A gasification process and reactor for the production of syngas by gasification of a carbonaceous feed. The gasification reactor comprises a pressure vessel encasing a gasifier unit with a reactor chamber having its lower end opening into an open-ended skirt portion arranged above a slag collection bath. The skirt portion is arranged within the impacting scope of one or moreappers.
GASIFICATION REACTOR AND PROCESS

[0001] The present invention relates to a gasification reactor and a process for the production of syngas by gasification of a carbonaceous feed, wherein the reactor comprises a pressure vessel encasing a gasifier unit and a slag collection bath.

[0002] Synthetic gas, or syngas, is produced by gasification of carbonaceous feedstock, such as pulverized coal. The carbonaceous feed is partially oxidized in a gasifier unit by a plurality of burners extending into the gasifier. The produced syngas contains slag particles and fly ash as by-products. Slag particles swirl down into the slag collection bath, which typically contains water and is provided with an outlet for the removal of used water and collected slag. Part of the slag particles form deposits on the inner wall surfaces of the gasifier unit. If the slag lumps are sufficiently large and heavy, they fall down into the slag collection bath.

[0003] It has been found that, at least with some types of coal, the slag lumps can become very large before they fall down into the slag bath to such extent that they cannot pass the outlet of the slag collection bath. In some cases, the outlet was even blocked necessitating shut-down of the reactor.

[0004] The object of the invention is to reduce the risk of blockage of the outlet of the slag collection bath, and to be able to use gasification reactors for a broader range of coal types.

[0005] The object is achieved with a gasification reactor for the production of syngas by gasification of a carbonaceous feed, wherein the gasification reactor comprises a pressure vessel encasing a gasifier unit with a reactor chamber having its lower end opening into an open-ended skirt portion arranged above a slag collection bath, wherein the skirt portion is arranged within the impacting scope of one or more rappers.

[0006] Hitherto, rappers are typically used for removing fouling that does not fall off by itself. In this case, rappers are not required for slag removal since the slag deposits do fall down under their own weight from the skirt portion. However, it has now been found that by using one or more rappers, the size of the slag deposits can be controlled and be kept small enough to prevent blockage of the slag collection bath discharge. This way, the gasification reactor can be used for a broader range of carbonaceous feed types, including coal types producing high slag contents.

[0007] The skirt portion can for instance have a narrowing upper section narrowing down in upward direction, with the wider part of the skirt portion situated towards the slag bath. Such a section forms a particularly suitable spot for rapping, since the largest slag deposits are collected at the inner surface of that location. Alternatively, or additionally, the skirt portion may comprise a tubular, e.g., conical lower section arranged within the impacting scope of the one or more rappers.

[0008] Optionally, the upper section and/or other parts of the skirt portion can be built of parallel coolant conduits interconnected to form a gastight membrane. The coolant can for instance be water. By cooling the surface, more slag particles are collected on the surface. As a result, the slag content in the syngas is substantially reduced. In an alternative embodiment the skirt portion can, e.g., wholly or partly made of one or more plates, the skirt portion comprising an outer surface provided with one or more coolant channels.

[0009] To enforce and protect the impacted zone of the skirt portion anvil plates can be provided on the outer surface of the skirt portion in the impacting scope of one or more of the rappers.

[0010] The rappers can for example extend through the wall of the pressure vessel. This enhances accessibility of the rappers for maintenance and repair.

[0011] The rappers can for example comprise a housing extending from the outer surface of the pressure vessel, a striker rod having one end slideably supported by an opening in the housing and one end contacting the anvil plate, and an activatable impacting device having a rammer head movably in line with the striker rod between a distal position at a distance from the striker rod, and an impacting position in which it impacts the striker rod. Suitable rappers are for instance rappers of the type disclosed in WO 2010/063752 or WO 2010/063755.

[0012] Optionally, the skirt portion can be provided with a refractory liner, but to improve impact resistance against the rappers impact a refractory liner can be omitted.

[0013] Generally, the skirt portion will show rotational symmetry, e.g., having a cylindrical lower section and a conical upper section, but other suitable tubular configurations can be used as well, if so desired. The upper section of the skirt portion can be conical, or it can have any other narrowing geometry, if so desired.

[0014] The one or more rappers can be activated to rap with a desired frequency. The higher the frequency, the smaller the slag particles falling down into the slag collection bath.

[0015] An exemplary embodiment of the invention will now be described by reference to the accompanying drawing, in which:

[0016] FIG. 1: shows schematically a longitudinal cross section of a gasification reactor according to the present invention;

[0017] FIG. 2: shows in detailed cross section the rapper of the reactor in FIG. 1.

[0018] FIG. 1 shows a gasification reactor 1 for the production of syngas by partial combustion of a carbonaceous feed, in particular pulverized coal. The gasification reactor 1 comprises a gasifier unit 2 in a vertically oriented elongated pressure vessel 3. The gasifier unit 2 comprises a reactor chamber 2A and a skirt portion 2B. The reactor chamber 2A has a lower end 4 narrowing down to an opening 5 which opens into the space surrounded by the skirt portion 2B, and an open upper end 6 forming an outlet for the syngas, which can be further transported to, e.g., a cooler. The skirt portion 2B comprises a cylindrical lower section 8 arranged above a slag collection bath 7 and a conical upper section 9 narrowing down in upward direction to fence the opening 5, such that the top end of conical upper section 9 is narrower at the connection point with the lower end of the reactor chamber 2A than the bottom portion of upper conical section 9.

[0019] The skirt portion 2B is built of helically wound conduits 34 (see FIG. 2) for transporting a cooling liquid, such as water. The conduits 34 are interconnected to form a gastight membrane. In an alternative embodiment the skirt portion can be made of one or more plates comprising coolant channels on its outer surface.

[0020] The slag bath 7 comprises a cylindrical housing 11 encasing a conical funnel 12 narrowing down to a slag discharge opening 13.
In the embodiment shown in the drawing, the skirt portion 2B is not provided with a refractory liner. However, in other embodiments a refractory liner can be used, if so desired.

A plurality of burners 14 extend into the reactor chamber 2A to supply a mixture of pulverized coal, oxygen and steam. This mixture is ignited for partial combustion to produce synthetic gas, or syngas, with slag and fly ash as by-products. The syngas flows upward towards the opening 6. The freshly produced syngas contains slag particles. The larger, heavier parts fall down into the slag collection bath 7. Part of the hot syngas swirls down via the opening 5 into the space enclosed by the skirt 2B. This creates a turbulence within the skirt 2B. The cylindrical section 8 and the conical upper section 9 of the skirt 2B are cooled by a liquid coolant circulating through the conduits forming the skirt 2B. Syngas swirling within the space enclosed by the skirt portion 2B flows along the cooled surfaces 8, 9. The syngas cools down and leaves deposits of solidified slag particles on the cooled membrane of the skirt 2B. Once the deposits have grown sufficiently heavy, they fall down from the cooled membrane of the skirt 2B into the slag collection bath 7. To remove the collected slag, the slag collection bath 7 is regularly emptied by opening the slag discharge 13.

To prevent that the slag deposits grow too large before falling down, the conical upper section 9 of the skirt 2B is impacted by a rapper 15, which is shown in more detail in FIG. 2. In an alternative embodiment, the rapper 15 may for instance impact the cylindrical section 8 of the skirt portion 2B. It is also possible to combine rappers 15 impacting the conical upper section 9 with rappers impacting the cylindrical section 8.

The rapper 15 extends through the wall of the pressure vessel 3. The rapper 15 comprises an impact device 16 attached to a housing 17 on the wall of the pressure vessel 3. The housing 17 comprises a first flanged bus 18 branching off from the wall of the pressure vessel wall 3. The bus 18 comprises a flange 19 connected to a top flange 20 defining a passage opening 21 for a striker rod 22. In line with the passage opening 21 is a cylindrical spacer 23. The spacer 23 carries the impact device 16 which has a rammer head 24 in line with the striker rod 22 and opposite a free end 25 of the striker rod 22.

Near the conical surface of upper section 9 of the skirt 2B, the striker rod 22 comprises an end 26 engaging an anvil plate 27. The anvil plate 27 has one side 27A following the outer surface of the skirt portion 2B, and an opposite side 27B with a vertical flat surface engaging the end 26 of striker rod 19.

The striker rod 22 runs though a cylindrical support member 28 within the pressure vessel 3. The cylindrical support member 28 has one end closed with an end wall 29 with a central opening 30 in which the striker rod 22 is slideably supported. The opposite second end of the cylindrical support member 28 is connected to the top flange 20 in a gas tight manner.

The cylindrical support 28 encloses an inner space 31 which is in open connection to a sealing gas supply channel 32 which is operatively connected to a sealing gas supply 33. To prevent leakage of hot, inflammable and toxic syngas through the passage opening 30, an inert sealing gas such as nitrogen, is blown into the inner space 31 of the cylindrical support 28. The pressure within the pressure vessel 3 is substantially higher than atmospheric. As a result, a force is exerted on the striker rod 22 to push it out of the pressure vessel 3 via the passage opening 21. To compensate this force, the sealing gas is supplied to the cylindrical support 28 under overpressure, to produce a counterforce on the striker rod 22. The overpressure can be such that the striker rod 22 is firmly pressed against the anvil plate 27.

The impact device 16 can be actuated to knock with its knocker head 24 with a certain impact force onto the end of the striker rod 22. The striker rod 22 passes the impact load via the anvil plate 27 to the conical upper section 9. The shock load loosens the slag deposits which fall down into the slag collection bath 7.

In the embodiment shown in the drawing, only a single rapper 15 is shown. However, more than one rapper 15 can be used, if so desired.

1. A gasification reactor for the production of syngas by gasification of a carbonaceous feed, wherein the gasification reactor comprises a pressure vessel enclosing a gasifier unit with a reactor chamber having its lower end opening into an open-ended skirt portion arranged above a slag collection bath, wherein the skirt portion comprises an upper section connected to the lower end of the reactor chamber, the narrowing top end of upper section being narrower at the connection point with the lower end of the reactor chamber than the bottom portion of upper section and wherein one or more rapper anvil plates are provided on the outer surface of the upper section in the impacting scope of one of the one or more rappers.

2. A gasification reactor according to claim 1 wherein the skirt portion comprises a tubular lower section arranged within the impacting scope of the one or more rappers.

3. A gasification reactor according to claim 1, wherein at least the upper section of the skirt portion is built of parallel coolant conduits interconnected to form a gastight membrane.

4. A gasification reactor according to claim 1 wherein the skirt portion is at least partly made of one or more plates and wherein the skirt portion comprises an outer surface provided with one or more coolant channels.

5. A gasification reactor according to claim 1, wherein the one or more rappers extend through the wall of the pressure vessel.

6. A gasification reactor according to claim 1 wherein at least a part of the rappers comprise a housing extending from the surface of the pressure vessel, a striker rod having one end slideably supported by an opening in the housing and one end contacting the anvil plate, and an activatable impact device having a rammer head movable in line with the impacting rod between a distal position and an impacting position in which it impacts the striker rod.

7. A gasification reactor according to claim 1, wherein the upper section of the skirt portion is conical.

8. A gasification reactor according to claim 1 wherein the skirt portion is not provided with a refractory liner.

9. A process for the production of syngas by gasification of a carbonaceous feed in a gasification reactor comprising a pressure vessel enclosing a gasifier unit with a reactor chamber having its lower end opening into an open-ended skirt portion arranged above a slag collection bath, wherein skirt portion comprises an upper section connected to the lower end of the reactor chamber, the upper section being narrower at the connection point with the lower end of the reactor chamber than the bottom portion of upper section and wherein one or more rapper anvil plates are provided on the outer surface of
the upper section in the impacting scope of one of the one or more rappers and wherein the outer surface of the skirt portion is regularly impacted by one or more rappers to remove slag collected from its inner surface, which slag is subsequently collected in the slag collection bath.

10. A process according to claim 9 wherein the skirt portion is at least partly cooled by circulation of a coolant through coolant conduits.

11. A process according to claim 9, wherein the upper section of the skirt portion is conical.

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