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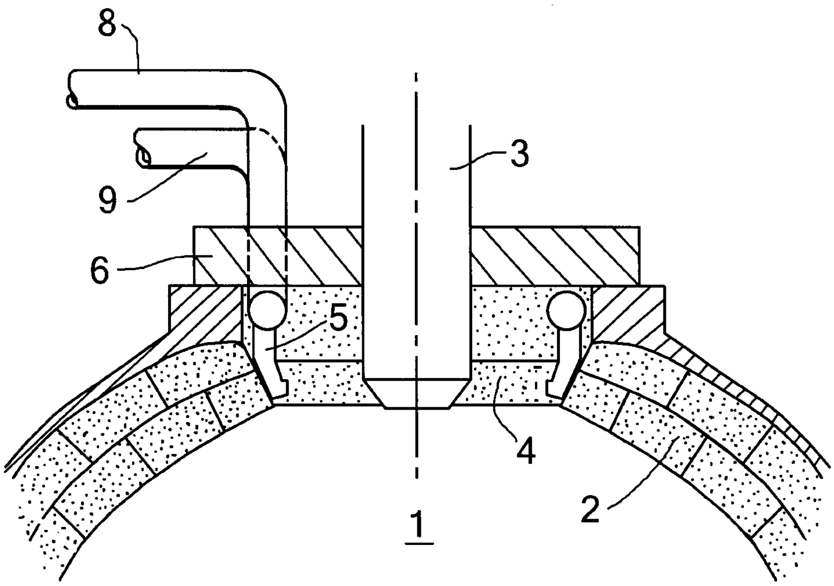
(54) Gasification reactor with cooled shield around burner

(57) Vertical elongated reactor vessel (1) provided at its inner side with a layer of refractory brick work (2) and at its upper end with a downwardly directed burner (3) as present in an opening through the wall of the vessel (1) and through an opening in the brick work (4), wherein the refractory brick work comprises a shield (5), which shield (5) extends substantially downwardly from the wall of the vessel (1) or from an optional flange (6) which flange (6) fixes the burner to the vessel, and which shield (5) is positioned around the burner (3), and which shield (5) is provided with passages (7) for a cooling medium, an inlet (8) for supply of a fresh cooling medium to said passages, and an outlet (9) for discharge of used cooling medium from the said passages (7).

Fig.1



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Description

Field of the invention

[0001] The invention is directed to an improved refractory lined gasification reactor and a process to produce syngas by using the said reactor.

Background of the invention

[0002] Such reactor is described in US-A-3048481. A gasification reactor is disclosed in which a layer of compressible insulating cement is present between the outer side of refractory brick and the inner wall of the vessel. This layer is present in order to prevent the channelling of hot gasses between the outer side of refractory brick and the inner wall of the vessel. A flanged nozzle is also provided at the upper end of the reactor to accommodate a burner. The nozzle is provided with refractory line preferably spaced away from the inner surface of nozzle and surrounded by compressible insulating cement.

[0003] Although the reactor according to US-A-3048481 may have less hot spots during operation, hot gas recirculation can still occur behind the refractory and around the burner area. A hot gas recirculation can cause refractory damage and burner damage.

[0004] An object of the present invention is to provide a reactor that limits the above problems. It is further objective of the present invention to improve reliability and to extend the service life of the burner and of the refractory bricks.

Summary of the Invention

[0005] This object is achieved with the vertical elongated reactor vessel provided at its inner side with a layer of refractory brick work and at its upper end with a downwardly directed burner as present in an opening through the wall of the vessel and through an opening in the brick work, wherein the refractory brick work comprises a shield (5),
which shield extends substantially downwardly from the wall of the vessel or from an optional flange which flange fixes the burner to the vessel, and which shield is positioned around the burner, and
which shield is provided with passages for a cooling medium, an inlet for supply of a fresh cooling medium to said passages, and an outlet for discharge of used cooling medium from the said passages.

[0006] Applicants found that by applying the present invention, the hot spots on the reactor wall and damage of the burner and of the refractory brick occurred less. It is believed that the circulation of gas between the refractory bricks and the reactor wall around the burner is avoided by positioning a cooled shield within the refractory bricks in the vicinity of the burner and surrounding the burner.

Brief description of the drawings

[0007]

Figure 1 illustrates an upper section of the reactor vessel with the shield according to the present invention.
Figure 2 is a top view of the reactor vessel.
Figure 3 shows one of the preferred embodiments for the shield.
Figure 4 shows the cross-section of the shield of Figure 3.
Figure 5 shows another preferred embodiment of the shield.

Detailed description of the drawings

[0008] Figure 1 schematically shows the top end cross section of the vertical elongated reactor vessel (1) provided at its inner side with a layer of refractory brick work (2) and at its upper end with a downwardly directed burner (3) as present in an opening through the wall of the vessel (1) and through an opening in the brick work (2). The refractory brick work comprises a shield (5).

[0009] Shield (5) extends substantially downwardly from the wall of the vessel (1) or from an optional flange (6) which flange (6) fixes the burner to the vessel. Shield (5) is positioned around the burner (3). The shield fully surrounds the burner (3) and the brick work (4) as present between the shield (5) and burner (3). In this manner no circulating gas can pass the shield.

[0010] The shield (5) preferably does not extend beyond refractory brickwork, because any part extending beyond the brickwork may be damaged at the operating conditions of the reactor.

[0011] The shield (5) is provided with passages (7) for a cooling medium, an inlet (8) for supply of a fresh cooling medium to said passages, and an outlet (9) for discharge of used cooling medium from the said passages (7).

[0012] The preferred shield (5) as shown in Figure 1 has a tubular part (10) and an inwardly tilted lower part (11) to provide support for the refractory brick work (4). Brick work (4) is the part of brick work (2) which is present between the burner (3) and the said shield (5).

[0013] The inwardly tilted lower part (11) of the said shield (5) preferably has a rim (12) to provide further support for the refractory brick work (4), as present between the burner (3) and the said shield (5). The rim (12) serves also to prevent sagging of the said refractory brick work (4).

[0014] The angle (α) between the tilted part (11) and the vertical is preferably between 5 and 45°.

[0015] Figure 2 schematically shows a preferred top cover flange (6) that is positioned on top of the reactor vessel (1). Flange (6) serves to fix burner (3) to the reactor vessel (1). To said flange (6) the shield (5) is fixed, preferably by welding. Through the said flange (6) an inlet conduit (8) to supply fresh cooling medium and an outlet conduit (9) for discharge of used cooling medium are present. Preferably multiple inlet conduits (8) and outlet conduits (9) are provided through the said flange (6).

[0016] Each of the passages (7) within the shield (5) is preferably connected at its inlet to a common distributor (13a) for cooling medium and is preferably connected at its outlet to a common collector (13b) for cooling medium. The common distributor (13a) and the common collector (13b) are respectively fluidly connected to the inlet (8) and outlet (9) for cooling medium. The common distributor (13a) and the common collector (13b) are preferably positioned at the upper end of the shield (5).

[0017] Figure 3 and Figure 4 show one of the preferred embodiments of the invention. In this embodiment the passages (7) for cooling medium are parallel conduits, each passage (7) having a first part (7a) extending from the upper end of the shield (5) to the lower end of the shield (5) and fluidly connected to a second part (7b) of said passage (7) extending from said lower part of the shield (5) to said upper part of the shield (5).

[0018] Figure 5 shows another preferred embodiment of the invention, wherein the passages (7c) for cooling medium are interconnected and coiled conduits. The common distributor (13a) and the common collector (13b) can be situated inside or outside the vessel (1).

[0019] The passages (7, 7a, 7b, 7c) are designed in such manner that no circulating gas can pass the shield. The said passages can be welded. Another option, as for the coiled passages (7c) presented in Figure 5, is that they can be positioned between an inner wall (14) and an outer wall (15), wherein the inner wall (14) and an outer wall (15) serve to provide a gas barrier against the channelling of hot gasses between the said passages. The space between the inner wall (14) and outer wall (15) and the coiled passages (7c) presented in Figure 5 can be filled with the cement filler to provide better heat conducting.

[0020] The cooling medium used to cool the shield is preferably water. The cooling water as supplied to the shield preferably has temperature of below 300 °C and a pressure of below 100 bar, and more preferably temperature below 200 °C and pressure below 60 bar.

[0021] The passages (7, 7a, 7b, 7c) are designed such that local velocity of water in said passages (7, 7a, 7b, 7c) for cooling medium is 0.5-5 m/s, preferably 1-3 m/s, and more preferably 1 m/s.

[0022] The shield is preferably made of a steel type material, more preferably material comprising Cr and Mo. This material is preferred because of its strength, high temperature resistance and good heat conductivity.

[0023] The reactor according to the present invention may be advantageously used in high temperature applications, preferably to prepare syngas by partial oxidation of hydrocarbon feed, wherein a cooling medium is used to cool the shield present around the burner.

[0024] The hydrocarbon feed may be a solid, gaseous fuel or a liquid fuel. Examples of solid fuel are coal, coal slurries, and biomass. Preferably the feed is a gaseous or liquid feed. Examples of possible feedstocks include natural gas, fractions obtained from (hydro-processed) tar sand sources and refinery streams such as middle distillates and more preferably fractions boiling above 370 °C, such as those obtained in a vacuum distillation column. Examples are the vacuum distillates and the residue as obtained by a vacuum distillation of the 370 °C plus fraction as obtained when distilling a crude petroleum feedstock or when distilling the effluent of a carbon rejection process as performed in a refinery. Examples of carbon rejection processes are the well known fluid catalytic cracking (FCC) process, thermal cracking and the vis-breaking process. The hot gas as obtained in a gasification process will comprise mainly of carbon monoxide and hydrogen.

[0025] A preferred feed for the partial oxidation process is a gaseous hydrocarbon, suitably methane, natural gas, associated gas or a mixture of C1-4 hydrocarbons. Examples of gaseous hydrocarbons are natural gas, refinery gas, associated gas or (coal bed) methane and the like. The gaseous hydrocarbons suitably comprises mainly, i.e. more than 90 v/v%, especially more than 94%, C_{1-4} hydrocarbons, especially comprises at least 60 v/v percent methane, preferably at least 75 percent, more preferably 90 percent. Preferably natural gas or associated gas is used.

[0026] The partial oxidation process may be performed according to well known principles as for example described for the Shell Gasification Process in the Oil and Gas Journal, September 6, 1971, pp 85-90. Publications describing examples of partial oxidation processes are EP-A-291111, WO-A-9722547, WO-A-9639354 and WO-A-9603345. In such processes the feed is contacted with an oxygen containing gas under partial oxidation conditions preferably in the absence of a catalyst.

[0027] The oxygen containing gas may be air (containing about 21 percent of oxygen) and preferably oxygen enriched air, suitably containing up to 100 percent of oxygen, preferably containing at least 60 volume percent oxygen, more preferably at least 80 volume percent, more preferably at least 98 volume percent of oxygen. Oxygen enriched air may be produced via cryogenic techniques, but is preferably produced by a membrane based process, e.g. the process as described in WO 93/06041.

[0028] Contacting the feed with the oxygen containing gas is performed in the burner of the reactor vessel. To adjust the H_2/CO ratio in the gaseous product obtained in the partial oxidation reaction, carbon dioxide and/or steam may be introduced into the feed. The gaseous product of the partial oxidation reaction preferably has H_2/CO molar ratio of from 1.5 up to 2.6, preferably from 1.6 up to 2.2.

[0029] The mixture of carbon monoxide and hydrogen as obtained by the above process may advantageously be used as feedstock for power generation, hydrogen manufacture, a Fischer-Tropsch synthesis process, methanol synthesis process, a di-methyl ether synthesis process, an acetic acid synthesis process, ammonia synthesis process or to other processes which use a synthesis gas mixture as feed such as for example processes involving carbonylation and hydroformylation reactions.

Claims

1. Vertical elongated reactor vessel (1) provided at its inner side with a layer of refractory brick work (2) and at its upper end with a downwardly directed burner (3) as present in an opening through the wall of the vessel (1) and through an opening in the brick work (4), wherein the refractory brick work comprises a shield (5),
which shield (5) extends substantially downwardly from the wall of the vessel (1) or from an optional flange (6) which flange (6) fixes the burner to the vessel, and which shield (5) is positioned around the burner (3), and
which shield (5) is provided with passages (7) for a cooling medium, an inlet (8) for supply of a fresh cooling medium to said passages, and an outlet (9) for discharge of used cooling medium from the said passages (7).

2. Reactor vessel according to claim 1, wherein the cooled shield (5) has a tubular part (10) and an inwardly tilted lower part (11) to provide support for the refractory brick work (4), as present between the burner (3) and the said shield (5).

3. Reactor vessel according to claim 2, wherein the inwardly tilted lower part (11) of the said shield (5) has a rim (12) to provide further support for the refractory brick work (4), as present between the burner (3) and the said shield (5).

4. Reactor according to any of claims 2-3, wherein the angle (α) between the tilted part (11) and the vertical is between 5 and 45°.

5. Reactor vessel according to claims 1-4, wherein each passage (7) is connected at its inlet to a common distributor (13a) for cooling medium and is connected at its outlet to a common collector (13b) for cooling medium,
wherein the common distributor (13a) and the common collector (13b) are respectively fluidly connected to the inlet (8) and outlet (9) for cooling medium, and wherein the common distributor (13a) and the common collector (13b) are preferably positioned at the upper end of the shield (5).

6. Reactor vessel according to claim 5, wherein the passages (7) for cooling medium are parallel conduits, each passage (7) having a first part (7a) extending from the upper end of the shield (5) to the lower end of the shield (5) and fluidly connected to a second part (7b) of said passage (7) extending from said lower part of the shield (5) to said upper part of the shield (5).

7. Reactor vessel according to claim 5, wherein the passages for cooling medium are interconnected and coiled conduits (7c).

8. Reactor according to claims 1-7, wherein the shield (5) is made of a steel type material comprising Cr and Mo.

9. Process to prepare syngas by partial oxidation of gas or oil in a reactor vessel according to any one of claims 1-8 wherein a cooling medium is used to cool the shield.

10. Process according to claim 9, wherein the cooling medium is water.

11. Process according to claim 10, wherein the water as supplied to the shield has temperature of below 300 °C and a pressure of below 100 bar.

Fig.1

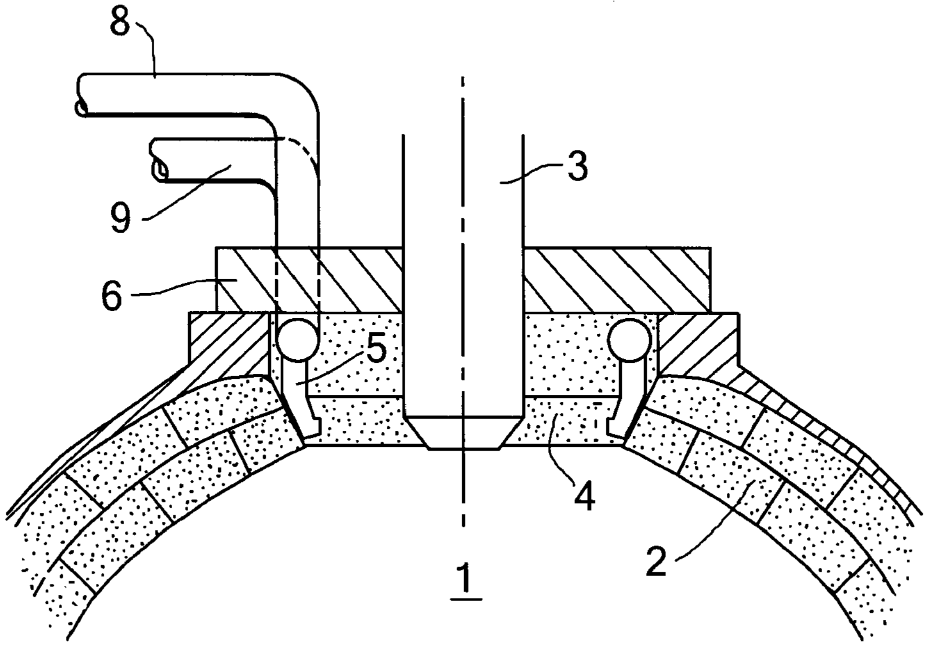
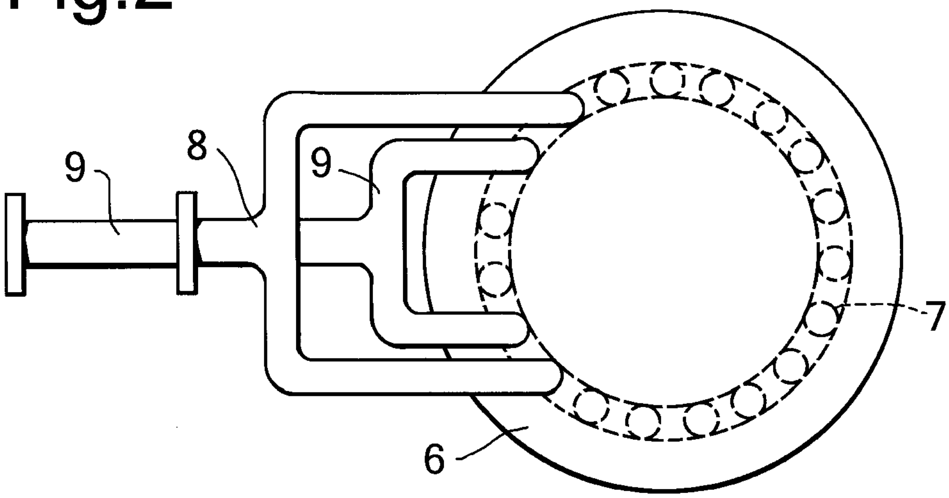


Fig.2



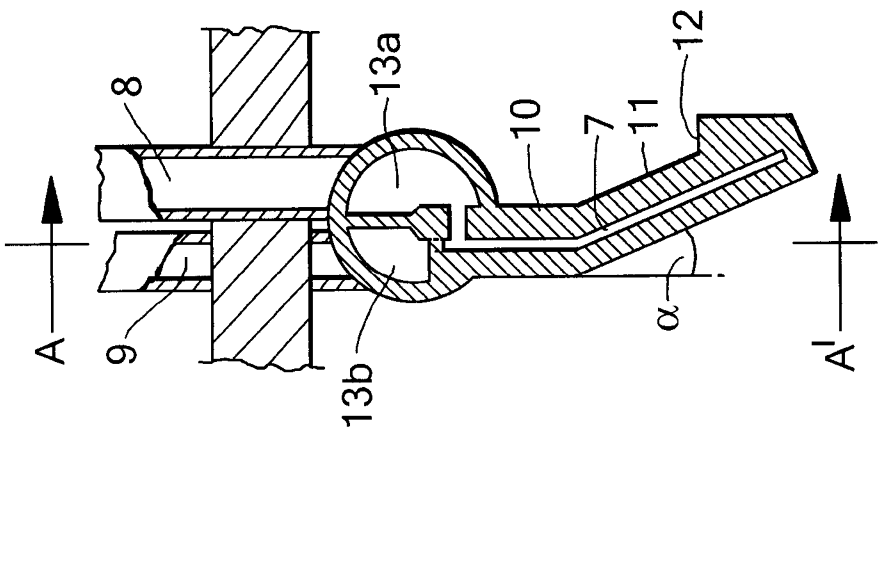


Fig.3

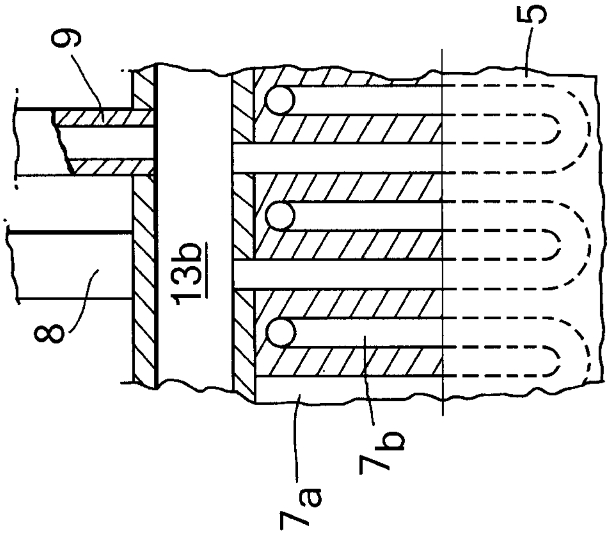


Fig.4
(A-A')

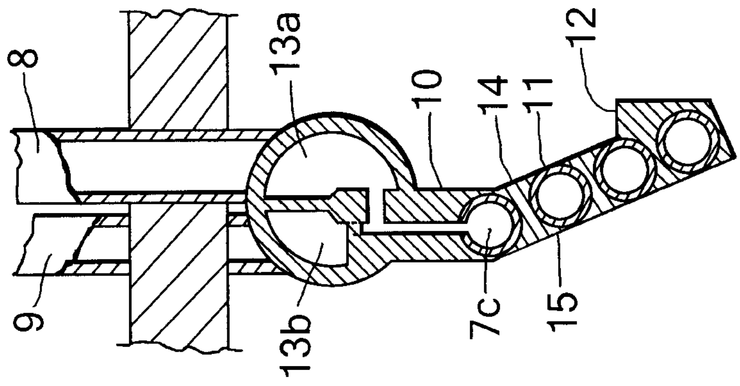


Fig.5

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EUROPEAN SEARCH REPORT

Application Number
EP 07 11 0873

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A	US 5 954 491 A (HELTON WOODWARD CLINTON [US] ET AL) 21 September 1999 (1999-09-21) * figure 4 * * column 4, line 31 - column 6, line 18 *	2-4	
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TECHNICAL FIELDS SEARCHED (IPC)

C10J
F23M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	20 November 2007	Lachmann, Richard

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
& : member of the same patent family, corresponding document

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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 07 11 0873

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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