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(54) **A process and apparatus for preparing synthesis gas by partial oxidation of a finely divided solid carbon-containing fuel.**

(57) A process and apparatus for preparing synthesis gas by partial oxidation of a finely divided solid carbon-containing fuel.

In an upflow entrained gasifier the gases leaving the reactor are cooled in a radiation or convection cooler located above the gasifier. In order to prevent the cooled gases to flow back into the gasifier part a restriction is provided between the gasifier and the cooler above. The gas velocity in the restriction should be at least 2 and maximum 30 times higher than the superficial upward velocity of the gases in the gasifier.

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The present invention relates to a process and an apparatus for preparing synthesis gas by partial oxidation of a finely divided solid carbon-containing fuel.

Finely divided solid carbon-containing fuels are applied in processes 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.

In partial oxidation processes of finely divided solid carbon-containing fuels, such as for example coal gasification, the fuel is fed from a supply device to a gasifier by means of a suitable carrier fluid.

The hot product gas usually contains sticky particles which lose their stickiness upon cooling.

The sticky particles in the hot product gas will cause problems in the plant where the product gas is further processed, since undesirable deposits of the particles on, for example, walls, valves or outlets will adversely affect the process. Moreover, such deposits are very hard to remove. The sticky particles may be partly or completely in the molten state; they may comprise metals, salts or ashes, and, in general, these particles lose their stickiness at a temperature below about 800 °C.

Therefore, conventionally the hot product gas is quenched in a quench section which is located above the product outlet on top of the reactor. In the quench section a suitable quench medium such as for example water or a gas is introduced into the product gas in order to cool the product gas.

Another possibility is not to apply a quench section, but to locate a radiation or convection cooler above or next to the reactor.

However, in such an arrangement the cooled gases will still flow backwards to the reactor.

It is an object of the invention to provide a process and apparatus for coal gasification wherein the backflow and downflow of cooled gases to the reactor are avoided.

The invention therefore provides a process for preparing synthesis gas comprising the steps of partial oxidation of a finely divided solid carbon-containing fuel with an oxygen-containing gas in an upflow reactor, cooling the gases leaving the reactor at its top in a radiation or convection cooler located above the reactor, characterized in that a restriction or neck has been provided between the reactor outlet and the inlet of the radiation cooler; and wherein the gas velocity in the restriction is at least 2 and maximum 30 times higher than the superficial upward velocity of the gases in the reactor.

The invention further provides an apparatus for carrying out the above partial oxidation process, said apparatus comprising an upflow reactor vessel having an outlet for the product gas at its top, a slag outlet at its bottom, one or more burners in its side wall, wherein a radiation or convection cooler is located above the reactor, characterized in that a restriction or neck has been provided between the outlet of the reactor and the inlet of the radiation cooler, and wherein the gas velocity in the restriction is at least 2 and maximum 30 times higher than the superficial upward velocity of the gases in the reactor.

Advantageously, the gas velocity in the restriction is 3-15 times higher than the superficial upward velocity of the gases in the reactor.

The superficial velocity is defined as the net gas flow in cubic metres per second at the prevailing pressure and temperature divided by the cross-section of the reactor. The superficial velocity can be calculated in any way suitable for the purpose by those skilled in the art taking into account recirculations in the reactor.

The invention will now be described by way of example in more detail by reference to the accom-

panying drawing, in which the figure represents schematically a longitudinal section of a reactor design of the invention.

Referring now to the figure, an upflow reactor vessel 1 has been shown The reactor vessel 1 is provided with a slag outlet 2 at its bottom, a plurality of burners 3, a gas outlet 4 at its top and a radiation cooler or convection cooler 5 comprising an inlet 5a above the reactor outlet 4. Advantageously, the burners 3 are located on the same horizontal level at circumferential spaced points.

The gases leaving the reactor are cooled in the radiation or convection cooler located above the reactor.

It will be appreciated that the radiation cooler can be provided with a finned cooled section perpendicular to the wall of the radiation cooler.

Between the upflow entrained reactor 1 and the radiation cooler 5 a restriction or neck 6 is provided in order to prevent the cooled gases to flow backwards, or downwards into the reactor.

The gas velocity in the restriction is at least 2 and maximum 30 times higher than the superficial upward velocity of the gases in the reactor.

In advantageous embodiments of the invention the diameters A and C of the reactor and the radiation cooler are 2-3 metres, advantageously 2.5 metres and the diameter B of the restriction is 0.8-1.2 metre, advantageously 1 metre, whereas the superficial velocity D in the reactor is 0.8-1.2 m/s, advantageously about 1 m/s, the superficial velocity in the restriction is 3-15 m/s, advantageously about 6.25 m/s and the height H of the reactor is 5-10 metres, advantageously 7 metres.

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

Claims

1. A process for preparing synthesis gas comprising the steps of partial oxidation of a finely divided solid carbon-containing fuel with an oxygen-containing gas in an upflow reactor, cooling the gases leaving the reactor at its top in a radiation or convection cooler located above the reactor, characterized in that a restriction or neck has been provided between the reactor outlet and the inlet of the radiation cooler; and wherein the gas velocity in the restriction is at least 2 and maximum 30 times higher than the superficial upward velocity of the gases in the reactor.

2. The process as claimed in claim 1, characterized in that the gas velocity in the restriction is 3-15 times higher than the superficial upward velocity of the gases in the reactor.

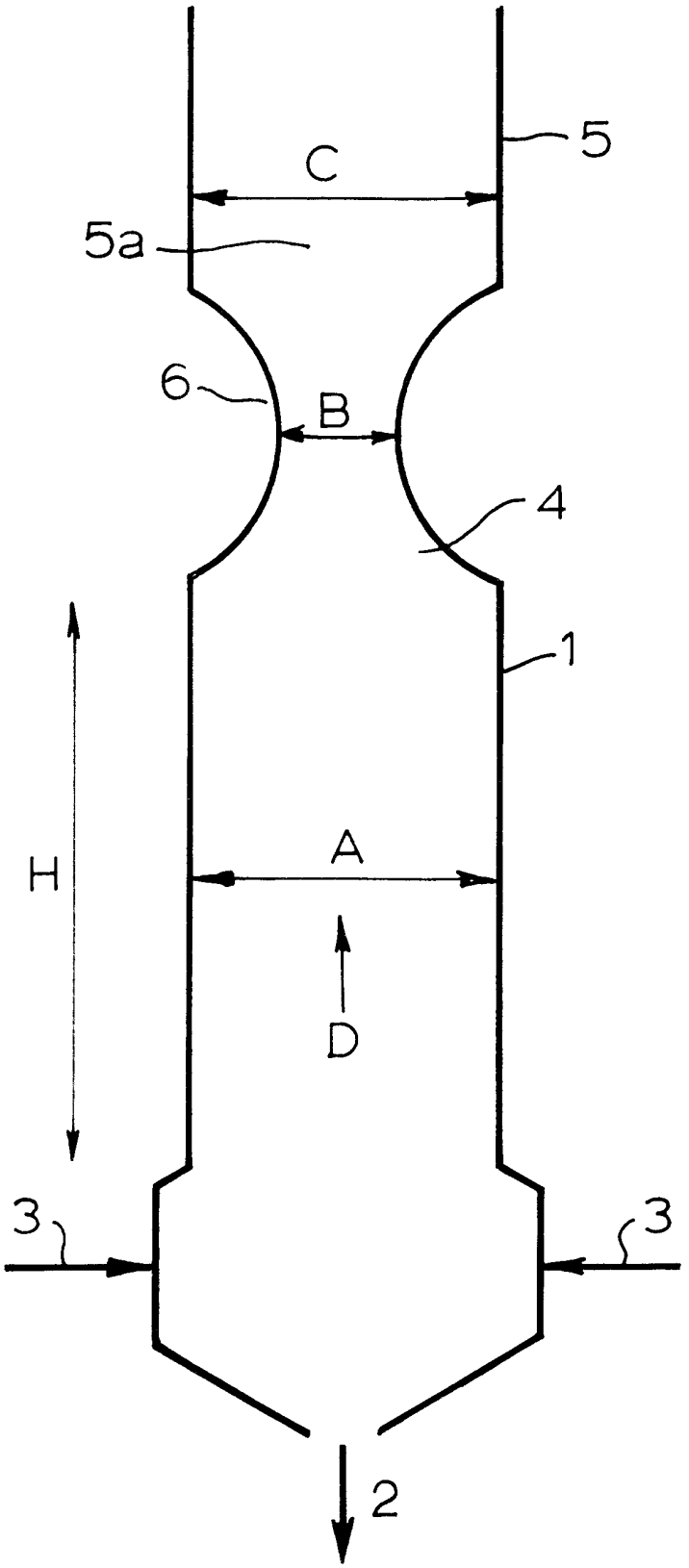
3. An apparatus for carrying out the partial oxidation process as claimed in claims 1 or 2, said apparatus comprising an upflow reactor vessel having an outlet for the product gas at its top, a slag outlet at its bottom, a plurality of burners in its side wall, wherein a radiation or convection cooler is located above the reactor, characterized in that a restriction or neck has been provided between the outlet of the reactor and the inlet of the radiation cooler, and wherein the gas velocity in the restriction is at least 2 and maximum 30 times higher than the superficial upward velocity of the gases in the reactor.

4. The apparatus as claimed in claim 3 characterized in that the radiation cooler comprises a radiant section provided with a finned cooling section perpendicular to the wall.

5. The apparatus as claimed in claims 3 or 4 characterized in that the superficial gas velocity in the restriction is 3-15 m/s, advantageously about 6.25 m/s.

6. The apparatus as claimed in any one of claims 3-5 characterized in that the superficial gas velocity in the reactor is 0.8-1.2 m/s, advantageously about 1 m/s.

7. The apparatus as claimed in any one of claims 3-6 characterized in that the diameters of the reactor, the radiation cooler and the restriction are 2-3, 2-3 and 0.8-1.2 metres respectively.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EUROPEAN SEARCH REPORT

Application Number

EP 91 20 2992

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	US-A-4 328 006 (MUENGER ET AL.) * claims 1,8,18; figure 1 * ---	1-7	C10J3/46
A	EP-A-0 050 863 (HITACHI) -----		
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			C10J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20 FEBRUARY 1992	MEERTENS J.

CATEGORY OF CITED DOCUMENTS

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