Reactor for producing a product gas from a fuel

**Field of the invention**

The present invention relates to a method for producing a product gas from a fuel, comprising inputting the fuel into a pyrolysis chamber and executing a pyrolysis process for obtaining a product gas, and recirculating parts of the fuel exiting from the pyrolysis chamber to a combustion chamber. In a further aspect, a reactor for producing a product gas from a fuel is provided, comprising a pyrolysis chamber connected to a fuel input, a first process fluid input, and a product gas output, a combustion chamber connected to a flue output, and a feedback channel connecting the pyrolysis chamber and the combustion chamber.

**Prior art**

International patent publication WO2014/070001 discloses a reactor for producing a product gas from a fuel having a housing with a combustion part accommodating a fluidized bed in operation, a riser extending along a longitudinal direction of the reactor, and a downcomer positioned coaxially around the riser and extending into the fluidized bed. One or more feed channels for providing the fuel to the riser are provided.

**Summary**

The present disclosure seeks to provide an improved reactor for processing fuels, such as biomass, waste or coal.

According to a first aspect of the present invention, a method according to the preamble defined above is provided, further comprising in the combustion chamber executing a gasification process in a fluidized bed using a primary process fluid, followed by a combustion process in an area above the fluidized bed using a secondary process fluid. The primary and secondary process fluids are e.g. air comprising oxygen. By creating a pyrolysis process, gasification process and combustion process separately several benefits can be achieved, including a more efficient operation and more ability to adapt to a specific fuel.

Accordingly, one aspect relates to a method for producing a product gas from a fuel, comprising inputting the fuel into a pyrolysis chamber and executing a pyrolysis process for obtaining a product gas, recirculating parts of the fuel exiting from the pyrolysis chamber to a combustion chamber, and in the combustion chamber executing a gasification process in a fluidized bed using a primary process fluid, followed by a combustion process in an area above the fluidized bed using a secondary process fluid, the gasification process being controlled by controlling the velocity and oxygen content of the primary process fluid, and the combustion process being controlled by controlling the velocity and oxygen content of the secondary process fluid, wherein the gasification process is operated with an equivalence ratio ER between 0.9 and 0.99, e.g. 0.95, the equivalence ratio ER being defined as the ratio of the amount of oxygen supplied divided by the amount of oxygen needed for complete combustion of the fuel.

Another aspect relates to a reactor for producing a product gas from a fuel, comprising a pyrolysis chamber connected to a fuel input, a first process fluid input, and a product gas output; a combustion chamber connected to a flue output; a feedback channel connecting the pyrolysis chamber and the combustion chamber; wherein the combustion chamber comprises a gasification zone accommodating a fluidized bed, and a combustion zone above the fluidized bed, wherein the reactor further comprises a primary process fluid input in communication with the gasification zone, and a secondary process fluid input in communication with the combustion zone.

CLAIMS

1. Method for producing a product gas from a fuel, comprising

inputting the fuel into a pyrolysis chamber (6) and executing a pyrolysis process for obtaining a product gas,

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- recirculating parts of the fuel exiting from the pyrolysis chamber (6) to a combustion chamber (20, 23), and

in the combustion chamber (20, 23) executing a gasification process in a fluidized bed (20) using a primary process fluid, followed by a combustion process in an area (23) above the fluidized bed (20) using a secondary process fluid , the gasification process being controlled by controlling the velocity and oxygen content of the primary process fluid, and the combustion process being controlled by controlling the velocity and oxygen content of the secondary process fluid,

wherein the gasification process is operated with an equivalence ratio ER between 0.9 and 0.99, e.g. 0.95,

the equivalence ratio ER being defined as the ratio of the amount of oxygen supplied divided by the amount of oxygen needed for complete combustion of the fuel.

2. Method according to claim 1, wherein the fluidized bed 20 is operated with an equivalence ratio ER of at least 1, e.g. equal to 1.05 or equal to 1.1,

the equivalence ratio ER being defined as the ratio of the amount of oxygen supplied divided by the amount of oxygen needed for complete combustion of the fuel.

3. Method according to claim 1 or 2, wherein the primary process fluid is used for controlling the temperature in the fluidized bed (20).

4. Method according to any one of claims 1-3, wherein the equivalence ratio is controlled by one or more of:

reducing supply of the primary process fluid, reducing oxygen content in the primary process fluid, adding an inert gas to the primary process fluid, and/or adding flue gas to the primary process fluid.

5. Method according to claim 4, wherein the equivalence ratio is controlled based on measurement of a temperature in the product gas, and/or a temperature in the flue

gas from the combustion process, and/or an oxygen content in the flue gas from the combustion process.

6. Reactor for producing a product gas from a fuel, comprising

- a pyrolysis chamber (6) connected to a fuel input (4), a first process fluid input (5), and a product gas output (10);
- a combustion chamber (20, 23) connected to a flue output (9);
- a feedback channel (11, 12, 12a) connecting the pyrolysis chamber (6) and the combustion chamber (20, 23);

wherein the combustion chamber comprises a gasification zone (20) accommodating a fluidized bed, and a combustion zone (23) above the fluidized bed,
wherein the reactor (1) further comprises a primary process fluid input (21) in communication with the gasification zone (20), and a secondary process fluid input (22) in communication with the combustion zone (23).

7. Reactor according to claim 6, wherein the primary and secondary process fluid input (21, 22) are arranged to provide air for a gasification and combustion process, respectively.

8. Reactor according to claim 7, further comprising a control unit (24) connected to the primary process fluid input (21) for controlling the velocity and oxygen content of a primary process fluid to the gasification zone (20).

9. Reactor according to claim 7 or 8, further comprising a control unit (24) connected to the secondary process fluid input (22) for controlling the velocity and oxygen content of a secondary process fluid to the combustion zone (23).

10. Reactor according to claim 8 or 9, wherein the control unit (24) is connected to one or more sensors.

11. Reactor according to any one of claims 6-10, wherein the secondary process fluid input (22) comprises a distribution device (25) positioned in the combustion zone (23).

12. Reactor according to any one of claims 6-11, wherein the first process fluid input (5) is arranged to provide a first process fluid, e.g. steam or air, to the pyrolysis chamber (6).

13. Reactor according to any one of claims 6-12, wherein the pyrolysis chamber (6) is formed by one or more riser channels (3) positioned in the reactor (1).

14. Reactor according to any one of claims 6-12, wherein the combustion chamber (20, 23) is formed by one or more riser channels (3) positioned in the reactor (1).

15. Reactor according to any one of claims 6-14, wherein the feedback channel (11, 12) comprises one or more downcomer channels positioned in the reactor (1).

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