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PROCESS OF PRODUCING FUEL GAS

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This invention relates to improvements in the invention described and claimed in the Patent No. 1,687,118 which describes a process for the production of fuel gases from small-sized solid fuel, in which the gasifying agent, such as air, steam, or the like, is blown into the gas producer in such a way as to set the small fuel moving or eddying up and down throughout the full depth of the charge in such a manner that the fuel presents the appearance of a boiling liquid.

We have now found that the said process may be carried out very advantageously while introducing the gasifying agent into the charge of coal from above as a high velocity blast preferably assisted by a suitable shape of the producer. If cylindrical producers are made use of, the gases may be admitted tangentially from above into the charge of coal, and if admitted with sufficient velocity, will set the entire charge in motion so that it becomes uniformly incandescent and furnishes a good producer gas. Water gas also may be made in this manner after the charge of coal has become glowing.

Part of the gasifying agent may also be simultaneously introduced from below the grate. In this case a small area of the grate on which the clinkers can settle is sufficient. This last-named method of operation presents the great advantage, especially when making water gas, that the charge of coal can be raised to incandescence by blasting in a much shorter time than when the gasifying agent is introduced from below the grate alone.

The present method of operation can be used, especially when dealing with a fuel bed 2 metres or more in depth, to prevent the troublesome vibration and bumping which take place in the charge when the gasifying agent is introduced exclusively from below and which are transmitted to the producer and set up continuous vibration therein. This phenomenon can be greatly diminished or entirely prevented by admitting additional air, steam or other gases, such as producer gas, and the like, directly into the mass of coal itself from all round the sides to break the current of the blast. These gases loosen the upper portion of the charge of coal and thus produce a more uniform movement therein. In the case of a cylindrical producer, these gases breaking the current of the blast are preferably introduced tangentially, thereby imparting a uniform rotary motion to the charge.

If a high-velocity blast be employed whether introducing from below or above or both below and above the grate, small fuel particles will be carried off as well as ash. The fine granular particles of fuel are deposited in a separating chamber and can be returned therefrom to the producer in a simple manner allowing them to slide back into the layer of fuel in the producer in a suitable way as for example automatically by gravitation. The fuel dust is carried off in the gas together with the ashes and when separated therefrom by washing or electrical precipitation, is lost to the gasification process.

We have found that the above mentioned defects may be remedied in the following manner. Air, preferably highly preheated, is introduced into the hot generated fuel gas, either into the upper part of the producer, that is to say, above the charge of coal in motion, or else the air is supplied to the producer gas after the latter has passed through the device for separating the fine granular particles. If the air is supplied only in such an amount that the combustion of the particles of fuel carried away is imperfect, that is to say, that small quantities of coal dust are still present in the resulting gas, this amount does not increase the proportion of carbon dioxide in the gas, the coal dust being consumed with formation of carbon monoxide. The supplementary air may be very strongly heated, which cannot be done, on account of the grate which otherwise would be damaged, with the air introduced into the bottom of the producer. The air may be replaced by oxygen, air enriched in oxygen, and the like.

The introduction of air into the upper part of the producer has the further advantage that the charge of coal can be very quickly raised to a high temperature by a powerful 100
supply of air, a condition which is highly advantageous in making water gas.

A particularly advantageous method may also be mentioned in connection with charging the fuel into the producer. It has hitherto been customary to charge the producer from the top by means of charging hoppers closed by a conical member. This method of charging, however, has the defect that, when small sized fuel containing fuel dust is used, the gas coming from the producer carries off the smallest particles from the fuel descending from the hopper. This drawback may be overcome by charging the fuel from the side, by means of one or more conveyor devices such as worms, directly into the eddying coal in the producer, and preferably directly above the grate. The fuel may also be introduced from below upwards in the same manner, all that is needed being to provide a gap in the grate and fit it with a suitable charging device.

The said method of charging the fuel can be carried on continuously with a very small expenditure of work, even when the depth of charge on the grate is 2 metres, or more. This result is attributable to the circumstance that the coal is kept in motion by the gases, it being impossible if the coal be stagnant to introduce the fuel from the side, for example, by a worm conveyor, with even the greatest expenditure of energy. When employing this method of charging, the finest particles are immediately consumed and therefore utilized. If, in steam blasting to generate water gas, fresh and especially bituminous fuel be introduced in the said manner laterally or from below the grade, into the glowing coal, permeated by the steam, it is found that water gas of high calorific value is obtained with large yields even at low temperatures. The fuel used may consist of brown coal, which should not be too damp, or also ordinary coal, pressed peat, sawdust and the like. The fuel should contain as high a percentage as possible of volatile organic substances, such as bitumen. The fresh material entering the agitated glowing coal mixes therewith immediately and furnishes tar vapors, accompanied in some cases by water vapor, which are constrained to pass through the bed of glowing coal. In so doing, the tar vapors are decomposed with a formation of ethylene, propylene, butylene and methane, or the last-named alone when the temperature is very high. In order to obtain an increased yield and a water gas of higher calorific value, liquid fuels such as tar, oils, mineral oil residues, molten asphalt and the like may be introduced besides.

In order to convert damp fuels into the dry state, the fuel to be dried may be introduced into the hot gases issuing from the producer, causing the fuel to be carried along by the current of gas into a separator and thereby dried. The dried fuel may then be passed direct from the separator, into the bed of fuel in the producer, by gravitation through a pipe which may be fitted with a worm conveyor for feeding the fuel from the pipe into the producer.

The following examples will further illustrate how the said invention may be carried into practical effect, but the invention is not limited thereto.

**Example 1**

About 4500 cubic metres of air per hour are admitted under the grate of a gas producer having a grate area of 4 square metres and containing a charge of coal about 120 centimeters in depth. Brown-coal with about 10 per cent of moisture is forced in, by a worm, just above the grate. Beyond the separator for the fine-granular coal carried away by the gas, where the temperature is about 900°C, a further 600 cubic metres of air at about that temperature are blown into the producer gas per hour. Experience has shown that the resulting gas consists of 58.6 per cent of nitrogen, 26.0 per cent of carbon monoxide, 10.2 per cent of hydrogen, 4.4 per cent of carbon dioxide and 0.8 per cent of methane, and still contains about 10 grams of coal dust per cubic metre.

**Example 2**

The drawing shows in vertical section a gas producer of rectangular cross section, with an area of 8 square metres. It is to be understood that the gas inlets and outlets are valve controlled although the valves are not shown. The bottom of the producer A is semi-cylindrical, and the clinker doors B of which only one is shown are situated in said semi-cylindrical bottom. In starting the producer, about 2 metric tons of glowing brown coal coke are introduced by means of a worm C, and fill the producer up to the marked level. About 9000 cubic metres of air per hour are blown in through nozzles D below and nozzles D' above the surface of the charge of fuel which is strongly agitated thereby. The temperature in the producer soon rises to 1000°C, whereupon about 3.5 metric tons per hour of friable brown coal, with about 10 per cent of moisture, are fed continuously into the producer by a worm E. A producer gas is obtained containing 7 per cent of carbon dioxide, 36 per cent of carbon monoxide, 8 per cent of hydrogen, 1.5 per cent of methane and 57.5 per cent of nitrogen, which passes off through a pipe F and separator G, carrying with it the greater part of the very fine ash from the brown-coal and is withdrawn by pipe K. The coal granules and coarser particles of ash carried off by the gas are deposited in the separator, and can be returned to the producer through a
When the producer has to be cleared of clinkers, the glowing coal in the separator is allowed to accumulate in the separator G to the extent of about 2 metric tons, and the coal in the producer A is gasified completely without being replenished, steam and air being admitted simultaneously through the nozzles D and nozzles D' in order to prevent the charge in the producer A from becoming too hot and the clinkers from caking together to an undesirable degree. When the coal in the said producer A has been completely gasified the clinker doors B of which only one is shown are opened, and the clinkers, which are loose, and porous, are drawn out. After closing the doors B, the glowing coal of a temperature of about 1000° C. in the separator G is blown into the producer A by the steam nozzle H, whereupon the work in the producer can be resumed at once. Air and steam alternatively are then blown in through the nozzles D and nozzles D' and after each blowing period the coal carried away into the separator during that period is returned to the producer.

The water gas issues from the producer through a pipe J.

**Example 3**

A layer of glowing brown coal coke, at a temperature of 700° C., and about 150 centimetres in depth, is introduced into a gas producer, with a shaft area of about 4 square metres, for making water gas according to the process of the above mentioned U. S. Patent No. 1,687,118. The charge is blasted with air to a temperature of about 1100° C. during which operation the depth of the charge falls to about 110 centimetres. Then, for about 5 minutes, 400 kilograms of steam, or thereabouts, are passed into the heated fuel instead of air, and about 900 kilograms of brown coal, containing about 10 per cent of moisture and about 10 per cent of tar, are introduced. During this period 550 cubic metres of water gas are formed, and the depth of the charge increases to about 130 centimetres. If no brown coal is introduced, the output of water gas is only about 400 cubic metres. The gas contains 0.3 per cent of carbon dioxide, 34.9 per cent of carbon monoxide, 42.6 per cent of hydrogen, 2.0 per cent of methane and 14.2 per cent of nitrogen at the outset, changing gradually, when the temperature in the producer falls to about 800° C., to 23.4 per cent of carbon dioxide, 32.2 per cent of heavy hydrocarbons, 21.9 per cent of carbon monoxide, 32.6 per cent of hydrogen, 5.6 per cent of methane and 8.2 per cent of nitrogen. In operating without the addition of brown coal, and with a temperature of 800° C., the resulting water gas contains 28 per cent of carbon dioxide, 4 per cent of carbon monoxide, 61 per cent of hydrogen, 1 per cent of methane and 6 per cent of nitrogen.

**What we claim is:**

1. The process of manufacturing fuel gas in a generator having a bed of small sized, incandescent solid carbonaceous fuel, which comprises blowing a gasifying medium through said material with sufficient speed to establish a boiling action of said material and simultaneously admitting a gasifying medium just above said fuel bed to assist said boiling action, thereby causing gasification of said material by reaction between said incandescent fuel and gasifying medium.

2. A process as defined in claim 1, including the additional steps of separating small particles of fuel entrained in the generated gas and returning them to the bed of fuel.

3. A process as defined in claim 1, wherein said gasifying medium is air and said carbonaceous fuel is brown coal coke.

In testimony whereof we have hereunto set our hands.

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