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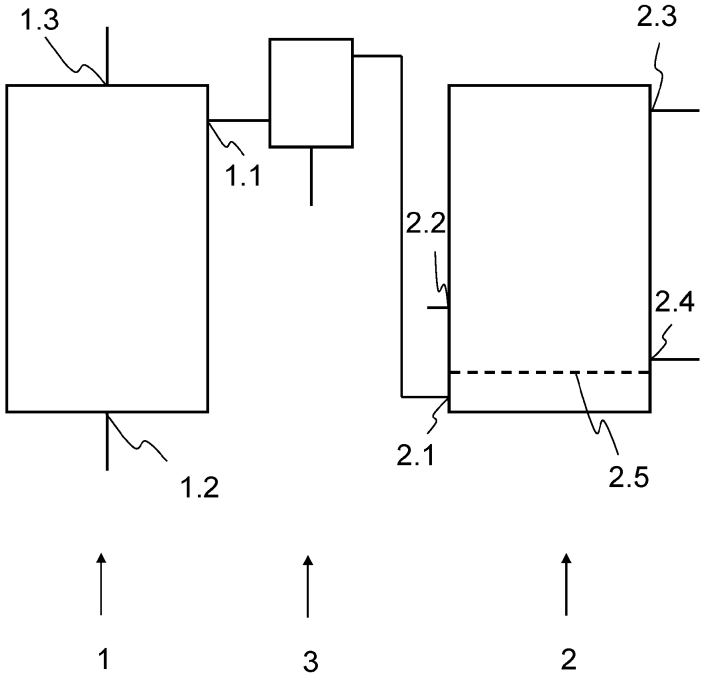
(54) METHOD AND SYSTEM FOR PROCESSING BIOMASS

(57) The present invention relates to a method and a system for processing biomass. The system comprises a gasifier (1) for the gasification of biomass to a gas mixture and a reactor (2) for treating particulate metal with the gas mixture or with a fraction of the gas mixture,



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Description

[0001] The present invention relates to a method and a system for processing biomass. The system comprises a gasifier for the gasification of biomass to a gas mixture.

[0002] Usually, the temperature of the gas mixture produced by the gasification is raised and an oxygen containing gas is added (such as air), wherein the energy of the following combustion reaction is used to supply thermal or electrical energy to an end user. Alternatively, it is known to withdraw the gas mixture from the gasifier to use the gas mixture as synthesis gas in the chemical industry. Using the gas mixture as synthesis gas makes it necessary that a pipeline network is installed, for providing the synthesis gas from the gasifier to the chemical industry site. As gasifiers for biomass are often installed in a decentralized manner, it is a great effort to install such pipeline network.

[0003] If there is a surplus of the produced gas mixture, while there is no or a little demand for thermal or electrical energy, there is a need for storing the gas mixture (or a fraction thereof) or for storing the thermal/electrical energy. For example, the produced gas mixture may be stored in a pressurized state, which makes it necessary that the gas mixture is pressurized.

[0004] In view of the above, it is an object of the present invention to provide an alternative method for storing the chemical energy of the produced gas mixture.

[0005] This object is achieved by a method and a system with the features of respective independent claims. Preferred embodiments of the invention are described in the subclaims and in the description, wherein single features of the preferred embodiments can be combined with each other in a technical meaningful manner. In particular, the features disclosed with regard to the method can be applied to the system and vise versa.

[0006] The object is in particular achieved with a method for processing biomass, comprising the following steps:

- Gasification of biomass to a gas mixture,
- Supplying the gas mixture or a fraction of the gas mixture to particulate metal.

[0007] The object is also achieved by a system for processing biomass, comprising

- a gasifier for the gasification of biomass to a gas mixture and
- a reactor for treating particulate metal with the gas mixture or with a fraction of the gas mixture, wherein an outlet of the gasifier for the gas mixture is connected to an inlet of the reactor.

[0008] With other words, the present invention suggests to supply the gas mixture (or a fraction thereof) produced by the gasification of biomass (such as wood, energy crops or waste from forests, yards or farms) to solid particulate metal, so that the solid particulate metal reacts with the provided gas (in particular, a reduction rection between the metal comprising molecules - for example metal oxides - of the solid particulate metal with at least some of the gaseous components of the supplied gas occurs), while keeping its solid state. The particulate metal may be embodied by particles (granulate, pellets) comprising or consisting of a metal (such as iron, zinc, copper or alkali metal, for example magnesium), in particular a metal in its oxidized state. For example, the particulate metal may be iron ore or iron ore pellets.

[0009] After the treatment with the gas, the particulate metal is still in particulate (particle, granulate, pellets) form. The metal (molecules) of the particulate metal is in particular in its reduced state due to the treatment with the gas. The thus treated (reduced) particulate metal can be stored and transported/conveyed in solid form which makes the handling much easier. Accordingly, the chemical energy of the gas mixture produced by the gasification of biomass can be stored as bulk material.

[0010] In order to make the stored energy available, the treated (reduced) solid particulate metal can be used in an exothermic oxidation reaction, from which energy can be withdrawn. The oxidation reaction can for example occur in a fluidized bed reactor, to which an oxygen containing gas (such as air) is supplied for fluidizing the treated solid particulate metal. Alternatively, a water vapor comprising gas may be supplied to the treated (reduced) solid particulate metal preferably in a fluidized bed reactor so that hydrogen can be withdrawn from the following rection. In both cases, the thus oxidized particulate metal may be further used in known processes. In a further embodiment, the treated particulate metal (which has a higher quality than untreated particulate matter) can be used directly in known processes, thereby saving energy in the known process.

[0011] The gasifier for the gasification of biomass may be of the common type and can be embodied as moving bed gasifier, counter-current fixed bed gasifier, as co-current fixed bed gasifier, as fluidized bed gasifier or as entrained flow gasifier.

[0012] The reactor for treating the solid particulate metal may be of any type of reactor known for treating solid particulate matter with a gas. For example, the reactor may be embodied as fixed bed reactor, as fluidized bed reactor or as circulating fluidized bed reactor, in which the particulate metal is provided as particulate matter and to which the gas mixture (or a fraction thereof) is supplied as process gas. If the reactor is embodied as fluidized bed reactor, the outlet of the gasifier is connected to the fluidizing bottom of the fluidized bed reactor such that in use the particulate metal in the fluidized bed reactor is fluidized by the supplied gas mixture. This way the contact time of the gas with the particulate metal can be enhanced and thereby the efficiency.

[0013] Principally, the gas mixture produced in the gasifier may be directly supplied (as a whole) to the reactor for treating the particulate metal. But, it is also possible

that the gas mixture is withdrawn from the reactor and is treated (separated, distilled, fractionized) before it is supplied to the particulate metal in the reactor. Such a treatment unit would be arranged between the outlet of the gasifier and the inlet of the reactor. If necessary, storage vessels for the gas mixture o for a fraction of the gas mixture may be arranged between the outlet of the gasifier and the inlet of the reactor.

[0014] Usually, the gas mixture produced by the gasification of biomass comprises a high content of carbon monoxide and as a further component hydrogen. The carbon monoxide and eventually the hydrogen react with the particulate metal within the reactor by a reduction reaction, so that the metal of the particulate metal is reduced. Accordingly, the carbon monoxide reacts with the particulate metal to (reduced) particulate metal and carbon dioxide. The hydrogen reacts with the particulate metal to (reduced) particulate metal and water. As the carbon monoxide is derived from biomass, the whole process is carbon dioxide neutral.

[0015] In order to enhance the yield of the reduction reaction the produced gas mixture may be treated (for example distilled), such that the gas supplied to the reactor consists mainly of carbon monoxide, wherein only unavoidable impurities may be present.

[0016] The invention and the technical background will now be described with regard to the figure, which shows and exemplary embodiment of the inventive system.

[0017] The system depicted in the figure comprises a gasifier 1, with a gas inlet 1.2 at its bottom and a biomass inlet 1.3 at its top. The gasifier 1 for the gasification of biomass also comprises a gas mixture outlet 1.1. The biomass supplied through the biomass inlet 1.3 is gasified within the gasifier 1, wherein the gases produced by the gasification of the biomass are withdrawn through the gas mixture outlet 1.1.

[0018] The system further comprises a treatment unit 3, which is connected to the gas mixture outlet 1.1. The treatment unit 3 may be used to clean or distill the gases withdrawn from the gas mixture outlet 1.1.

[0019] The outlet of the treatment unit 3 is connected to a reactor 2 of the system. The reactor 2 is embodied as fluidized bed reactor, wherein particulate metal can be supplied through a particulate metal inlet 2.2 into the reactor 2. The gas mixture produced in the gasifier 1 and eventually treated in the treatment unit 3 may be supplied through a gas inlet 2.1 to a fluidizing bottom 2.5 of the reactor 2. By supplying the gas through the gas inlet 2.1 the particulate metal within the reactor 2 is fluidized, wherein carbon monoxide and/or hydrogen of the supplied gas reduces the metal of the particulate metal. The reduced particulate metal may be withdrawn through a particulate metal outlet 2.4, whereas the reaction gases may be withdrawn through a gas outlet 2.3 at the top of the reactor 2.

[0020] This way the chemical energy provided by the gas mixture produced in the gasifier 1 may be stored within the particulate metal treated in the reactor 2 and therefore in a solid state, wherein the whole process is CO2 neutral.

[0021] The treated (reduced) particulate metal may be supplied to an oxidation reactor, in which an oxygen containing gas may be supplied to the treated particulate metal, so that an exothermic reaction is started from which thermal energy can be withdrawn. Alternatively, the treated (reduced) particulate metal my be supplied to an oxidation reactor, in which a water vapor containing gas may be supplied to the treated particulate metal, so that a reaction is started from which hydrogen can be withdrawn.

Reference signs

[0022]

1	Gasifier
1.1	Gas mixture outlet
1.2	Gas inlet
1.3	Biomass inlet
2	Reactor
2.1	Gas inlet
2.2	Particulate metal inlet
2.3	Gas outlet
2.4	Particulate metal outlet
2.5	Fluidizing bottom
3	Treatment unit

Claims

1. Method for processing biomass, comprising the following steps:

   1) Gasification of biomass to a gas mixture,
   2) Supplying the gas mixture or a fraction of the gas mixture to particulate metal.

2. Method according to claim 1, wherein a fraction of the gas mixture supplied to the particulate metal comprises carbon monoxide (CO) and or hydrogen (H2).

3. Method according to claim 2, wherein the fraction of the gas mixture supplied to the particulate metal consists of carbon monoxide.

4. Method according to one of the preceding claims, wherein the particulate metal is reduced by a reduction reaction with the gas mixture or a fraction of the gas mixture.

5. Method according to one of the preceding claims, wherein the particulate metal is fluidized by the supply of the gas mixture or a fraction of the gas mixture.

6. Method according to one of the preceding claims,

wherein the particulate metal comprises a metal of the following group:

- Iron (Fe),
- Zinc (Zn),
- Copper (Cu)
- Alkali metal, in particular Magnesium (Mg).

7. Method according to one of the preceding claims, wherein the particulate metal is iron ore or iron ore pellets.

8. System for processing biomass, comprising

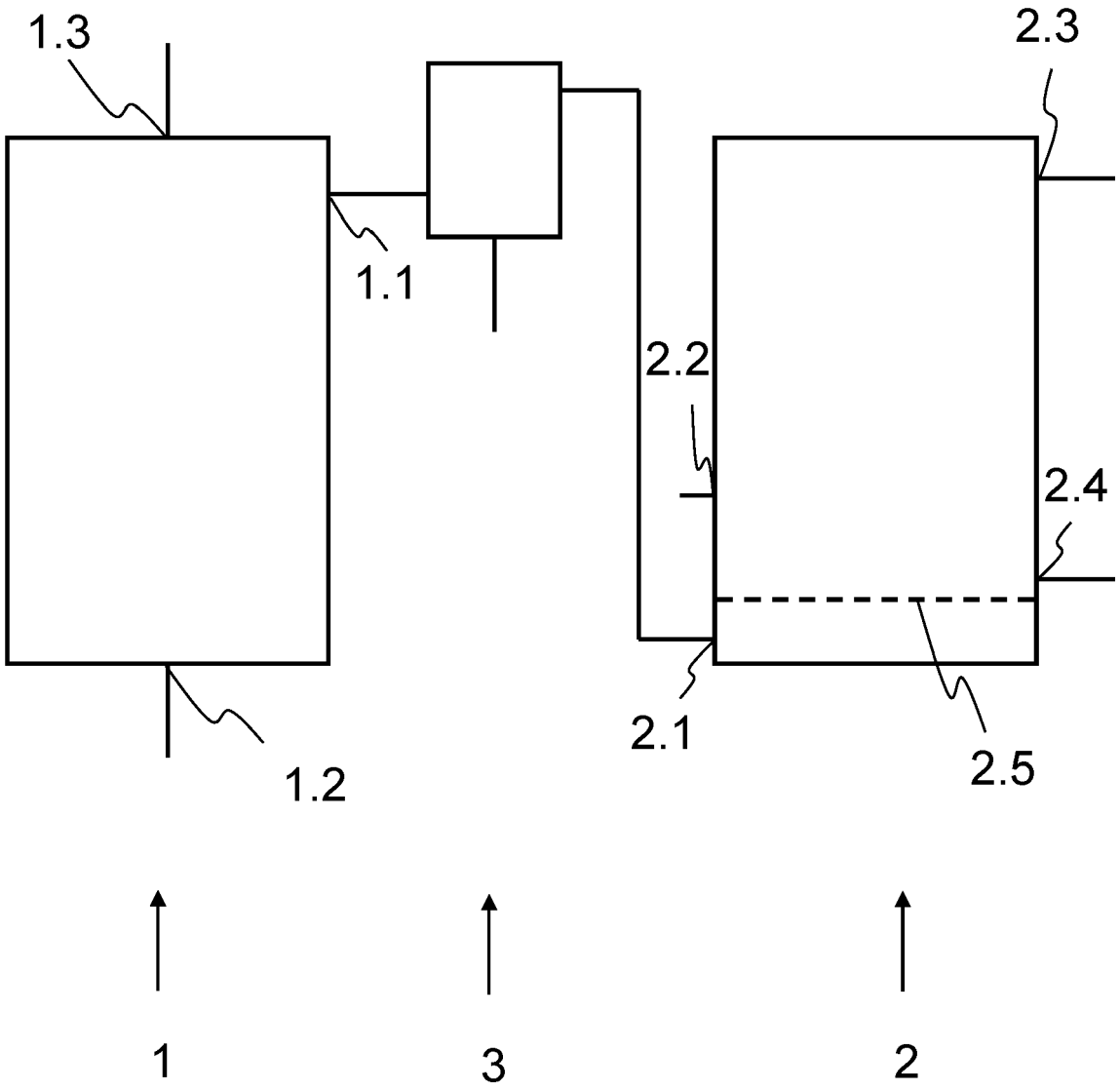
- a gasifier (1) for the gasification of biomass to a gas mixture and
- a reactor (2) for treating particulate metal with the gas mixture or with a fraction of the gas mixture, wherein

an outlet (1.1) of the gasifier (1) for the gas mixture is connected to an inlet (2.1) of the reactor (2).

9. System according to claim 8, wherein the reactor (2) is a fluidized bed reactor and the outlet (1.1) of the gasifier (1) is connected to a fluidizing bottom (2.5) of the fluidized bed reactor such that particulate metal in the fluidized bed reactor is fluidized.

10. System according to one of claims 8 or 9, wherein the gasifier (1) is one of the following types: moving bed, counter-current fixed bed, co-current fixed bed, fluidized bed, entrained flow.

11. System according to one of claims 8 to 10, wherein a treatment unit (3) for the gas mixture is arranged between the outlet (1.1) of the gasifier (1) and the inlet (2.1) of the reactor (2).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EUROPEAN SEARCH REPORT

Application Number
EP 21 20 5890

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X	US 2009/308204 A1 (KOOIJ CHRISTIAAN JOHANNES [NL]) 17 December 2009 (2009-12-17) * figures 3-6 * * claims 1-47 * * paragraphs [0080], [0043] *	1-6,8, 10,11	
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TECHNICAL FIELDS SEARCHED (IPC)

C10J
C21C
C22B
C21B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	20 April 2022	Lachmann, Richard

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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