



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
21.12.2022 Bulletin 2022/51

(51) International Patent Classification (IPC):
C10L 5/44 ^(2006.01) **C10L 5/36** ^(2006.01)

(21) Application number: **22179147.8**

(52) Cooperative Patent Classification (CPC):
C10L 5/442; C10L 5/363; C10L 2290/02;
C10L 2290/06; C10L 2290/08; C10L 2290/30;
C10L 2290/541

(22) Date of filing: **15.06.2022**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

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(30) Priority: **15.06.2021 NL 1044066**

(54) **METHOD AND SYSTEM FOR COMBINED DRYING OF BIOMASS AND CAPTURE OF CARBON DIOXIDE**

(57) Method and system for drying biomass, said method comprising the steps: supplying a first biomass as fuel to a thermal boiler, which is arranged for heating a thermal medium by combustion of the first biomass supplied; drying a second biomass in a dryer by evaporation of water from the second biomass, wherein the dryer is heated by the heated thermal medium from the

thermal boiler, and wherein the cooled thermal medium is returned to the thermal boiler; supplying combustion gases, coming from the thermal boiler, to a CO₂ capture module, configured to capture the CO₂ in the combustion gases and form a stream of CO₂ by means of energy released from the dryer in the stream of evaporated water obtained from the second biomass.

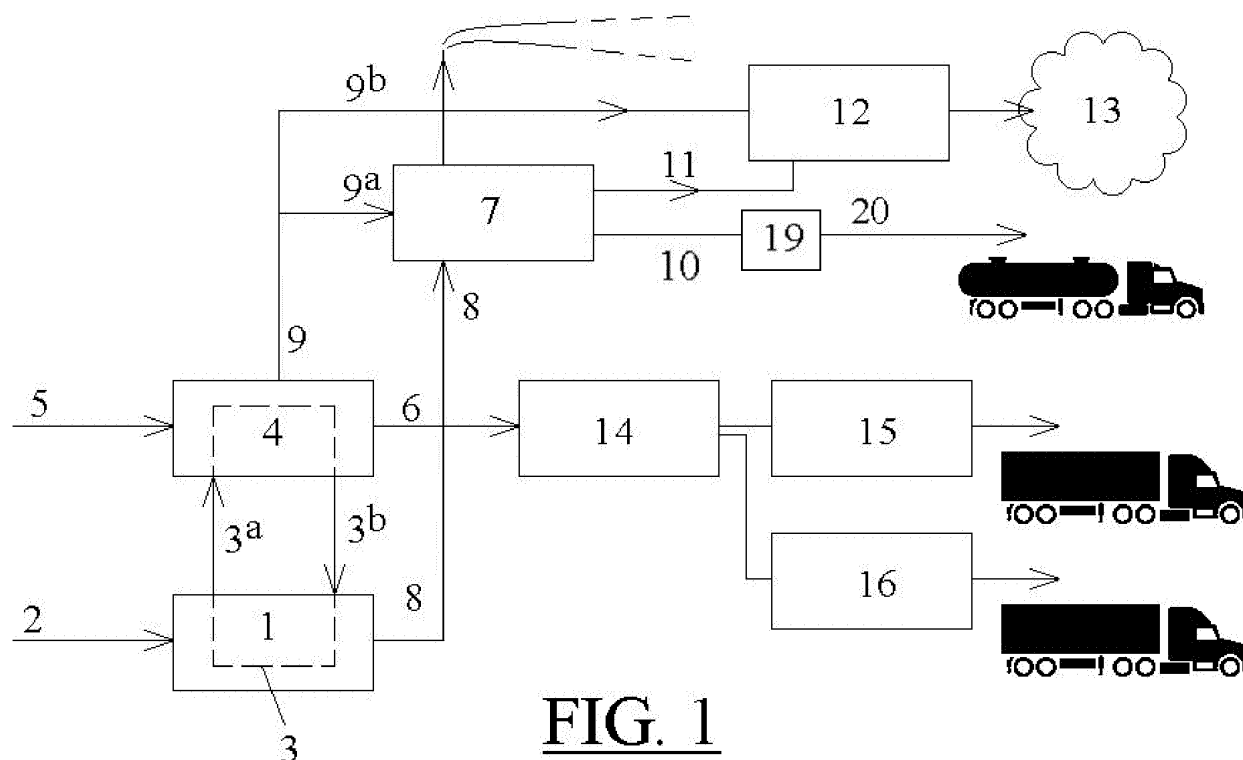


FIG. 1

Description

[0001] The invention relates to a method and system for drying biomass. The method and the system are suitable for drying (wet) biomass for which further processing is difficult, such as ligneous residual streams (residual wood) such as prunings, waste wood, so that these residual streams are suitable for the production of biopellets for (use in) wood pellet boilers and/or (other) installations.

[0002] The present invention aims to provide a production process with a substantially negative CO₂ footprint ("carbon footprint"; for this concept see for example https://en.wikipedia.org/wiki/Carbon_footprint).

[0003] Ligneous residual streams are difficult to reuse sustainably and to recycle to a usable product. A good option is processing of the ligneous residual streams to biopellets, which can be used as fuel for example in stoves and boilers for heating installations and the like. Compared to the use of natural gas, a substantial decrease in CO₂ emission can be achieved. A drawback of processing ligneous residual streams is high energy consumption, and thus high CO₂ emission and CO₂ footprint, as a result of pretreatment and drying of these residual streams. In order to make these residual streams suitable for pressing of biopellets, among other things the residual streams are separated into usable and unusable fractions, and then the usable fractions are among other things rinsed/washed, comminuted to wood chips, sieved into fractions and then dried. The wood chips have a high moisture content because moist residual streams such as prunings are used and because during processing and making the residual streams suitable, rinsing and washing with water take place. Even when biomass is used as fuel for the thermal boiler of the wood chip dryer, production of biopellets from ligneous residual streams leads to undesirable extra CO₂ emission.

[0004] The aim of the invention is therefore to provide a method and system for drying wet, ligneous residual streams, wherein extra CO₂ emission is prevented and a greater reduction in CO₂ emission is achieved compared to the use of natural gas.

[0005] For this purpose, according to the invention a method is provided for drying biomass, said method comprising the steps:

- supplying a first biomass as fuel to a thermal boiler, which is arranged for heating a thermal medium by combustion of the first biomass supplied;
- drying a second biomass in a dryer by evaporation of water from the second biomass, wherein the dryer is heated by the heated thermal medium from the thermal boiler, wherein the cooled thermal medium is returned to the thermal boiler;
- supplying combustion gases, coming from the thermal boiler, to a CO₂ capture module, configured to capture the CO₂ in the combustion gases and to form a CO₂ stream by means of energy released from the

dryer in the stream of evaporated water obtained from the second biomass.

[0006] By using the energy in the stream of evaporated water obtained from the second biomass in the CO₂ capture module, a considerable decrease in CO₂ emission is achieved and improved heat integration is obtained for the method for drying biomass.

[0007] Preferably, the method according to the invention further comprises supplying a part of the energy released from the dryer in the stream of evaporated water, and/or energy released from the CO₂ capture module, to an external heating system. By further heat integration with (external) heating systems such as district heating or heating a greenhouse, a further decrease in CO₂ emission can be obtained.

[0008] The dried second biomass from the dryer is preferably successively cleaned, post-comminuted and pelletized to biopellets; in particular, the second biomass comprises wet wood chips. Very good results in the form of high-grade biopellets were obtained when feeding the dryer with biomass that contains wet wood chips and treating the dry wood chips prior to pressing the biopellets.

[0009] The second biomass is rinsed and/or sieved and/or comminuted prior to the drying step. Owing to the improved heat integration, it is possible to produce high-grade biopellets by improving the second biomass qualitatively by applying among other things rinsing and washing steps, so that the second biomass comprises less contamination but acquires a higher water content thereby and will consume more energy during drying, which will not lead to an appreciable increase in CO₂ emission.

[0010] In a preferred embodiment, the CO₂ capture module comprises a quenching unit, an absorption unit and a stripper unit. As a result, good heat integration can be obtained with the drying process because the energy in the stream of evaporated water can be used in for example the stripper unit.

[0011] Besides the method presented above, the present invention also comprises a system for drying biomass, comprising:

- a thermal boiler, which is arranged for heating a thermal medium by combustion of first biomass that is supplied;
- a dryer, which is heated by the heated thermal medium from the thermal boiler, wherein the cooled thermal medium is returned to the thermal boiler, wherein the second biomass is dried in the dryer by evaporation of water from the second biomass to a stream of evaporated water;
- a CO₂ capture module that is arranged to capture the CO₂ in the combustion gases from the thermal boiler and form a stream of CO₂ by means of energy released from the dryer in the stream of evaporated water obtained from the second biomass.

[0012] The system according to the invention is preferably arranged for supplying a part of the energy released from the dryer in the stream of evaporated water, and/or energy released from the CO₂ capture module, to an external heating system.

[0013] The system according to the invention further comprises means that are arranged so that second biomass dried by the dryer is successively cleaned, post-comminuted and pelletized to biopellets.

[0014] Preferably, units are provided prior to the dryer for rinsing and/or sieving and/or comminuting the second biomass.

[0015] In particular, the second biomass comprises wet wood chips.

[0016] In an advantageous embodiment, the CO₂ capture module comprises a quenching unit, an absorption unit and a stripper unit.

[0017] In a practical embodiment, the stream of CO₂ from the capture module is liquefied in a cooling and compression unit.

[0018] The advantages of the system for drying biomass tally with the advantages of the method for drying biomass.

[0019] The invention will now be discussed further on the basis of the following description of the figure.

[0020] Fig. 1 shows schematically an embodiment example of a system according to the invention, in which the method can be carried out.

[0021] Fig. 1 shows schematically an embodiment example of a system according to the invention, arranged for drying (wet) biomass and arranged for reducing CO₂ emission through improved heat integration. In the embodiment example, (wet) wood chips are dried as second biomass 5 and processed further and then pressed to high-grade, certified biopellets for example for wood pellet boilers/installations. The second biomass 5 is preferably a moist ligneous residual stream of little value such as prunings from landscape maintenance or other waste wood. There is not usually any good, alternative (re)use available for this biomass.

[0022] The system comprises

- a thermal boiler 1, which is arranged for heating a thermal medium 3 by combustion of first biomass 2 that is supplied;
- a dryer 4, which is heated by the heated thermal medium 3a from the thermal boiler 1, wherein the cooled thermal medium 3b is returned to the thermal boiler 1, wherein second biomass 5 is dried in the dryer 4 by evaporation of water from the first biomass 5 to a stream of evaporated water 9;
- a CO₂ capture module 7, which is arranged for capturing the CO₂ in the combustion gases 8 from the thermal boiler 1 and to form a stream of CO₂ 10 by means of energy released from the dryer in the stream of evaporated water 9 obtained from the second biomass 5. Depending on the requirements, a first portion 9a of the stream of evaporated water 9

can be used in the CO₂ capture module 7.

[0023] First biomass 2 is used as fuel for the thermal boiler 1. First biomass 2 may be identical to second biomass 5, but may also be another biomass fraction, of a different composition, for example a waste stream from the cleaning/washing step of the second biomass or for example waste pellets 16 from the pelletizing unit.

[0024] A suitable thermal oil may be used as thermal medium 3, or some other suitable fluid for example such as (superheated) steam of for example 225°C at 25 bar.

[0025] The system according to the invention shown in Fig. 1 is moreover arranged for supplying a second portion 9b (for example approx. 30%) of the stream of evaporated water 9 released from the dryer 4 or at least the energy (in the form of heat) therefrom, and/or the energy 11 released as residual product from the CO₂ capture module or at least the heat therefrom, to an external heating system 12 for example for (town) district heating 13.

[0026] The system according to the invention shown in Fig. 1 further comprises means that are arranged for successively cleaning and post-comminuting the dry wood chips 6, produced by the dryer 4, in unit 14 and for pelletizing them for example to pellets with a size of for example 6 mm in unit 15, obtained from the clean fraction, plus pellets with a size of for example 8 mm in unit 16, obtained from the waste fraction. To achieve the intended negative carbon footprint it is important that practically all material streams are used, including the waste stream (waste fraction). This relates to approx. 10-12% of the input of the dry chips 6 that are processed to 8 mm industrial pellets in unit 16.

[0027] A short English description of the operation of the CO₂ capture module 7 is given below:

The CO₂ capture module/system 7 works like this:

The precleaned (ready to exhaust to the surroundings if not used for CO₂ capture) combustion gases 8 are led into the CO₂ capture system 7.

[0028] The first step is to precool the flue gases; this is done in a quenching/scrubber tank. After cooling and pre-washing the flue gases are led into an absorber vessel. This vessel contains mass-transfer equipment facilitating the transfer of the CO₂ from the flue gas into the absorption liquid. The absorption liquid (e.g. GALLOXOL®) is an aqueous liquid which contains a salt amine which dissolved in the water can react with the CO₂ in the air via gas/liquid contact. The salt-amine CO₂ reaction is reversible and very selective towards CO₂.

[0029] The mixture content is guaranteed as a risk free and mineral based mixture with no harmful components.

[0030] After the absorption the flue gases are exhausted through the chimney without CO₂.

[0031] The CO₂ rich absorption liquid flows into the regenerator/stripper. The mixture is heated with waste heat in the flow of evaporated water 9 from the dryer 4. The heating of the mixture releases the CO₂ as a CO₂/water vapor mixture.

[0032] The CO₂/water vapor mixture is cooled and condensed free water removed. The heat produced from the cooling process is reused in the process or used for another heat demanding process.

[0033] The pure still slightly wet CO₂ is then dried and further purified in a CO₂ dryer unit up to high technical quality.

[0034] Subsequently, the CO₂ gas 10 undergoes a cleaning process to ensure food grade quality by compressing and cooling in a liquefying unit 19 and stored to make the liquid CO₂ 20 portable in trucks.

[0035] It should be noted that the electrical energy required for carrying out the method according to the invention obviously preferably consists of sustainably generated "green power", but a negative CO₂ footprint is also obtained with "grey power".

[0036] Thus, the present invention provides a production process with a substantially negative CO₂ footprint, which can be confirmed by research that has been carried out and published:

<https://www.stichtingbeon.nl/houtpellets-jalo-biopellets-scoren-positief-op-duurzaamheid/> and
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Claims

1. Method for drying biomass, comprising the steps:

- supplying a first biomass as fuel to a thermal boiler, which is arranged for heating a thermal medium by combustion of the first biomass supplied;
- drying a second biomass in a dryer by evaporation of water from the second biomass, wherein the dryer is heated by the heated thermal medium from the thermal boiler, wherein the cooled thermal medium is returned to the thermal boiler;
- supplying combustion gases, coming from the thermal boiler, to a CO₂ capture module, configured to capture the CO₂ in the combustion gases and form a stream of CO₂ by means of energy released from the dryer in the stream of evaporated water obtained from the second biomass.

2. Method according to Claim 1, comprising supplying a part of the energy released from the dryer in the stream of evaporated water, and/or energy released from the CO₂ capture module, to an external heating system.

3. Method according to Claim 1 or 2, wherein the second biomass dried by the dryer is successively cleaned and post-comminuted, and is pelletized to biopellets.

4. Method according to Claims 1-3, wherein the second biomass is rinsed and/or sieved and/or comminuted before the drying step.

5. Method according to Claims 1-4, wherein the second biomass contains wet wood chips.

6. Method according to Claims 1-5, wherein the CO₂ capture module comprises a quenching unit, an absorption unit and a stripper unit.

7. Method according to Claims 1-6, wherein the stream of CO₂ from the capture module is liquefied in a cooling and compression unit.

8. System for drying biomass, comprising:

- a thermal boiler (1), which is arranged for heating a thermal medium (3) by combustion of first biomass (2) that is supplied;
- a dryer (4), which is heated by the heated thermal medium (3a) from the thermal boiler (1), wherein the cooled thermal medium (3b) is returned to the thermal boiler (1), wherein second biomass (5) is dried in the dryer (4) by evaporation of water from the second biomass (5) to a stream of evaporated water (9);
- a CO₂ capture module (7), which is arranged to capture the CO₂ in the combustion gases (8) from the thermal boiler (1) and form a stream of CO₂ (10) by means of energy released from the dryer in the stream of evaporated water (9) obtained from the second biomass (5).

9. System according to Claim 8, arranged for supplying a part (9b) of the energy in the stream of evaporated water (9) released from the dryer (4), and/or energy (11) released from the CO₂ capture module (7), to an external heating system (12).

10. System according to Claim 8 or 9, comprising means (14,15,16) that are arranged so that second biomass (6) dried by the dryer (4) is successively cleaned, post-comminuted and pelletized to biopellets.

11. System according to Claims 8-10, wherein units are provided prior to the dryer for rinsing and/or sieving and/or comminuting the second biomass (5).

12. System according to Claims 8-11, wherein the second biomass (5) contains wet wood chips.

13. System according to Claims 8-12, wherein the CO₂ capture module comprises a quenching unit, an absorption unit and a stripper unit.

14. System according to Claims 8-13, wherein a cooling and compression unit (19) is provided, which lique-

fies the stream of CO₂ (10) from the capture module.

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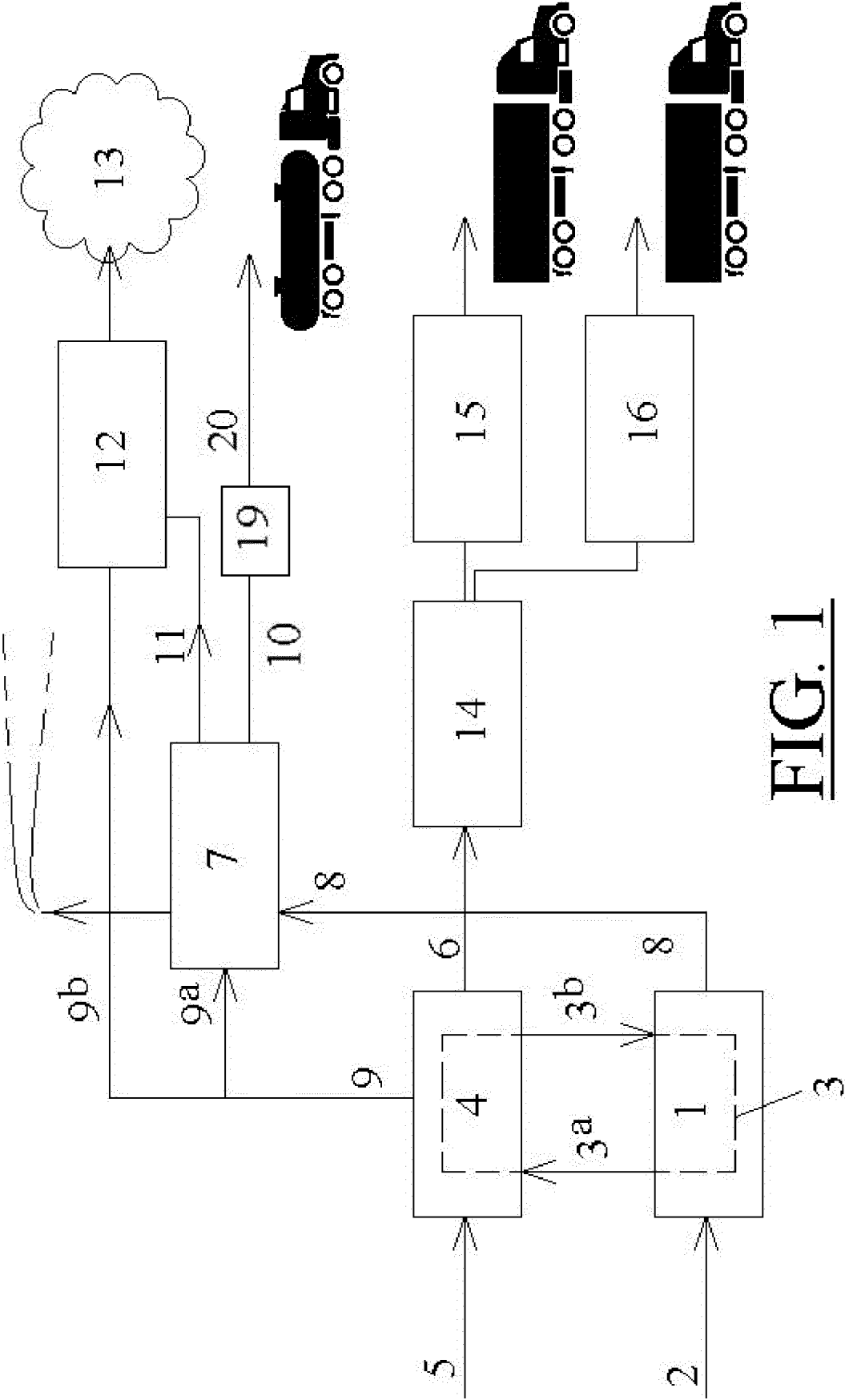


FIG. 1



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Application Number

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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