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(54) APPARATUS FOR THE PREPARATION AND COOLING OF SYNTHESIS GAS

(54)

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The invention relates to an apparatus for the preparation and cooling of a gas mixture containing hydrogen and carbon monoxide (synthesis gas), comprising a reactor for the partial combustion of hydrocarbons with air, oxygen or with oxygen-enriched air, at superatmospheric pressure, with the optional supply of steam, and also a heat exchanger connected to the gas discharge of the reactor.

The invention also relates to a process in which the apparatus is used.

It is known that synthesis gas may be prepared by partial combustion of hydrocarbons, with the optional supply of steam. In this process soot is produced in the form of solid particles. The reactor in which this partial combustion is carried out is generally connected to a waste-heat boiler designed in such a way that the hot gases which leave the reactor at a temperature of 1300°C-1500°C are cooled to a temperature below 400°C. A waste-heat boiler suitable for this cooling comprises one or more helical coils through which the gas mixture is passed and around which a coolant, for example water, flows, in which use is made of the heat exchange for the recovery at the same time of evaporated coolant at high pressure, for example, high-pressure steam. Because of their large cooling surface, waste-heat boilers of this type are not suitable if the cooled gas is desired to have a relatively high temperature, for example, a temperature of 900°C-1100°C. This is desired, for example, when the cooled gas is wanted for use in the recovery of metals from ore and other processes which are carried out at higher temperatures. In this case it is desirable for the cooling to be effected to this relatively high temperature in a reliable and accurate manner.

The invention now provides an apparatus which is very suitable for the preparation of synthesis gas and a relatively moderate cooling of the gas obtained in a reliable and accurate manner.

The invention therefore relates to an apparatus for the preparation and cooling of a gas mixture containing hydrogen and carbon monoxide, comprising a reactor for the

partial combustion of hydrocarbons with air, oxygen or with oxygen-enriched air, at superatmospheric pressure, with the optional supply of steam, and also a heat exchanger connected to a gas discharge of the reactor, in which the heat exchanger comprises a space through which the gas mixture is passed and in which space are arranged one or more cooling tubes which is (are) closed relative to the said space and is (are) provided with a co-axial inner tube for the supply of coolant, which inner tube has such an outflow opening that the coolant can reach the end of the cooling tube closed relative to the said space.

Coolant, which is preferably introduced into the inner tube under pressure, flows against the closed end of the cooling tube(s), and subsequently flows in counter-current to the coolant in the inner tube through the space formed by the wall of the cooling tube and the wall of the inner tube.

The cooling tube(s) with the inner tube arranged therein is (are) preferably accommodated in such a way in the space through which the synthesis gas is passed, that the longitudinal axis of the cooling tube(s) is parallel with the direction of flow of the gas, and that the coolant which flows in the space between the wall of the cooling tube and the wall of the inner tube is in parallel flow with the synthesis gas to be cooled.

The cooling tube(s) is (are) preferably passed through the wall of the heat wxchanger by means of a gland so that it (they) is (are) movable longitudinally. The heat exchanger has the shape of, for example, a vertical cylindrical vessel with an inner brickwork of refractory material, in which the cylindrical inner space through which the synthesis gas is passed is connected at the bottom to the gas discharge of the reactor, and in which the heat exchanger has a gas discharge at the top of the space through which the gas is passed, the centre line of said discharge being normal to the centre line of the said space, so that the gas is discharged laterally, and in which one cooling tube is present which is passed

movably and gas-tight through the closed upper end of the cylindrical vessel, and in which the coolant inlet and outlet are outside the cylindrical vessel. By moving the cooling tube the area of the cooling surface can be adjusted. Any soot layer deposited on the outer wall of the cooling tube can be removed, for example, by means of a scraping action of the gas-tight gland of the cooling tube, or with the aid of means specially provided for this purpose, for example, a concentric steel brush arranged around the tube, or with the aid of steam introduced through one or more openings around the cooling tube.

When the apparatus according to the invention is used, the gas is preferably passed into the heat exchanger and around the cooling tube(s) therein with a kinetic energy of 600-3000 $kg/m.^2sec.^2$ per m^3 of gas and at a gas pressure of 1-3 atm. gauge.

The apparatus is particularly suitable for the preparation and cooling of synthesis gas containing 12-18% by weight of hydrogen and 12-18% by weight of carbon monoxide, in which hydrocarbons are subjected to partial combustion with air in a ratio of 5-7 kg of air per kg of hydrocarbon and the synthesis gas leaving the reactor and having a temperature of 1300°C-1400°C is cooled to a temperature of 900°C-1000°C at a pressure of 2 atm. gauge and a kinetic energy of 1500 $kg/m^2.sec.^2$ per m^3 of gas. By moving the cooling tube(s) the area of the cooling surface is adjusted in such a way that the temperature of the cooled gas has the desired value between 900°C and 1000°C when leaving the heat exchanger. It is preferred to use water as a coolant for the cooling tube(s).

The invention will now be further explained with reference to the diagrammatic drawing which shows a preferred embodiment of the invention in which the heat exchanger is designed in such a way that the synthesis gas is cooled in parallel flow.

Referring to the drawing, the reference numeral 1 designates a reactor for the partial combustion of hydrocarbons with air, oxygen or with oxygen-enriched air.

The reactor also comprises a burner part 2. Hydrocarbons are passed through a line 3 to the burner part. Air, oxygen or oxygen-enriched air is supplied through a line 4, while steam, if added, may be supplied through line 3 or line 4. The reactor is constructed with refractory brickwork 5 and its gas discharge 6 is connected to a gas inlet 16 of a heat exchanger 7. The gas mixture at superatmospheric pressure flows through a space 9 of the heat exchanger which is provided with a refractory lining 8. The gas flows around a cooling tube 10 closed at the bottom, which tube is provided with an inner tube 11. The cooling tube is passed gas-tight through a gland 14 of the heat exchanger. Coolant, for example water, is supplied in an excess amount through an inlet 12, preferably under pressure, and leaves the cooling tube through a discharge 13. The cooled gas is discharged through a gas discharge conduct 15. The cooling tube with inner tube is movably arranged in gland 14 and is shown in the drawing in the maximum moved-in position, thus achieving maximum cooling of the gas.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. An apparatus for the preparation and cooling of a gas mixture containing hydrogen and carbon momoxide, comprising a reactor for the partial combustion of hydrocarbons with air, oxygen or with oxygen-enriched air, at superatmospheric pressure, with the optional supply of steam, and also a heat exchanger connected to a gas discharge of the reactor, in which the heat exchanger comprises a space through which the gas mixture is passed and in which space are arranged one or more cooling tubes which is (are) closed relative to the said space and is (are) provided with a co-axial inner tube for the supply of coolant, which inner tube has such an outflow opening that the coolant can reachtthe end of the cooling tube closed relative to the said space.

2. An apparatus as claimed in claim 1, in which the longitudinal axis of the cooling tube(s) is parallel with the direction of flow of the gas such that the gas is cooled in parallel flow.

3. An apparatus as claimed in claim 1 or 2, in which the cooling tube(s) is (are) passed through the wall of the heat exchanger by means of a gland.

4. A process for the preparation and cooling of a gas mixture containing hydrocarbon and carbon monoxide, in which use is made of an apparatus as claimed in claim 1, in which process the gas mixture is passed into the heat exchanger at a kinetic energy of 600-3000 $kg/m^2.sec.^2$ per m^3 of gas and at a gas pressure of 1-3 atm. gauge.

5. A process for the preparation and cooling of a gas mixture containing hydrogen and carbon monoxide as claimed in claim 4, in which process a gas mixture containing 12-18% by weight of hydrogen and 12-18% by weight of carbon monoxide is produced by partial combustion of hydrocarbons with air in a ratio of 5-7 kg of air per kg of hydrocarbon and the resultant gas

mixture is cooled to a temperature of 900°C-1000°C by passing the hot gas mixture into the heat exchanger at a presssure of 2 atm. gauge and a kinetic energy of 1500/kg/m^2.$sec.^2$ per m^3 of gas, the cooling tube(s) being moved into the heat exchanger for such a distance that the temperature of the cooled gas obtains the desired value between 900°C and 1000°C.

6. A process as claimed in claim 5, in which process the cooling tube(s) is (are) cooled with water.

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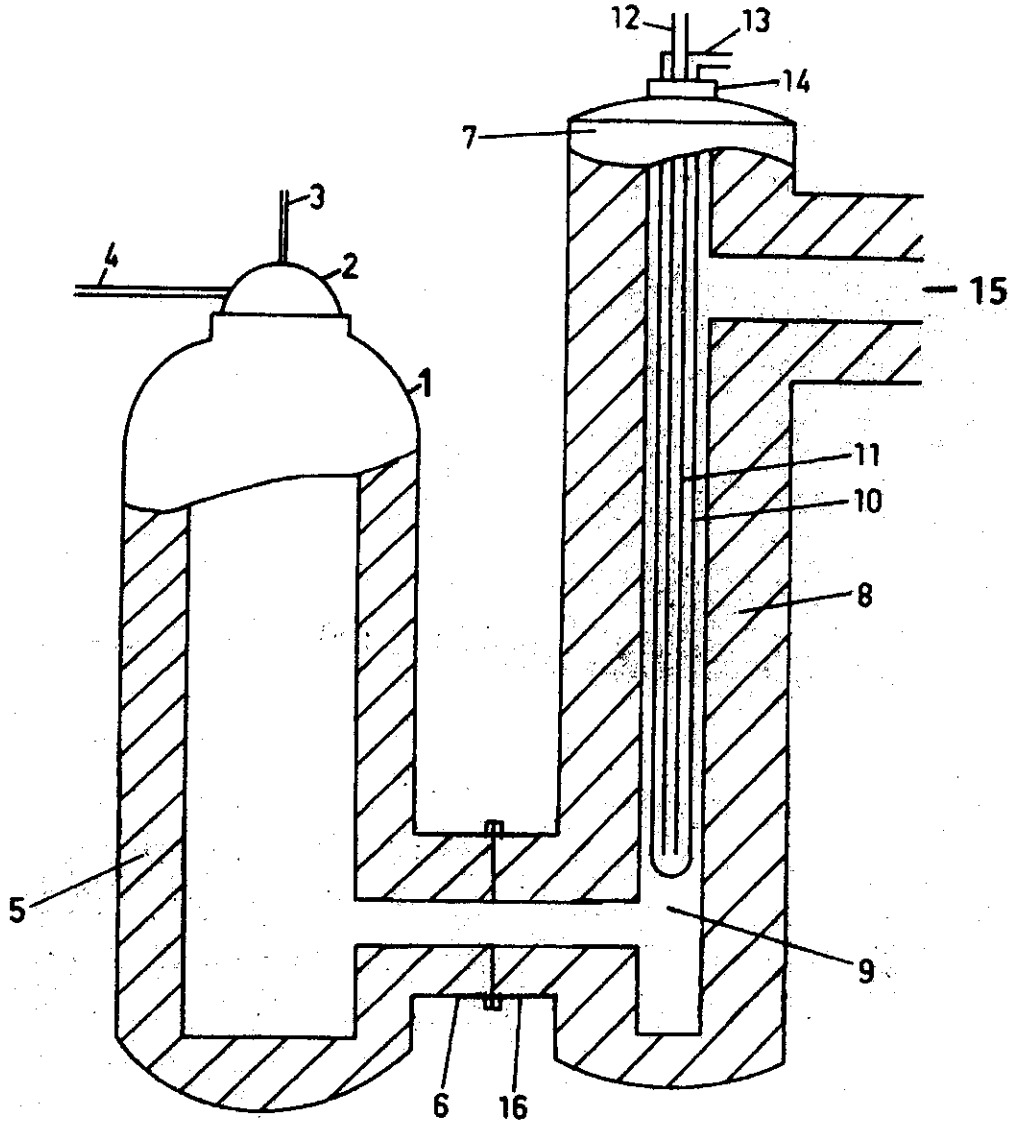

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