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

(57) Process and apparatus for producing synthesis gas by partial combustion of carbon-containing fuel with oxygen-containing gas in a reactor in which slag is removed through a slag discharge in the bottom and passed by gravity into a water bath where it is cooled by water. The steam which is produced is first used to cool the slag and is further used as an additional quench gas. A quench medium is contacted countercurrently with the slag leaving the gasifier.

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PROCESS AND APPARATUS FOR THE PREPARATION OF SYNTHESIS GAS

The invention relates to a process and apparatus for the preparation of synthesis gas by the partial combustion of a carbon-containing fuel with an oxygen-containing gas in a reactor wherein the synthesis gas obtained is discharged through an outlet at the bottom of the reactor and is fed through a waste heat boiler connected to and located essentially vertically below the reactor and wherein slag is removed through the outlet in the bottom of the reactor and passed by gravity through a slag discharge means extending inside or alongside the waste heat boiler, into a water bath where it is cooled by quenching.

The partial combustion of 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 carbon-containing fuel is generally meant coal or another solid fuel, such as brown coal, peat, wood, coke, soot etc, but liquid fuels, such as tar sand oil or shale oil, and mixtures of liquid and/or particulate solid fuels, and hydrocarbon gases, 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 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 the shape of a sphere, cone, block or a cylinder. Advantageously the reactor mainly has the shape of a circular cylinder.

The supply of carbon-containing fuel and oxygen-containing gas to the reactor can take place in any manner suitable for the purpose. However, both the fuel and the oxygen-containing gas and the moderator are advantageously supplied through the wall of the reactor in pairs of burners. This is advantageously performed by means of at least two burners arranged symmetrically in relation to the reactor axis.

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 at the bottom of the gasifying vessel, in which water bath the slag descending due to its gravity, is captured, quenched, and forms glassy granules. The slag particles are periodically or continuously removed from the water bath by means of conventional arrangements.

Further, it has already been proposed to locate a waste heat boiler essentially vertically below the reactor in such a way that slag, ash and product gas are leaving the gasifier through only one opening (outlet) in the gasifier bottom.

It is an object of the invention to provide a process and an apparatus for producing synthesis gas wherein the capacity of such waste heat boiler per unit gas produced is increased.

The invention therefore provides a process for producing synthesis gas by the partial combustion of a carbon-containing fuel with an oxygen-containing gas in a reactor wherein the synthesis gas obtained is discharged through an outlet at the bottom of the reactor and is fed through a waste heat boiler connected to and located essentially vertically below the reactor and wherein slag is removed through the outlet in the bottom of the reactor and passed by gravity through a slag discharge means extending inside or alongside the waste heat boiler into a water bath where it is further cooled by water, characterized in that a quench medium is supplied to said slag discharge means and is contacted with the slag leaving the reactor through said slag discharge means.

The invention also provides an apparatus for the partial combustion of a carbon-containing fuel with an oxygen-containing gas, which apparatus comprises a reactor which is equipped with a gas outlet at the bottom and a waste heat boiler connected to and located essentially vertically below the reactor, and a slag discharge means extending inside or alongside the waste heat boiler and debouching into a water bath characterized in that a supply means is present for supplying a quench medium to said slag discharge means in such a way that the quench medium is contacted with the slag leaving the reactor through said slag discharge means.

In an advantageous embodiment of the invention the quench medium, for example a gas, is contacted countercurrently with the slag, and this quench medium can advantageously be supplied to the slag discharge means before the slag is dropped in the water bath.

In an advantageous embodiment of the present invention steam is produced from boiling water in the water bath and can be first used to cool the slag when leaving the gasifier and passing by gravity into the water bath and subsequently used as an additional quench gas for quenching the product gas.

The invention will now be described in more detail by way of example with reference to the accompanying drawing, in which the figure - schematically represents a longitudinal section of an apparatus according to the invention.

Referring now to the figure a longitudinal section of a gasifier or reactor 1, provided with a plurality of burners 2 has been represented. At the bottom of the gasifier the product gas can be quenched by any quench medium suitable for the purpose, if desirable. Such quench medium, for example gas, can be supplied through any suitable line 4,4'. The product gas leaving the gasifier via an outlet 3 is fed through a waste heat boiler 5 comprising cooling means such as coils or panels for indirect heat transfer (schematically represented in longitudinal section by the shading) which is suitably connected to and vertically located below the gasifier 1. The waste heat boiler as such is not part of the present invention and will not be described in detail, since its operation is known to those skilled in the art.

The product gas leaving the waste heat boiler through an outlet means 6 can advantageously be supplied to a suitable means 7 for (dry) solids removal, in which ash is discharged via a line 8. Dust-free gas leaving the means 7 through a line 8a may be processed further in any suitable way for the purpose.

Slag (represented by reference numeral 3b) leaving the gasifier 1 at the outlet 3 passes by gravity via a slag discharge 3a to a water bath 9. The slag discharge 3a is vertically located below the outlet 3 of the gasifier 1 and is advantageously surrounded by the outer shell of the waste heat boiler. The pressures prevailing in the gasifier, waste heat boiler and slag discharge are such that discharge of product gas from the reactor into the slag discharge 3a is prevented. Such process features just as constructional features are not part of the present invention and will not be described or shown in the figure for reasons of clarity. Through any suitable supply means 11 any suitable quench medium can be supplied to the slag discharge means 3a, for example before the slag is contacted with the water in the water bath, in such a way that the slag leaving the gasifier through the outlet 3 is contacted with the said quench medium countercurrently. (Recycle) gas or steam can for example be used as a quench medium. The water bath temperature can be such that the water bath 9 contains boiling water. After the boiling water bath the slag is passing via line 10 to a slag lockhopper (not shown). It will be appreciated that any suitable slag removal system can be applied.

The boiling water in the bath 9 produces steam (arrow A) which can be used to cool the slag when leaving the gasifier and passing by gravity into the water bath. The said steam and/or additional steam and/or gas passing through line 11 may further be used as an additional quench gas for quenching the product gas at the outlet 3. In this way the heat contained in the slag leaving the reactor is used for raising steam in the waste heat boiler thus increasing the overall thermal efficiency of the process.

It will be appreciated that in an advantageous embodiment of the invention the slag discharge means 3a may be extending alongside the waste heat boiler.

Further, it will be appreciated that in an advantageous embodiment of the present invention the sizing and process conditions of the configuration as described earlier are as follows: unit capacity: 1000 t/d Illinois No. 6 coal; process conditions of gas ex gasifier: 5.40 m^3/s, 25 bar , 1450 °C; process conditions of recycle gas used as quench medium: 1.75 m^3/s, 26 bar , 200 °C; diameter of gasifier: 2.5-3.0 m, length of gasifier: 5-8 m, diameter of gasifier exit: 0.8-1.2 m, diameter of slag discharge means: 0.8-1.2 m, diameter of waste heat boiler: 1.5-1.8 m and length of waste heat boiler: 15-25 m.

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 producing synthesis gas by the partial combustion of a carbon-containing fuel with an oxygen-containing gas in a reactor wherein the synthesis gas obtained is discharged through an outlet at the bottom of the reactor and is fed through a waste heat boiler connected to and located essentially vertically below the reactor and wherein slag is removed through the outlet in the bottom of the reactor and passed by gravity through a slag discharge means extending inside or alongside the waste heat boiler into a water bath where it is further cooled by water, characterized in that a quench medium is supplied to said slag discharge means and is contacted with the slag leaving the reactor through said slag discharge means.

2. The process as claimed in claim 1 characterized in that the quench medium, for example a gas, is contacted countercurrently with the slag.

3. The process as claimed in claim 1 or 2 characterized by the step of producing steam from boiling water in the water bath, said steam being first used to cool the slag and subsequently as an additional quench gas of the product gas.

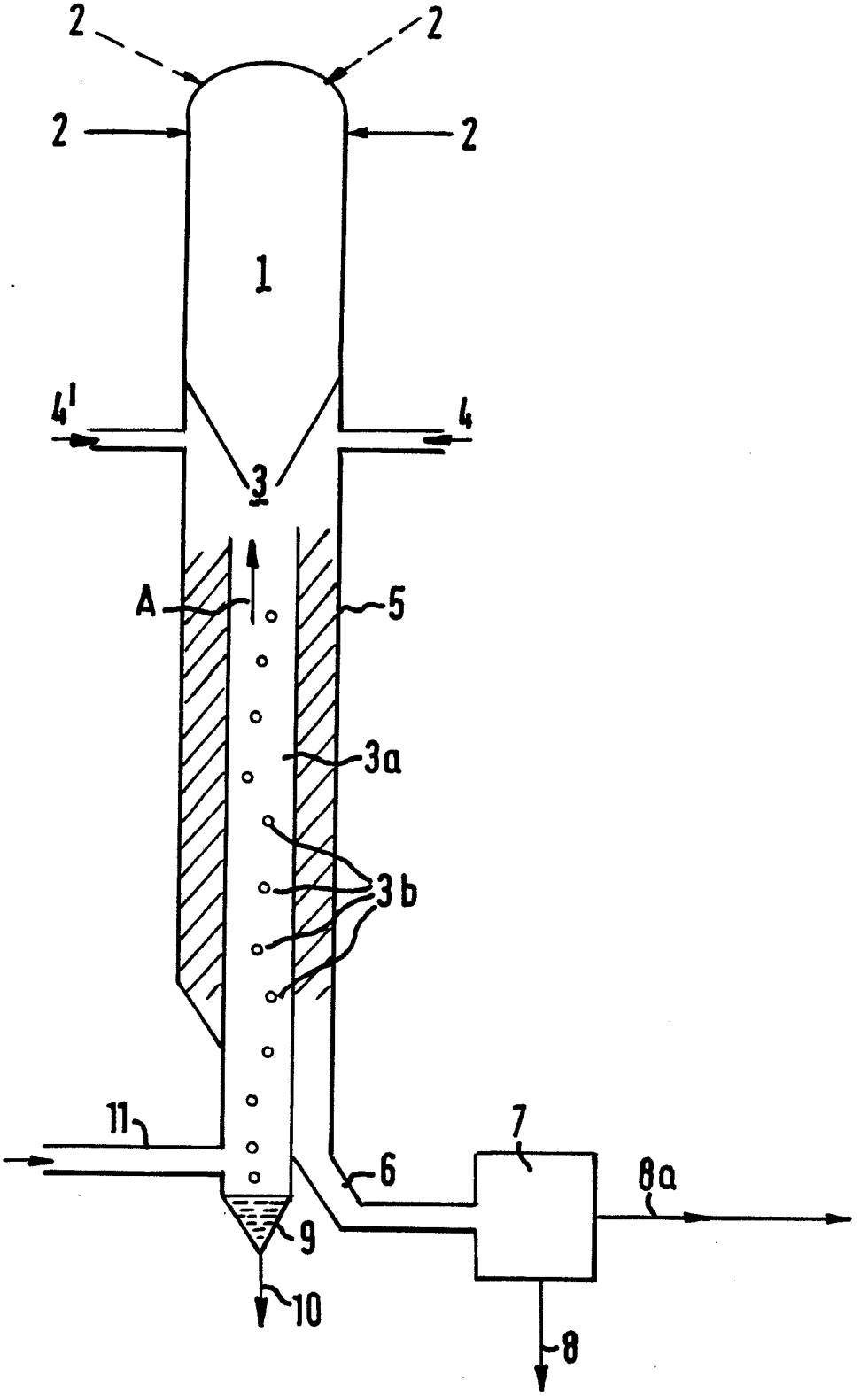
4. The process as claimed in claim 1 or 2 characterized in that the quench medium is supplied to the said slag discharge means before the slag is contacted with water in the water bath.

5. An apparatus for the partial combustion of a carbon-containing fuel with an oxygen-containing gas, which apparatus comprises a reactor which is equipped with a gas outlet at the bottom and a waste heat boiler connected to and located essentially vertically below the reactor, and a slag discharge means extending inside or alongside the waste heat boiler and debouching into a water bath characterized in that a supply means is present for supplying a quench medium to said slag discharge means in such a way that the quench medium is contacted with the slag leaving the reactor through said slag discharge means.

6. The apparatus as claimed in claim 5 characterized by means for supplying a quench medium countercurrently with the slag.

7. The apparatus as claimed in claim 5 or 6 characterized in that the quench medium is supplied to the said slag discharge means before the slag is contacted with the water in the water bath.

8. Synthesis gas whenever obtained by the process as claimed in any one of claims 1-4.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