ashing arrangement. The Winkler producer has one peculiarity in that most of the ash (80 - 90%) is carried over by the gas produced on the fuel bed and out of the producer.

A secondary supply of the gasification agent above the fuel bed is used to gasify the remaining combustible constituents in the dust particles carried over. For fuels mostly used in Germany the temperature of the fuel bed is about 800 - 950° C, and in the producer dome near the gas outlet about 950 - 1100° C. The temperature of fusion of the slag and sintering of the ashes must accordingly lie above the gas outlet temperature to avoid the formation of deposits in the gas outlet resulting from the fusion or sintering of the fly ash.

At the high temperature in the upper part of the producer there is an almost complete cracking or decomposition into carbon monoxide and hydrogen, of any tar still remaining in the fuel, as well as of the gaseous hydrocarbons, leaving but a small residual amount of methane.

The sensible heat of the gas is utilized by introducing back of the producer a waste heat boiler with a steam superheater and feed water preheater. In the design of this equipment attention must be paid to the dust carried by the gas. The steam pressure is preferably fixed at 25 - 50 atm, and the superheating at 400 - 450° C, and the energy of the high pressure steam is utilized in steam engines, before returning part of the steam to the producer. Depending on the nature on the gas produced 0.4 - 0.5 kg/m^3 steam is generated in the waste heat boiler. The preliminary de-ashing is done next, with the gas still at about 250° C. Dust collectors are provided for this purpose, operated on the principle of centrifugal separation. The coarse de-ashing may also be done by hot gas electrostatic filtration. The dry dust produced is withdrawn by screw conveyors, and if necessary burned in suitable firing boxes.

The gas passes after the coarse de-ashing through a washer where an additional amount of dust is separated out by continuous changes in the direction of the flow and a continuous flow of water. The amount of dust is further reduced in a water sprayed cooler, and the temperature of the gas lowered to the outside temperature.

The final elimination of dust required for most processes is done in centrifugal washers for the cold gas or by electrostatic precipitation.

The dust laden water from the preliminary cooler, final cooler and centrifugal washer can be readily clarified in the usual ways.

Measurements of temperature and pressure, the quantitative estimation of the fual consumption, gasifying agent, cooling water and of the gas produced is done at the different strategic points. The supplying of fuel, the ash removal and dust removal are done automatically, and the labor is limited to watching the measuring instruments and attention to the mechanically operated equipment.

The large producers are started with a small preheater generator.

III. Technical Data.

Some operating data are here presented to illustrate the manifold possibilities of the Winkler producer already mentioned above. These were obtained in the gasification of Mid-German brown coal (TBK) and the l.t.c. coke from brown coal (BSK).

Table 1.
Fuel Gasified:

a) Analysis of fuel

Fuel	Moisture	Ash	C	H	O	N	lower heating value
TBK	8.0%	12.7%	56.3%	4.3%	15.0%	0.7%	5270 kcal/kg
BSK	6.0	20.6	66.5	2.5	3.8	0	5700

b) Screen analysis (particle size in mm)

Fuel	0-0.2	0.2-0.5	0.5-1.0	1.0-2.0	2.0-3.0	3.0-6.0
TBK	20%	15%	17%	16%	12%	17%
BSK	20	16	20	26	8	10

Table 2.
Properties of gas.

Fuel	Nature of gas	CO_2	CO	H_2	CH_4	N_2	Lower heating value
TBK	City gas (Schwachgas)	7.7%	22.5%	12.6%	0.7%	55.7%	1030 kcal/mm³
	Mixed Gas	15.1	32.9	29.7	1.3	19.8	1800 " "
	Water gas	17.5	41.8	37.2	0.9	1.0	2210 " "
BSK	City gas	4.3	32.7	7.6	0.5	54.6	1135 " "
	Mixed gas	13.0	38.0	26.5	0.6	21.3	1760 " "
	Water gas	16.5	42.6	39.0	0.7	0.7	2200 " "

Table 3.
Consumption Figures.
(approximate)

Fuel	Nature of gas	Consumption per nm^3 of the gas produced			
		Fuel	Air	Oxygen 98% pure	Steam, 1-2 atm.
		kg/nm^3	nm^3/nm^3	nm^3/nm^3	kg/nm^3
TBK	City gas	0.36	0.72	-	-
	Mixed gas	0.55	0.23	0.17	0.22
	Water gas	0.68	-	0.27	0.33
BSK	City gas	0.31	0.72	-	-
	Mixed gas	0.47	0.23	0.17	0.24
	Water gas	0.56	-	0.27	0.36

Some fluctuations for these consumption figures for fuel, air, steam and oxygen result from:

a) the nature of fuel.

b) when the production load of the producer varies within wide limits.

c) when there is a non-uniformity in the moisture content or the particle size of the fuel. There is a maximum efficiency for every fuel at some load on the producer; the efficiency is less at a greater or smaller load.

The Winkler producers are constructed in units of 3000 to 100,000 m^3/h capacity. The largest producers have been already in operation for many years.

The construction rights for the Winkler producer installations have been vested in the BAMAG-MEGUIN A. G., Berlin.

A-Fuel supply
B-Fuel bin
C-Feed worm drive
D-Producer
E-Gasification agent
F-Outlet worm drive
G-Producer off-gas burner
H-Raw gas pipe line
J-Waste heat boiler
K-Coarse dust removal
L-Washer
M-Sprinkling cooler
N-Final Dust removal
O-Pure gas pipe line

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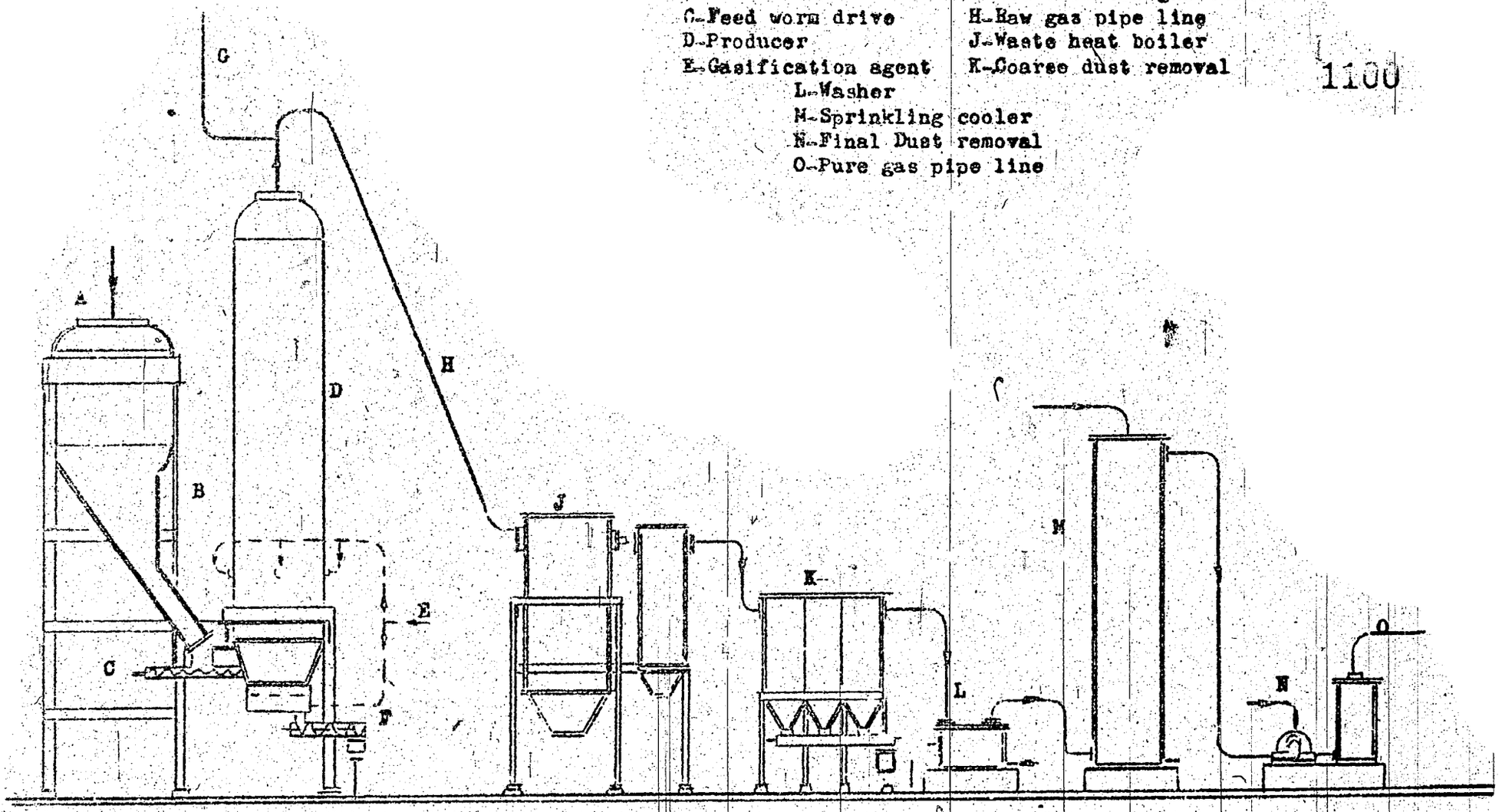

GENERAL VIEW OF THE WINKLER GAS PRODUCER.

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