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(54) Process and apparatus for the preparation of synthesis gas.

(57) A process for the preparation of synthesis gas by partial combustion of finely divided solid carbon-containing fuel with an oxygen-containing gas in a reactor. The liquid slag formed during the partial combustion process falls into a water bath or slag quench vessel where it solidifies and from there falls by gravity into a lockhopper from which the solidified slag is batchwise sluiced out of the gasification system. A gas bubble or gascap is created and maintained in the lockhopper, the pressure of the gas bubble being lower than the pressure in the slag quench vessel. Thus an initial downwards flow of water and slag is created during opening of the valves between the lockhopper and the slag quench vessel.

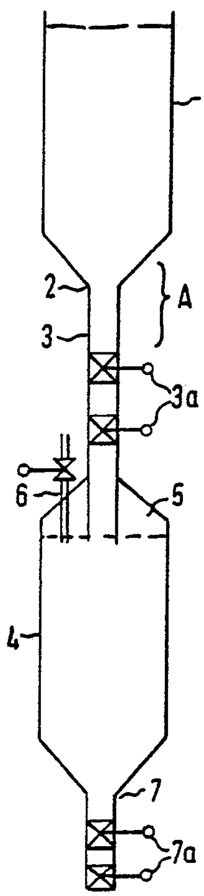

FIG.1

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PROCESS AND APPARATUS FOR THE PREPARATION OF SYNTHESIS GAS

The invention relates to a process for the preparation of synthesis gas by the partial combustion of a finely divided solid carbon-containing fuel with an oxygen-containing gas in a reactor wherein liquid slag formed during the partial combustion process is removed through an outlet in the bottom of the reactor and passed by gravity through a slag discharge means into a water bath or slag quenching vessel where it is solidified by quenching.

The partial combustion of finely divided solid carbon-containing fuel with substantially pure oxygen as oxygen-containing gas yields synthesis gas mainly consisting of carbon monoxide and hydrogen. When the oxygen-containing gas is air or oxygen-enriched air, the synthesis gas formed of course also contains a substantial quantity of nitrogen. By finely divided solid carbon-containing fuel is generally meant coal or another solid fuel, such as brown coal, peat, wood, coke, soot etc., but mixtures of liquid or gas and particulate solid fuels, are also possible.

Advantageously, a moderator is also introduced into the reactor. The object of the moderator is to exercise a moderating effect on the temperature on the reactor. This is ensured by endothermic reaction between the moderator and the reactants and/or products of the synthesis gas preparation. Suitable moderators are steam and carbon dioxide.

The gasification is advantageously carried out at a temperature in the range from 1200 to 1700 °C and at a pressure in the range from 1 to 200 bar.

The reactor in which the preparation of synthesis gas takes place may have any suitable shape.

The supply of finely divided solid carbon-containing fuel and oxygen-containing gas to the reactor can take place in any manner suitable for the purpose and will not be described in detail.

Liquid slag formed in the partial combustion reaction drops down and is drained through the outlet located in the reactor bottom.

To remove the slag from the gasifying process, it is already known to arrange a quenching water bath or slag quench vessel located below the reactor and connected therewith in any way suitable for the purpose, in which water bath or slag quench vessel the slag descending due to its gravity, is captured, quenched, and forms clinker granules or agglomerations. After such granulation, the clinker is periodically or continuously removed from the said water bath or slag quench vessel by means of conventional arrangements.

This may for example be carried out by means of a lockhopper from which solidified slag is batchwise sluiced out of the gasification system.

During the sluicing cycle the lockhopper is isolated from the gasification system by closing one or more valves in the connecting line between the slag quench vessel and the lockhopper.

However, the slag which is produced in the meantime in the partial combustion process collects in the slag quench vessel above these valves where it shows a tendency for bridging at the narrow space just above the said valves.

However, it has appeared very difficult to have the slag to fall into the lockhopper after reconnecting the lockhopper to the gasification system.

Even water jet nozzles for agitation purposes proved to be not successful. Therefore, it is an object of the invention to provide a process and an apparatus for producing synthesis gas by the partial combustion of finely divided solid carbon-containing fuel wherein the liquid slag formed during the partial combustion process can be removed from the slag quench vessel easily in a very effective and efficient manner.

It is another object of the invention to provide a quick performance test of the valves between the slag quench vessel and the lockhopper.

The invention therefore provides a process for the preparation of synthesis gas by partial combustion of finely divided solid carbon-containing fuel with an oxygen-containing gas in a reactor, wherein liquid slag formed during the partial combustion process falls into a water bath or slag quench vessel where it solidifies and from there falls by gravity into a lockhopper from which the solidified slag is batchwise sluiced out of the gasification system, said lockhopper and slag quench vessel being connected through one or more valves, comprising the steps of creating and maintaining a permanent gas bubble or gascap in the lockhopper, the pressure of the said gas bubble being lower than the pressure in the slag quench vessel, thus creating an initial downwards flow of water and slag during opening of the valves between the lockhopper and the slag quench vessel.

The invention also provides an apparatus for carrying out the above process comprising a slag quench vessel, connected through one or more valves to a lockhopper provided at its bottom with an outlet comprising one or more valves, and means for creating and maintaining a permanent gas bubble or gascap in the lockhopper.

In an advantageous embodiment of the invention the gas bubble in the lockhopper can be created by inserting downwardly a pipe of a certain length into the top of the lockhopper.

In another advantageous embodiment the gas bubble consists of an inert gas such as nitrogen.

The invention will now be described in more detail by way of example with reference to the accompanying drawings, in which figs. 1 and 2 - schematically represent advantageous embodiments of the apparatus of the invention.

Referring now to figs. 1 and 2 a cross-section of a slag quench vessel 1 provided with an outlet 2 has been represented. The slag quench vessel 1 is part of a gasification system and is located below a reactor or gasification zone wherein the partial combustion process is carried out, and is connected thereto in any manner suitable for the purpose.

The gasification zone has not been represented for reasons of clarity. The outlet 2 of the slag quench vessel 1 is connected by any suitable connecting line 3 to a lockhopper 4 located below the said slag quench vessel. In the line 3 one or more valves 3a are provided.

In the lockhopper 4 a permanent gas bubble or gascap 5 is maintained, at a pressure lower than the pressure in the slag quench vessel 1. The gas bubble may for example consist of an inert gas such as nitrogen.

The lockhopper 4 is provided with an outlet 7 at its bottom and one or more valves 7a for discharging the solidified slag from the gasification system during a sluicing cycle. The slag can be discharged to any means suitable for the purpose (not shown for reasons of clarity). The gas bubble 5 in the lockhopper may be maintained by supplying inert gas (such as nitrogen) to the lockhopper 4 by means of a conduit or pipe 6 penetrating into the upper interior space of the lockhopper, as shown in fig. 1, or advantageously by means of a pipe 6a in fluid communication with the vertically disposed conduit between the slag quench vessel 1 and the lockhopper 4, as shown in fig. 2, and wherein said vertical conduit penetrates into the interior of said lockhopper a distance sufficient to maintain the gas bubble in the uppermost part of the lockhopper.

The operation of the system of the invention is as follows:
the liquid slag which is formed in the gasification system during the partial combustion process falls into the water bath or slag quench vessel 1 where it solidifies.

From the slag quench vessel 1 it falls by gravity into the lockhopper 4 from which the solidified slag is batchwise sluiced out of the gasification system. It will be clear to those skilled in the art that at appropriate times the valves 3a and 7a should be opened and closed respectively.

During the sluicing cycle the lockhopper 4 is isolated from the gasification system since the valves 3a between the slag quench vessel and the lockhopper are closed, whereas the valves 7a at the outlet 7 of the lockhopper 4 are opened. Thus, slag which is produced in the meantime, will collect in the slag quench vessel 1 above the valves 3a and has a tendency for bridging at the narrow space just above these valves (schematically represented by the bridging region A).

According to the invention, after reconnecting the lockhopper 4 to the gasification system by closing the valves 7a and opening the valves 3a the gas bubble in the lockhopper having a lower pressure than the pressure in the slag quench vessel creates an initial downwards flow of water and slag thus resulting in a debridging action in the region A.

It will be appreciated that the gas bubble also allows a quick performance test of the valves. If the volume of the gas bubble changes with time this is an indication of valve leakages.

It will further be appreciated that the pressure of the gas bubble in the lockhopper can be higher than the pressure of the discharge means outside the lockhopper. In this manner unloading of the lockhopper is facilitated and possible bridging at the outlet 7 of the lockhopper is reduced.

Various modifications of the present invention will become apparent to those skilled in the art from the foregoing description and accompanying drawing. Such modifications are intended to fall within the scope of the appended claims.

Claims

1. A process for the preparation of synthesis gas by partial combustion of finely divided solid carbon-containing fuel with an oxygen-containing gas in a reactor, wherein liquid slag formed during the partial combustion process falls into a water bath or slag quench vessel where it solidifies and from there falls by gravity into a lockhopper from which the solidified slag is batchwise sluiced out of the gasification system said lockhopper and slag quench vessel being connected through one or more valves, comprising the steps of creating and maintaining a permanent gas bubble or gascap in the lockhopper, the pressure of the gas bubble being lower than the pressure in the slag quench vessel, thus creating an initial downwards flow of water and slag during opening of the valves between the lockhopper and the slag quench vessel.

2. The process as claimed in claim 1 wherein the gas bubble is maintained by supplying gas to the lockhopper by means of a conduit or pipe extending into the upper interior space within the lockhopper.

3. The process as claimed in claim 1 or 2 wherein the gas bubble consists of an inert gas.

4. The process as claimed in claim 3 wherein the said inert gas is nitrogen.

5. Process substantially as described in the description with reference to the accompanying drawings.

6. An apparatus for carrying out the process as claimed in any one of claims 1-5 comprising a slag quench vessel, connected through one or more valves to a lockhopper provided at its bottom with an outlet, comprising one or more valves, and means for creating and maintaining a permanent gas bubble in the lockhopper.

7. The apparatus as claimed in claim 4 comprising a conduit or pipe extending into the upper interior space within the lockhopper.

8. Apparatus substantially as described in the description by reference to figs. 1 and 2 of the accompanying drawings.

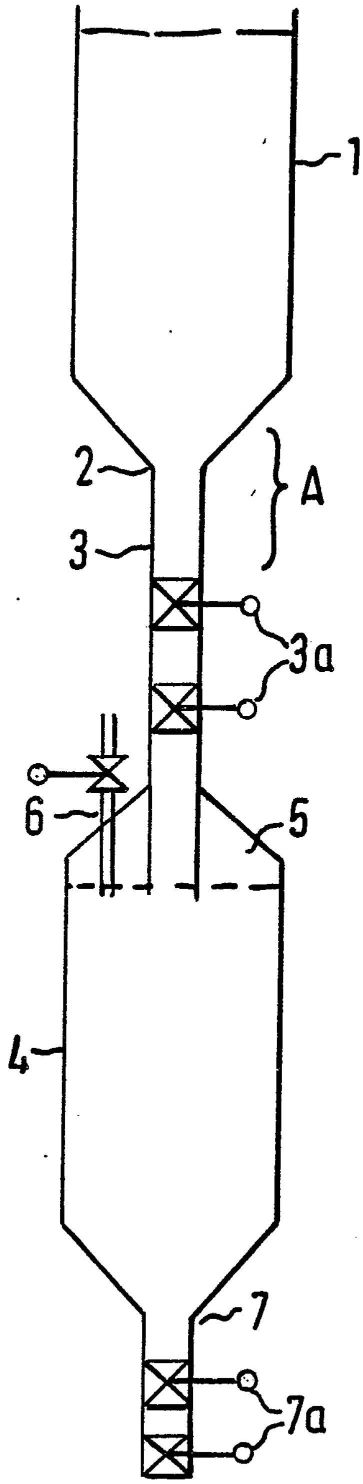

FIG.1

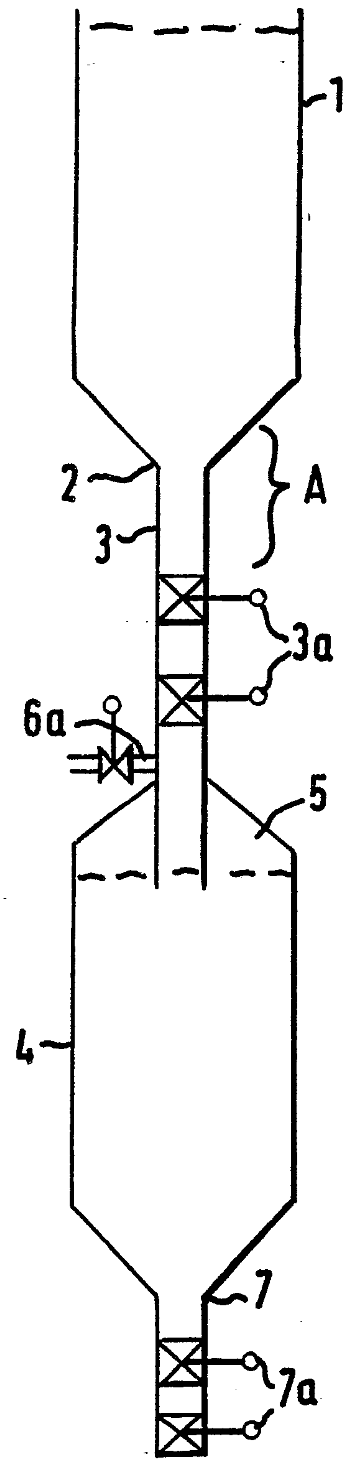

FIG.2