

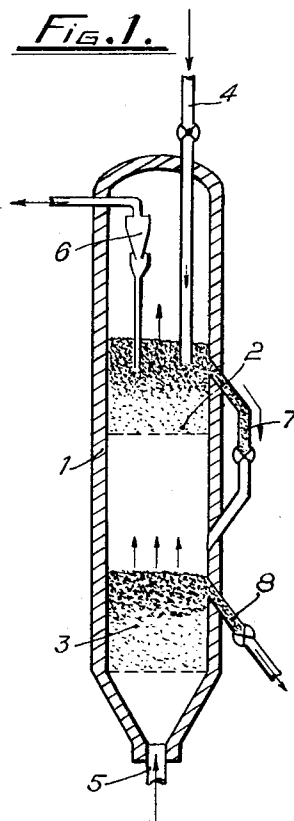
July 10, 1962

Filed Oct. 2, 1958

P. FOCH
PROCESS OF LOW AND HIGH TEMPERATURE
FLUIDIZED CARBONIZATION OF COAL

3,043,752

2 Sheets-Sheet 1



INVENTOR
PIERRE FOCH
KARL W. FLOCKS
ATTORNEY

July 10, 1962

P. FOCH
PROCESS OF LOW AND HIGH TEMPERATURE
FLUIDIZED CARBONIZATION OF COAL

3,043,752

Filed Oct. 2, 1958

2 Sheets-Sheet 2

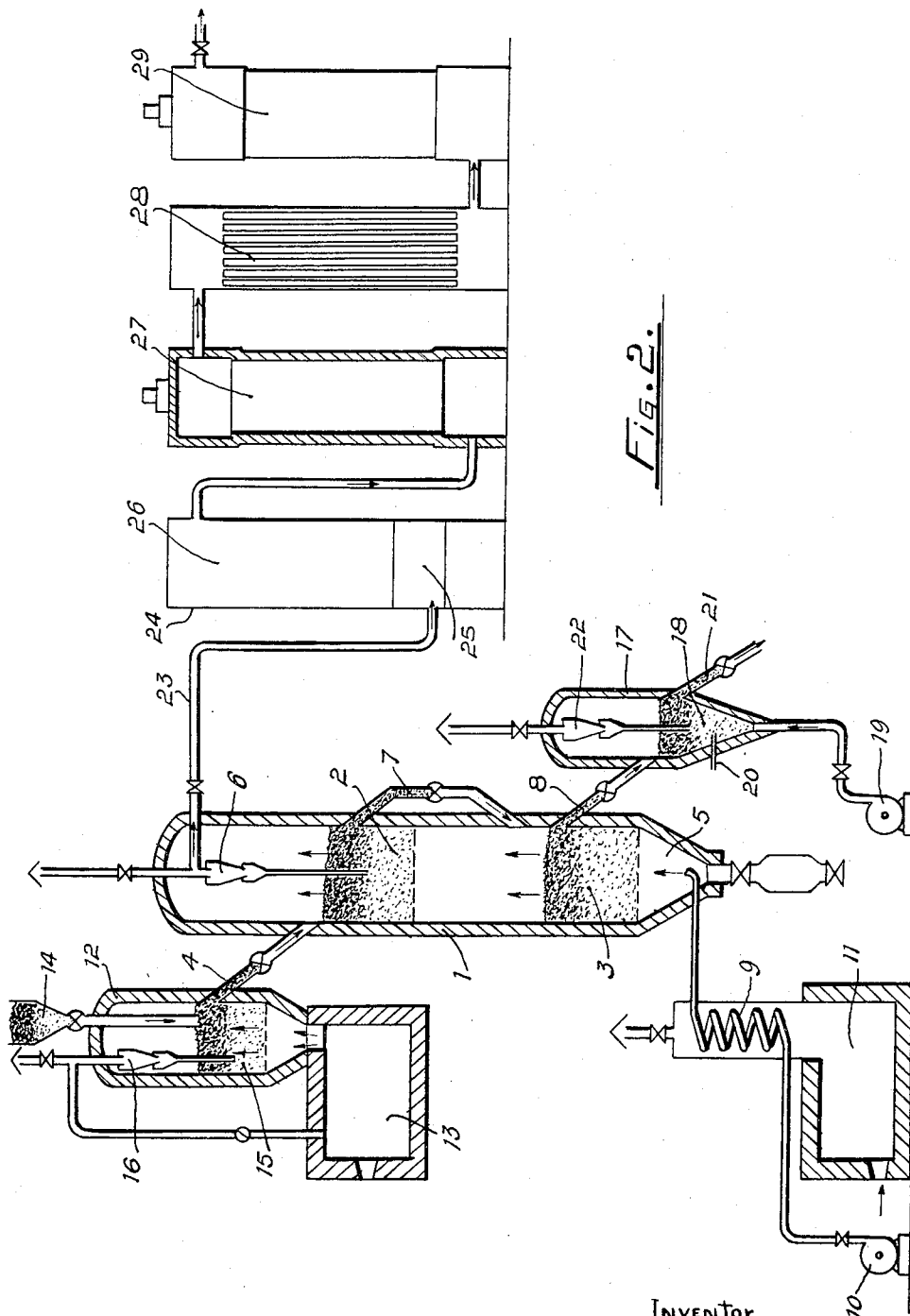


Fig. 2.

By

INVENTOR
PIERRE FOCH
KARL W. FLOCKS
ATTORNEY

1

3,043,752

PROCESS OF LOW AND HIGH TEMPERATURE FLUIDIZED CARBONIZATION OF COAL

Pierre Foch, Forbach, Moselle, France, assignor to Charbonnages de France, Paris, France, a public institution of France

Filed Oct. 2, 1958, Ser. No. 764,898

Claims priority, application France Oct. 30, 1957

1 Claim. (Cl. 202-9)

Numerous methods are known for the carbonisation of coal (mineral coal or lignite) enabling a coke or a semi-coke to be rapidly obtained by fluidisation.

In these methods, the fluidising gas is oxidising or neutral, and its nature defines the various types of carbonisation. Often, the coal is preheated to a lower temperature than that of the first stage of the pyrolysis, i.e. substantially below 400° C.

The necessary heat to maintain the carbonisation reaction is provided either by a partial combustion of the mass (when the fluidising gas is oxidising), or by the sensible heat of the fluidising gas (when the fluidising gas is neutral, such as hot fumes or overheated steam), or by wall or heating tube radiation.

In all the aforesaid methods, coke or semi-coke, a combustible gas (diluted to a greater or lesser degree with nitrogen and carbon dioxide), coal-tar and water are obtained with varying outputs and qualities. It is well known that a low-temperature carbonisation (i.e. between 450° and 600° C.) produces on the one hand a semi-coke having a fairly high content of light and very reactive volatile materials, and on the other hand a gas containing a high proportion of tar with a high content of products having a high molecular weight.

Previous attempts to carry out such a carbonisation in several stages have not been successful because of the considerable operational difficulties encountered, since tars produced by the product-distillation effected at the lower stages are condensed on the products in the upper stages and cause the caking thereof, thus preventing fluidisation and therefore rapidly interfering with the efficient running of the operation. It is also well known that a fluidised carbonisation at a higher temperature, in the range of 800°-900° C., yields much less tar (with a more extensive cracking thereof), while the coke obtained has a low reactivity and a low content of volatile materials (about 2-3%). However, there is at present no known method of obtaining at the same time a good amount of slightly cracked tar and a coke of low reactivity with a very low content of volatile materials.

The present invention has for its object a method for achieving this result, as well as a reactor for the carbonisation of coal by the fluidisation technique enabling this method to be carried out.

The method according to the present invention essentially comprises the carbonisation at high temperature by the fluidisation technique of the semi-coke obtained by carbonisation at low temperature by the fluidisation technique of crude coal wherein the fluidising agent for the said low-temperature carbonisation consists of the gases issuing from the high-temperature carbonisation.

The apparatus for the carrying out of the aforesaid method consists of a two-stage reactor, comprising a low temperature carbonisation stage, making use of the fluidisation technique of carbonizing crude finely divided coal by means of a fluidising agent supplied through a suitable grid, and comprising a high temperature carbonisation stage making use of the fluidisation technique for treating the semi-coke produced in the former stage, suitable means being provided for making use of

2

the gases issuing from the second stage as the fluidising agent for the first stage.

It can be seen that according to the method of the invention, there is introduced into the system on the one hand, crude finely divided coal (generally preheated to a temperature below 300-400° C. according to the kind of coal), and on the other hand, a single fluidising agent; and that there are collected, on the one hand, a high-temperature coke from the second processing stage, and on the other hand, gases containing the low-temperature distillation products from the first stage.

These gases which contain a large quantity of tar with a high content of products of high molecular weight, are protected against any severe action, since they are taken directly from the zone favourable to the plentiful formation of tar and are evacuated with a view to being condensed before the occurrence of any objectionable thermal cracking action. Moreover, they cannot have any caking action with the products from the other stage.

The method offers several advantages. After tar removal and debenzolization, the gas produced has a high calorific power, which is much higher than that of the gases obtained by one-stage carbonisation methods using the fluidisation technique. The sensible heat of the gas is recuperated up to pre-carbonisation temperature, thus improving the thermal output of the installation.

Other features and advantages of the present invention will become clear on reading the following description with reference to the accompanying drawings, showing diagrammatically and merely by way of example, one possible embodiment of the method according to the invention, in the case of carbonisation by partial combustion; but it is to be understood that the method can also be used in the case of carbonisation by the sensible heat of the fluidising agent and in the case of carbonisation by means of heating walls or tubes.

FIGURE 1 of the accompanying drawings shows one embodiment of an apparatus suitable for practising the method of the invention; and

FIGURE 2 shows an installation for the production of tar and coke, by the use of the method of the invention.

In order to provide a better understanding of the method of the invention, it will be described more particularly in connection with the carbonisation obtained by internal heating means, according to the embodiments shown in FIGURE 1.

FIG. 1 is illustrative of the principle of the invention and includes a two-stage reactor 1, the precarbonization stage 2, the carbonization stage proper 3, the coal inlet 4, the fluidizing gas inlet 5, the dust-removing cycloner 6 for the recuperation of gases, the tubular conduit 7 for the outflow to stage 3 of the semi-coke obtained at stage 2, and the conduit 8 for the overflow and discharge of the fluidized coke formed at stage 3.

More specifically, the carbonisation reactor 1 is a two-stage apparatus wherein the gases and the solids are flowing in counter-current from one stage to the other. The coal is fed at 4 at a temperature t_1 which is normally within the range of from 200° C. to 320° C., to the pre-carbonisation stage 2, where it is fluidised by the gases heated to a temperature of about 800° C. and issuing from the lower stage 3. A portion of the sensible heat of these gases is thus recuperated, with the result that a low-temperature pre-carbonisation of the coal is effected (usually between 400° C. and 550° C.) which converts it into a semi-coke.

From this stage 2, the semi-coke passes through the conduit 7 to the lower fluidising stage 3, which is the

3

carbonisation stage proper, where it is heated to a temperature which is normally between 750° C. and 850° C. and converted by internal heating into a substantially degasified coke, which overflows through the overflow conduit 8, at the outlet of which it can be collected.

The gas containing oxygen required for the internal heating can be cold or hot; it is often desirable to use air preheated to a temperature t_2 which is normally between 400° C. and 600° C., and which is introduced at 5.

Usually, no tar or substantially no tar is formed during the carbonisation at this lower stage 3. The gases leaving that stage at a temperature of about 800° C. can provide, at least for the major part, the heat required to bring the coal at stage 2 from its temperature t_1 at which it is fed at 4 to the precarbonisation temperature, by yielding a portion of their sensible heat.

On the other hand, a large amount of low-temperature tar is produced in the precarbonisation stage 2, this tar being entrained by the gases leaving the apparatus after removal of the dust therein in a known manner by a cyclone separator 6.

Thus is achieved the double aim of producing a large quantity of tar and a substantially degasified coke.

The necessary control means, which are known in the art, will now be disclosed. Generally, the temperature of both stages 2 and 3 are determined by various considerations, such as the quality of the products to be obtained, economy etc. Now it is obvious that the temperature of the precarbonisation stage 2 depends on the temperature of the carbonisation stage 3; this means that once the latter temperature has been selected, the precarbonisation temperature could not be selected arbitrarily if no control means were available.

These control means are disclosed hereunder, it being understood that they can be used singly or in combination in the same apparatus, viz:

The temperature t_1 for heating the coal;

The temperature t_2 of the fluidising gas and if needs be the composition thereof;

The addition of air, inert gas or water at one or several selected points in the gas circuit, downstream of the high-temperature fluidised bed, e.g. in the fluidised precarbonisation bed, or between both fluidised beds;

An indirect cooling or heating in one or several selected areas of the installation.

In addition to what is set forth in the objects and advantages outlined above, and those advantages that will be obvious from the comparison of the method of this invention with the one-stage carbonization methods, it is to be noted that the calorific power of the gas produced is increased and that the recuperation of the sensible heat of the gas is ensured up to the precarbonisation temperature, thus improving the thermal efficiency of the installation.

In FIGURE 1 describing this method, the stages 2 and 3 are superposed but it is obvious that the method can be carried out in two separate reactors, the relative positions of which can be chosen arbitrarily, so long as the principle described above, for obtaining at the same time a high production of tar and a substantially degasified coke, is respected.

Moreover, it is important to point out that the above description has been made in the case of carbonisation with internal heating means, but that it can be equally well applied to the carbonisation by a hot fluid or to the carbonisation by external heating means, or to a combination of these two methods, since the use of one or several of the above outlined control means will always enable a wide range of temperatures of both carbonisation stages to be selected.

There will now be described, also by way of explanation without any intent of limiting the invention, an installation for the production of tar and of coke making

4

use of the method of the invention, and with particular reference to FIGURE 2 of the drawing.

The installation shown is of a conventional type, but it differs from the known installations in that it comprises a carbonisation reactor or fluidiser of the type previously described in connection with FIGURE 1, i.e. wherein the sensible heat of the gases issuing from the carbonisation stage 2 at a temperature of 800° C. is directly recuperated, these gases being used for the precarbonisation of the coal which has been previously preheated at about 300° C., in an independent apparatus to be described later, said coal being converted into a semi-coke at about 500° C.

For the purpose of simplification, like elements are indicated by the same numerals as in FIGURE 1.

The preheating of the air introduced at 5 into the reactor is provided for by an air-heating apparatus of conventional design 9, supplied from a compressor 10 and heated by gas in a hearth 11.

The preheating of the coal introduced through the inlet 4 into the reactor is ensured by fluidisation in a separate fluidiser 12, comprising a pressurised hearth 13 producing hot neutral fumes.

The damp coal consisting of washed and uncrushed small coal is continuously supplied through a feed-hopper 14 into a bed 15, where it is fluidised by hot fumes issuing from the hearth 13. The hot coal overflows into the conduit 4, whence it is brought to the precarbonization stage 2 of the reactor 1. The hot fumes issuing from the fluidiser 12 are rendered dust-free by a cyclone separator 16 before being discharged into the atmosphere.

The coke produced at the carbonisation stage proper 3 overflows into the conduit 8 which conveys it into a cooler 17, which is also operated by fluidisation. The hot coke from the reactor is introduced into a bed 18 fluidised by any suitable cold gas, for example by air or fumes, which is fed to the base of the fluidiser by a compressor 19. The major part of the cooling is provided for by an injection of water 20 into the fluidised bed 18. The evaporation of the water is instantaneous and lowers the bed temperature to about 70° C. The cooled and absolutely dry coke overflows into a conduit 21 and is conveyed to storage or loaded on wagons. The fumes issuing from the fluidiser 17 are rendered dust free by means of a cyclone 22 before being discharged into the atmosphere.

The gases leaving the precarbonization stage 2 at about 500° C. are first rendered dust-free by the cyclone 6 as has been stated before, then they are freed from the tars contained therein. For this purpose they are conveyed by a conduit 23 to a condensation zone, comprising several series-mounted apparatus, including:

(i) An oil sprinkled column generally indicated by 24, which provides, at a first stage 25, for the recuperation of the pitch-tar and the cooling of the gases down to about 250° C.-300° C., then, at a second stage 26, for the recuperation of one part of the oil;

(ii) An electro-filter 27 which frees the gases from their medium oil, without this oil being mixed with water, the gases being brought down to a temperature of about 100° C.

(iii) An indirect condenser 28 where the gases are cooled to their temperature of use.

In order to obtain a perfectly cool, dry and oil-free gas, it may be advantageous to pass the gases through a second electro-filter 29.

It is to be understood that this invention has been described and shown by way of explanation without limitation of the same, and that numerous alterations of detail can be made therein without falling outside the scope of the present invention.

I claim:

A method for the carbonization of coal in a reactor

5

having a low temperature carbonization stage and a carbonization stage separated by a grid for obtaining simultaneously a gas containing a large amount of tar with a high content of high molecular weight products and a highly degasified coke, comprising introducing finely divided crude coal preheated to a temperature below 400° C. into the low temperature carbonization stage of the reactor, maintaining a fluidized mass in said stage, carbonizing said fluidized preheated mass of crude coal at a low temperature in the range of between 450° C. and 600° C. to form semi-coke and to distill gas containing a large amount of tar rich in high molecular weight products; transferring the fluidized mass of semi-coke obtained by said low temperature carbonization directly by overflow and gravity into the carbonization stage of the reactor; maintaining a fluidized mass in said carbonization stage, carbonizing at the carbonization stage of the reactor said fluidized mass of semi-coke coming from the

6

low temperature carbonization stage at a high temperature of over 700° C. to obtain a substantially degasified coke; and using the gases issuing from said high temperature carbonization directly through the grid separating both stages of the reactor, both as a fluidizing and low temperature carbonizing agent for the crude coal and as an entraining agent of the tar-rich gases distilled during said low temperature carbonization.

References Cited in the file of this patent

UNITED STATES PATENTS

2,131,702	Berry	Sept. 27, 1938
2,582,712	Howard	Jan. 15, 1952
2,618,589	Nicholson et al.	Nov. 18, 1952
2,626,234	Barr et al.	Jan. 20, 1953
2,710,828	Scott	June 14, 1955
2,807,571	Murphy et al.	Sept. 24, 1957
2,955,077	Welinsky	Oct. 4, 1960