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(54) **METHOD AND SYSTEM FOR TREATING BIOMASS**

(57) The invention relates to a method for treating biomass. In a first step (S10), the biomass (10) and a treatment medium (11) are fed into a treatment unit (12) such that the treatment medium (11) interacts with the biomass (10) in order to provide pre-treated biomass (10a, S10). In another step (S20), the pre-treated biomass (10a) is filtrated in a separation unit (20) arranged downstream the treatment unit (12), wherein a filtrate (21)

is separated from the pre-treated biomass (10a) in the separation unit (20, S20). In another step (S30), the pre-treated biomass (10a) is fed into a reactor unit (30) arranged downstream the separation unit (20), wherein a steam treatment of the pre-treated biomass (10a) takes place within the reactor unit (30, S30). The invention also relates to a device (1) for treating biomass.

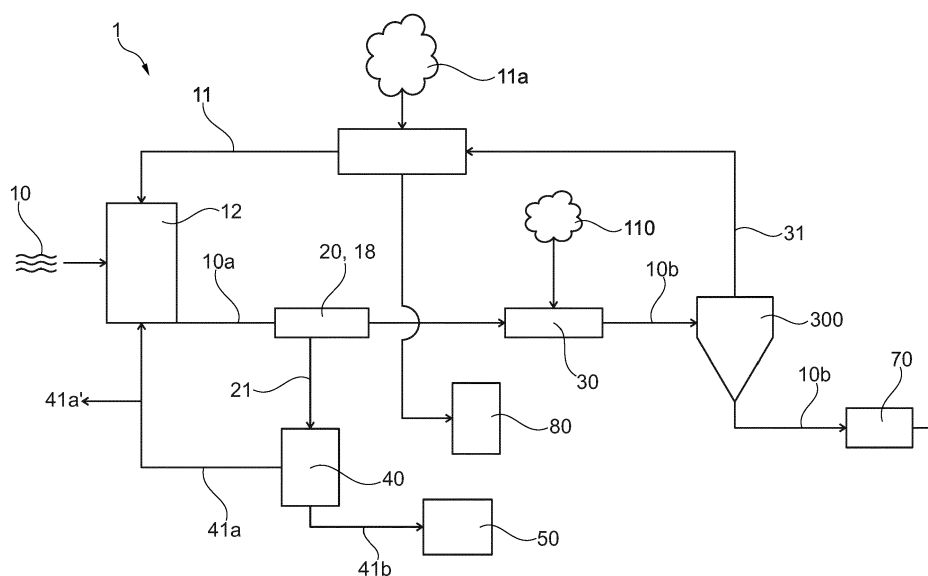


Fig. 1

Description

Field of the invention

[0001] The invention generally relates to treatment systems for treating biomass. In particular, the invention relates to a method for treating biomass and a device for treating biomass.

Background of the invention

[0002] The production of biocoal plays an important role in today's biomass treatment processes. For example, biocoal is produced by steam explosion of heated biomaterial. Therein, the ash content and energy density are important properties of the final product. The yield of a steam explosion biocoal process is quite high and mainly all the material, e.g. the biomass, remains in the final product. However, depending on which raw material is used, high ash content can be a problem as it is not removed during steam explosion. The yield loss is partly due to hemicellulose that is degraded into by-products such as furfural, low molecule weight organic acid etc. The presence of furfural and other similar degradation products can be a problem during the production of the biocoal. Furthermore, off-gassing and smell problems during the storage of the final products may occur. The presence of low energy value compounds, for example hemicellulose, is also a limitation for a high energy density.

[0003] Current processes to decrease ash content during the production of the biocoal include chip washing which is not easily applicable to all materials, in particular bark or forest residue. The non-optimal utilization of the different wood components is a limiting factor for the economy of biocoal processes.

Summary of the invention

[0004] It is an object of the present invention to provide an improved process for treating biomass.

[0005] This object is achieved by the subject-matter of the independent claims. Further exemplary embodiments are evident from the dependent claims and the following description.

[0006] According to a first aspect of the present invention, a method for treating biomass is provided. In a step of the method, the biomass and a treatment medium are fed into a treatment unit such that the treatment medium interacts with the biomass in order to provide pre-treated biomass. For feeding the biomass into the treatment unit, a plug screw may be used which is arranged upstream of the treatment unit. This pre-treated biomass is filtrated in a separation unit which is arranged downstream the treatment unit, wherein the filtrate is separated from the pre-treated biomass in the separation unit. The pre-treated biomass is afterwards fed into a reactor unit which is arranged downstream the separation unit, wherein a

steam treatment of the pre-treated biomass takes place within the reactor unit.

[0007] In particular, the pre-treated biomass is exposed to steam within the reactor unit, wherein the steam is fed into the reactor unit in addition to the pre-treated biomass. By treating the pre-treated biomass with steam in the reactor unit, a treated biomass is generated. This treated biomass may be discharged from the reactor unit afterwards, wherein a steam explosion on the treated biomass may take place during the discharge of the treated biomass, for example in a blow valve arranged downstream the reactor unit. A restriction which may have the shape of a hole through which the treated biomass is discharged may provide a means in which the steam explosion occurs. In particular, this restriction makes it possible that the steam can expand such that a flashing may occur. The steam may for instance be water steam.

[0008] In another step, the final product, e.g. biocoal, may be produced based on the treated biomass leaving the reactor unit. However, the final product is not necessarily biocoal. In particular, the composition of the final product may be dependent on the raw material, e.g. the biomass, fed into the treatment unit and on the treatment of the biomass during the different steps of the method.

[0009] Using such a method for treating biomass makes it possible that a considerable reduction of the ash content or hemicellulose content can be achieved within the pre-treated biomass before the steam explosion is exerted on the pre-treated biomass. Furthermore, a better fractionation of the biomass as well as a more even treatment, particularly in subsequent process steps like for instance steam explosion, may be achieved. This ensures a reduced ash content in the final product and that a higher energy value of the final material, e.g. the biocoal material that may be present in pellets form, can be achieved. Valuable parts of the filtrate may be used for other applications in the process. In general, a higher yield over the steam explosion reactor as well as less degradation products can be achieved with the inventive method for treating biomass.

[0010] The biomass may comprise wood material, non-wood material, bark or forest residues. The final product to be achieved by the method may be biocoal in the form of pellets for example. After the biomass is fed into the treatment unit which may be a vertical reactor unit, a reaction between the biomass and the treatment medium, which is also filled into the treatment unit, takes place in order to provide the pre-treated biomass. The treatment medium may for instance be steam or an impregnation liquid filled into the treatment unit. Therefore, the pre-treated biomass may either be a pre-steamed biomass or an impregnated biomass. In this manner, two different types of biomass treatment processes may be covered by the inventive method. In another embodiment, the biomass may also be pre-steamed before the impregnation stage. In particular, the biomass may also be pre-steamed before feeding the biomass into the treatment unit. A steaming of the biomass, e.g. a steam treat-

ment of the biomass may therefore be carried out in separate subsequent steps.

[0011] After the biomass has been pre-treated in the treatment unit, a filtration of the pre-treated biomass is carried out in the separation unit. Therefore, the pre-treated biomass may be transferred from the treatment unit to the separation unit, for example by means of a conveyor unit. Such a conveyor unit may comprise a screw conveyor. However, the conveyor unit may also comprise a chute such that the pre-treated biomass may fall from the treatment unit into the separation unit. Therefore, gravity effects may also be used in order to convey the pre-treated biomass from the treatment unit to the separation unit. In the separation unit, which is arranged downstream the treatment unit, the pre-treated biomass is filtrated such that a filtrate is provided in the separation unit. In particular, the filtrate is separated from the pre-treated biomass within the separation unit. The filtration of the pre-treated biomass in the separation may also be referred to as dewatering of the pre-treated biomass. The filtrate may be collected and sent to a further refining process which will be described in detail hereinafter. The separation unit may be combined with a feeding part of the reactor unit. Therefore, the separation unit may be a separation unit and a feeding unit simultaneously.

[0012] After the filtrate is separated from the pre-treated biomass in the separation unit, the pre-treated and now also filtered biomass is fed into the reactor unit arranged downstream the separation unit. For example, the pre-treated biomass is transferred from the separation unit to the reactor unit by means of a further conveyor unit, for example by means of the screw conveyor. The conveyor unit for transferring the pre-treated biomass from the separation unit to the reactor unit may be a plug screw feeder. The conveyor unit, in particular the plug screw feeder may be adapted to seal the reactor unit from parts upstream of the reactor unit, for example from the separation unit and from the treatment unit. The transfer of the pre-treated biomass from the separation unit to the reactor unit may comprise a feeding of the pre-treated biomass to the reactor unit as well as a further separation of filtrate from the pre-treated biomass even after the separation unit. At the reactor unit, in particular at an outlet of the reactor unit, a steam explosion on the pre-treated biomass takes place. Therefore, the treated biomass is discharged from the reactor unit such that the treated biomass is transferred through a blow valve or a restriction arranged at the outlet of the reactor unit in order to expand the treated biomass thereafter.

[0013] In the context of the present invention, a steam explosion may be understood as a violent boiling or a flashing of water into steam. Therefore, steam is introduced into the reactor unit such that the steam may act on the pre-treated biomass within the reactor unit. Excess steam may be recovered after discharging the biomass from the reactor unit, i.e. after the steam explosion in the reactor unit. This steam may be recirculated to other steps in the treatment process. After the steam treatment

of the pre-treated biomass has been carried out, the steamed biomass may be discharged from the reactor unit where a steam explosion of the treated biomass takes place. In particular, the steam explosion occurs when discharging the treated biomass out of the reactor unit. After the steam explosion on the pre-treated biomass has been carried out, the steamed and/or steam exploded biomass may be subjected to further treatment steps after the reactor unit. The end product or final product of the method may for instance be biocoal in the form of pellets.

[0014] According to an embodiment of the invention, the separated filtrate is divided or split within a filtration unit into a first filtrate portion with a solid matter content that is lower than a predetermined threshold value and a second filtrate portion with a solid matter content that is higher than the predetermined threshold value.

[0015] In this manner, it is possible to distinguish between different by-products of the biocoal production process. For example, the separated filtrate is discharged from the separation unit and may be used for other production steps in the treatment method. Therefore, the selection of filtrate portions which are suitable to be used in further treatment steps can be carried out in the filtration unit. It is possible that the first filtrate portion with the solid matter content that is lower than the predetermined threshold value can be recirculated back to the treatment unit such that the first filtrate portion can be used, in particular reused, as treatment medium in the treatment unit. Furthermore, it is possible that the second filtrate portion with a solid matter content that is higher than the predetermined threshold value can be used in a further processing step within the treatment process of the biomass. For example, the second filtrate portion may be transferred to a further refining before using it in another treatment step. However, the first filtrate portion and/or the second filtrate portion may also be discharged from the treatment process in order to be separately used for other purposes which means that the filtrate portions are not used in the treatment process again.

[0016] According to another embodiment of the invention, the solid matter content of the first filtrate portion represents a content of hemicellulose and/or a content of ash in the first filtrate portion. The solid matter content of the second filtrate portion, however, represents a content of hemicellulose and/or a content of ash in the second filtrate portion.

[0017] Thus, it is possible to separate or split a filtrate portion with a high hemicellulose or ash content from a filtrate portion with low hemicellulose or ash content. However, the predetermined threshold value which may be manually or automatically set determines whether the filtrate portion belongs to the first filtrate portion or to the second filtrate portion. The first filtrate portion may therefore comprise a hemicellulose and/or ash content that is lower than the predetermined threshold value and a second filtrate portion may comprise a hemicellulose and/or

ash content that is higher than the predetermined threshold value. In this manner, it is possible to provide two streams of filtrate in which one stream of the filtrate, e.g. the first filtrate portion, has a low hemicellulose and/or ash content and the second filtrate portion has a high hemicellulose and/or ash content. The filtrate content may contain chemicals.

[0018] According to another embodiment of the invention, a recirculation of the first filtrate portion back to the treatment unit is carried out such that the first filtrate portion is reused for pre-treating the biomass in the treatment unit. Both the recirculated first filtrate portion and the treatment medium fed into the treatment unit interact with the biomass within the treatment unit in order to provide the pre-treated biomass.

[0019] Thus, it is possible to reuse treatment medium which was fed into the reactor unit for pre-treating the biomass by filtrating a part of this treatment medium in the separation unit and in the filtration unit and recirculating this part of treatment medium back to the treatment unit. However, it is possible to reuse the first filtrate portion for treatment in the treatment unit only if the first filtrate portion has a hemicellulose and/or ash content that is lower than the predetermined threshold value. In this manner, a recirculation of filtrates with high hemicellulose and/or ash content back to the treatment unit can be prevented.

[0020] According to another embodiment of the invention, the second filtrate portion is fed into a refining unit for further processing the second filtrate portion by means of one of a chemical reaction, a thermal reaction and a biochemical reaction.

[0021] Therefore, it is possible to further process or refine filtrate portions separated from the pre-treated biomass, wherein the separated filtrate portions may only be used for further processing or refining if the hemicellulose and/or ash content is higher than the predetermined threshold value. The first filtrate portion and the second filtrate portion may be transferred in separate lines, for example by means of pumps integrated into these lines. However, the first filtrate portion is pumped back to the treatment unit whereas the second filtrate portion is pumped to the refining unit such that the chemical reaction, the thermal reaction and the biochemical reaction can be carried out in combination or alternatively. Such a refining process provides the possibility to obtain valuable by-products of the biocoal production process.

[0022] According to another embodiment of the invention, the second filtrate portion is screened for determining a composition of the second filtrate portion before feeding the second filtrate portion into the refining unit. The screening may be carried out in a screening unit.

[0023] The screening of the second filtrate portion may allow an evaluation of the quality of the second filtrate portion and the products which can be obtained by a refining of the second filtrate portion in the refining unit. In particular, the screening allows the determination of the

composition of the second filtrate portion and therefore a determination of the hemicellulose and/or ash content in the second filtrate portion. The results of the screening may be used in order to decide whether a further reduction or increase of the hemicellulose and/or ash content in the second filtrate portion is required. It is also possible that the first filtrate portion is screened before feeding it back to the treatment unit such that a specified purity degree of the recirculated treatment medium can be ensured.

[0024] According to another embodiment of the invention, steam, in particular a part of the steam from the steam treatment of the pre-treated biomass in the reactor unit is recovered such that this steam can be discharged from the reactor unit.

[0025] Furthermore, steam, in particular a part of the steam from the steam explosion on the treated biomass at the discharge of the reactor unit is recovered.

[0026] Therefore, it is possible to reuse excess steam from the steam treatment step in the reactor unit and from the steam explosion step after the treatment step in the reactor unit, wherein the recovered steam may be fed into a heat exchanger, a condensation unit or directly into the treatment unit. These aspects will be described in more detail hereinafter.

[0027] According to another embodiment of the invention, the recovered steam is fed into the treatment unit, wherein the recovered steam is used for pre-treating the biomass in the treatment unit. The condensation of at least a part of the recovered steam is carried out in a condensation unit such that thermal energy is provided during the condensation of the recovered steam by means of the condensation unit.

[0028] In this embodiment, the recovered steam is used in the condensation unit to produce thermal energy which can be used for the treatment process itself or for external devices. Valuable components in the steam can be partly or totally separated from the steam flow, for example by a partial condensation in the condensation unit.

[0029] According to another embodiment of the invention, the treatment medium is steam fed into the treatment unit for pre-steaming the biomass within the treatment unit such that a pre-steamed biomass is provided representing the pre-treated biomass.

[0030] Steam is provided for the treatment of the biomass in the treatment unit. Additional recovered steam can be fed into the treatment unit from the reactor unit. In this manner it is possible to provide a pre-steaming of the biomass before the separation of the filtrate and before the steaming, e.g. the main steaming, in the reactor unit. In this embodiment, the pre-treated biomass may also be referred to as pre-steamed biomass as the biomass is pre-steamed in the treatment unit.

[0031] According to another embodiment of the invention, an impregnation liquid is fed into the treatment unit for impregnating the biomass within the treatment unit such that an impregnated biomass is provided represent-

ing the pre-treated biomass.

[0032] Thus, the treatment of the biomass by means of the impregnation liquid is an alternative treatment to the treatment of the biomass by means of the steam fed into the treatment unit. Therefore, the biomass is impregnated in the treatment unit before the filtrate is separated from the pre-treated biomass and before the steam treatment of the pre-treated biomass is carried out in the reactor unit. In this embodiment, the pre-treated biomass may also be referred to as impregnated biomass as the biomass is impregnated in the treatment unit. In particular, the treatment medium is the impregnation liquid with which the biomass is impregnated within the treatment unit in order to provide the impregnated biomass. It is possible that both steam and impregnation liquid are fed into the treatment unit in order to pre-treat the biomass.

[0033] According to another embodiment of the invention, the impregnation liquid is filled into the treatment unit up to a predetermined fill level such that the impregnation of the biomass takes place during a transfer of the biomass through the treatment unit.

[0034] It is possible that all the biomass which is transferred through the treatment unit interacts with the impregnation liquid since the biomass is transferred through the impregnation liquid stored in the treatment unit. For example, the treatment unit is a vertical reactor unit in which the biomass is conveyed by means of a screw conveyor in an upward direction. For example, the treatment unit which may have a longitudinal shape may be vertically arranged with respect to an earth surface. The raw material, e.g. the biomass, may be introduced or fed into the treatment unit by means of a screw conveyor, for example by means of a force feed screw or a plug screw feeder or a combination thereof. In this manner, a pre-compression of the biomass can be achieved before the biomass enters the treatment unit.

[0035] According to another embodiment of the invention, the impregnation liquid is selected from the group comprising water, acid, a catalyst or mixtures thereof. For example, the catalyst may be an acid. For example, the impregnation liquid is water.

[0036] According to another embodiment of the invention, a pressure within the treatment unit is controlled such that the interaction between the treatment medium and the biomass takes place under a pressurized condition.

[0037] Preferably, the impregnation of the biomass with impregnation liquid is carried out under pressurized conditions in the treatment unit. The pressurization in the presence of an acid or a catalyst during the impregnation of the biomass in the treatment unit is a further preferred embodiment. Therein, the catalyst may also comprise an acid.

[0038] Using pressurized conditions during the treatment of the biomass, in particular in the presence of acid or a catalyst which may be an acid in the impregnation liquid, results in an enhanced solubilization of the hemicellulose. This in turn results in an improved separation

of the filtrate with a higher hemicellulose content from the pre-treated biomass.

[0039] According to another embodiment of the invention, a temperature within the treatment unit is controlled such that the interaction between the treatment medium and the biomass takes place under a heated condition.

[0040] The pressurization in the presence of an acid or a catalyst during the impregnation of the biomass in the treatment unit is preferably carried out at a temperature of about 140°C. In this manner, the solubilization of hemicellulose to be removed from the pre-treated biomass can be accelerated and improved. In a subsequent feeding system or within the separation unit, which is arranged downstream the treatment unit, the hemicellulose can be removed from the pre-treated biomass. A retention time of the pre-treated biomass can be achieved in a buffer tank, a chute or a bin arranged between the treatment unit and the separation unit. Furthermore, a combined impregnation and removal of hemicellulose can be achieved which requires less equipment.

[0041] Increasing the temperature and/or the pressure in the treatment system may improve the reaction between the treatment medium and the biomass. In particular, the reaction kinetics can be influenced by heating the biomass during the treatment in the treatment unit.

[0042] For a pressurized impregnation, the temperature may be between 100 and 205 °C. Other temperature ranges may be between 100 and 140 °C or between 180-205 °C, preferably the temperature is between 185 and 195 °C. The pressure in the treatment unit may be the pressure corresponding to the temperature. For example, the pressure may be between 0 and 16.2 bar. Other pressure ranges may be between 0 and 2.6 bar or between 2.6-9 bar. Preferably, the pressure is between 10.2 and 13 bar.

[0043] According to another embodiment of the invention, the reactor unit, in which the steam treatment takes place, is a continuous reactor or a batch reactor.

[0044] According to another aspect of the invention, a device for treating biomass is provided. The device comprises a treatment unit, a separation unit arranged downstream of the treatment unit and a reactor unit arranged downstream of the separation unit. The biomass and a treatment medium are fed into the treatment unit such that the treatment medium can interact with the biomass in order to provide pre-treated biomass. The pre-treated biomass is filtrated in the separation unit such that a filtrate is separated from the pre-treated biomass. The pre-treated biomass is then fed into the reactor unit and a steam treatment of the pre-treated biomass takes place in the reactor unit.

[0045] It is possible that a steam separation unit is arranged downstream of the reactor unit, wherein, in the steam separation unit, excess steam from the steam treatment in the reactor unit is separated from the steam treated biomass. The steam separation unit may for instance be a cyclone or a mechanical steam separation system.

[0046] In the treatment unit, the biomass is either pre-steamed at atmospheric pressure or under high pressure and increased temperature. The pre-treated biomass is then fed into the separation unit in which the filtrate is separated, e.g. the biomass is dewatered and afterwards, the pre-treated biomass is fed into the reactor unit in which the steam treatment takes place. Steam is added into the reactor unit to obtain a desired pressure and/or temperature. The pre-treated biomass is steam-treated in the reactor unit. Furthermore, the treated biomass is steam-exploded when discharging the treated biomass from the reactor unit. The reactor unit may be a continuous reactor or a batch reactor. The filtrates which are separated in the separation unit may be collected and sent to further refining. For example, the filtrate can be concentrated with ultra-filtration and/or the ultra-filtrated filtrate, e.g. the first filtrate, can be reused in the process wherein the second filtrate portion is used for further refining. The refining or conversion into other products of the filtrate can be carried out by a chemical, a thermal or a biochemical reaction. Furthermore, it is possible to refine or convert the filtrate into the other products by a combination of a chemical, a thermal and a biochemical reaction. During conversion of the filtrate, lactic acid, acetic acid, furfural and other by-products may be obtained. Furthermore, a screening of the filtrate can be carried out before or after the ultra-filtration. The ultra-filtration in the filtration unit may be applied for further refinement to remove ash, minerals and fiber that have been pressed out of the raw material in the separation unit.

[0047] The recovered steam in the reactor unit can be used for the pre-steaming of the biomass in the treatment unit. The biomass in the treatment unit may for instance comprise wood raw material. Furthermore, valuable components present in the steam can be partly or totally separated from the steam flow, for example by partial condensation with recovery of energy. Alternatively, the steam can be used in a heat exchanger and all the products are recovered. In this case, the steam is not used directly for the pre-steaming within the treatment unit. This aspect will be described in more detail in the description of the figures.

[0048] In another embodiment, raw material, e.g. the biomass, is impregnated with water and preheated in an atmospheric or pressurized impregnation stage, for example within the treatment unit. The impregnation may be carried out before feeding the biomass into the reactor unit and in particular before feeding the biomass into the separation unit. The impregnated biomass is dewatered, e.g. the filtrate is separated from the biomass between the impregnation stage and the reactor unit. For example, a plug screw that is used for feeding the pre-treated biomass into the reactor unit may also be used to separate the filtrate from the pre-treated biomass in the separation unit. In particular, the separation unit may comprise a screw conveyor, e.g. a screw press. Furthermore, a separate drainage equipment can be used in the separation unit in order to separate the filtrate or drain the filtrate out

of the pre-treated biomass in the separation unit. The filtrate is usually rich in hemicellulose as well as ash.

[0049] The filtrate can be concentrated, for example with ultra-filtration and the filtrate can be reused in the process, for example in the treatment unit, whereas another part, e.g. the second portion of the filtrate, is used for further refinement. In particular, the first filtrate portion is reused in the treatment unit, for example as impregnation liquid, and the second filtrate portion is used for further refining in the refining unit. The refining or conversion into other products of the second filtrate portion can be carried out by a chemical, a thermal or a biochemical reaction or a combination thereof. The screening of the filtrate can be carried out before or after the ultra-filtration and a further refining to remove ash, minerals and fiber that have been pressed out of the biomass may also be carried out.

[0050] The recovered steam can be used for the pre-steaming of the biomass in the treatment unit. Valuable components present in the steam can be partly or totally separated from the steam flow, for example by partial condensation. Alternatively, the steam can be used in a heat exchanger and all the products can be recovered in this way. In this case, the recovered steam is not used directly for the pre-steaming within the treatment unit.

[0051] The inventive method provides for a higher energy value of the final pellets, e.g. the biocoal pellets, and a recovery of hemicellulose that can be used for other applications. In particular, the inventive method or device provides for a removal of hemicellulose that can be recovered for other applications. For example, a chemical, a biochemical or a thermal conversion into other products may be carried out. A further consequence of the inventive method and device is a higher yield over the steam explosion reactor, e.g. the reactor unit, and a less degradation of products as well as a higher energy density. The removal of hemicellulose also leads to a lower ash content, a lower content of byproducts and a reduced off-gassing.

[0052] When using raw material, e.g. biomass, with high sand content or high ash content, the inventive method or device is of particular advantage because the content of ash in the final product can be decreased. The quality of the biocoal, which may be the end product of the method, may be improved although bark and forest residues, which normally lead to a high hemicellulose and ash content, are used as raw material. If the temperature of the process is controlled, a defined pre-heating may be achieved such that the need for steam in the reactor unit is reduced.

[0053] Furthermore, the recovery of steam from a blow line is used in the pre-steaming, e.g. in the treatment unit. A cleaning of the steam may be carried out in order to separate unwanted products from the steam before recirculating the steam from the reactor unit back to the treatment unit. Furthermore, condensate from the condensation unit may be used in the treatment unit. The separation or a concentration of hemicellulose from the

filtrate, for example by ultra-filtration, and the recirculation of the filtrate to the treatment unit may reduce the amount of fresh treatment medium required in the treatment unit. In another embodiment, the filtrate is sent to a further refining step.

[0054] Furthermore, a pre-steaming before the treatment of the biomass in the treatment unit is also possible. The biomass may also be washed before the pre-steaming in the treatment unit. The separation of the filtrate may be carried out pressurized if the pre-steaming or impregnation in the treatment unit is carried out pressurized. However, the separation of the filtrate may also be carried out at atmospheric pressure. The filtrate may be sent to fermentation, aerobic and anaerobic digestion, with or without an intermediate or a simultaneous enzymatic treatment. For example, biogas may be produced during the treatment of the filtrate. The filtrate may contain sugar, e.g. monomers or oligomers, tannin, extractives, etc. The filtrate may further be refined and transformed, for example in the refining unit.

[0055] Ethanol or another solvent can be added into the treatment unit and the pH value in the treatment unit may be adjusted, for example such that a slightly alkaline pH value is obtained in the treatment unit.

Brief description of the drawings

[0056]

- Fig. 1 schematically shows a device for treating biomass according to an embodiment of the invention.
- Fig. 2 schematically shows a part of a device for treating biomass according to an embodiment of the invention.
- Fig. 3 schematically shows a part of a device for treating biomass according to another embodiment of the invention.
- Fig. 4 schematically shows a device for treating biomass using an impregnation of the biomass according to an embodiment of the invention.
- Fig. 5 schematically shows a part of a device for treating biomass using an impregnation of the biomass according to an embodiment of the invention.
- Fig. 6 schematically shows a part of a device for treating biomass using an impregnation of the biomass according to another embodiment of the invention.
- Fig. 7 shows a flow diagram of a method for treating biomass according to an embodiment of the invention.

Detailed description of the drawings

[0057] In Fig. 1, a device 1 for treating biomass 10 is shown. The biomass 10 is fed into a treatment unit 12 in which the biomass 10 interacts with a treatment medium 11 also fed into the treatment unit 12. After an interaction or reaction between the biomass 10 and the treatment medium 11, a pre-treated biomass 10a is provided. The pre-treated biomass 10a is fed into a separation unit 20 comprising a screw press 18 in which the filtrate 21 is separated from the pre-treated biomass 10a. The filtrate 21 is fed into the filtration unit 40 after it has been separated from the pre-treated biomass 10a in the separation unit 20, in particular in the screw press 18 of the separation unit 20. In the filtration unit 40, a first filtrate portion 41a is separated from a second filtrate portion 41b wherein the first filtrate portion 41a has a solid matter content that is lower than a predetermined threshold value and the second filtrate portion 41b has a solid matter content that is higher than the predetermined threshold value. The solid matter content of the first filtrate portion 41a and the second filtrate portion 41b represent a content of hemicellulose and/or an ash content in the first filtrate portion 41a and in the second filtrate portion 41b respectively.

[0058] The first filtrate portion 41a may be introduced into the treatment unit 12 such that the first filtrate portion 41a may be reused as treatment medium which interacts with the biomass 10 in the treatment unit 12. A filtrate part 41a' may be branched off the first filtrate portion 41a before the first filtrate portion 41a is introduced into the treatment unit 12.

[0059] After the filtrate 21 has been separated from the pre-treated biomass 10a in the separation unit 20, the pre-treated biomass 10a is fed into a reactor unit 30 in which a steam treatment of the pre-treated biomass 10a takes place. Steam 110 is added into the reactor unit 30.

[0060] After the steam treatment in the reactor unit 30, the treated biomass 10b, e.g. the steamed biomass, is discharged from the reactor unit 30, wherein a steam explosion on the treated biomass 10b takes place when discharging the treated biomass 10b from the reactor unit 30. The treated biomass 10b is fed into a steam separation unit 300 which may be a cyclone or a mechanical steam separation system. Excess steam from the reactor unit 30 may be recovered in the steam separation unit 300, wherein the recovered steam 31 is reused in the treatment unit 12. In particular, the recovered steam 31 is used for pre-steaming the biomass 10 in the treatment unit 12. In this case, the pre-treated biomass 10a is a pre-steamed biomass. The treated biomass 10b may be fed into a drying unit 70 in which the treated biomass 10b is dried and prepared for further processing. Further processing may comprise the production of biocoal, e.g. biocoal pallets.

[0061] The treatment medium 11 used in the treatment unit 12 in order to pre-treat the biomass 10 may be steam which is introduced from a steam source 11a. The steam

from the steam source 11 a may be combined with the recovered steam 31 which together provide the steam, e.g. the treatment medium 11 in the treatment unit 12. The recovered steam 31 may also be converted into thermal energy, for example by condensation of the steam, wherein the thermal energy may be stored in a storage unit 80 or used for external devices. The recovered steam 30 may also be condensed in order to extract valuable components out of the recovered steam 31, wherein the components may also be stored in the storage unit 80.

[0062] The second filtrate portion 41b may be fed into a refining unit 50 in which the second filtrate portion 41b is further processed by means of one of a chemical reaction, a thermal reaction and a biochemical reaction. Furthermore, combinations of these reaction types are also possible. However, the refined second filtrate portion 41b may be used to produce valuable byproducts of the biomass treatment process.

[0063] Fig. 2 shows another embodiment of a part of the device 1 for treating biomass 10. Therein, the biomass 10 is fed into the treatment unit 12 together with the treatment medium 11. The treatment medium 11 may be steam which comes from a separate steam source 11a. In the treatment unit 12, a reaction or interaction between the treatment medium 11 and the biomass 10 takes place such that a pre-treated biomass 10a, in particular a pre-steamed biomass, is provided. The pre-treated biomass 10a is fed into the separation unit 20 comprising the screw press 18 in which the filtrate 21 is separated from the pre-treated biomass 10a. The separated filtrate 21 may be further processed as described with reference to Fig. 1.

[0064] The pre-treated biomass 10a is fed into the reactor unit 30 after it has been discharged from the separation unit 20, wherein a steam treatment of the pre-treated biomass 10a is carried out in the reactor unit 30. Steam 110 is added into the reactor unit 30. The treated biomass 10b is then fed into the steam separation unit 300 which may be a cyclone or a mechanical steam separation system. Excess steam from the reactor unit 30 may be recovered in the steam separation unit 300. The treated material may then be fed into the drying unit 70 downstream of the steam separation unit 300 in order to dry the treated biomass 10b for further processing. Recovered steam 31 coming from the steam separation unit 300 is then fed into a condensation unit 60 wherein a condensation of the recovered steam 31 takes place. Condensated product 32 provided by the condensation of the recovered steam 31 in the condensation unit 60 may be collected in the storage unit 80. A part of the recovered steam 31 may, however, be recirculated back to the treatment unit 12 in order to pre-steam the biomass 10 in the treatment unit 12.

[0065] Fig. 3 shows another embodiment of a part of the device 1 for treating biomass 10. Therein, all the components of the device 1 are the same as the components shown in Fig. 1 except the fact that the recovered steam 31 is fed into a heat exchanger 65 instead of a conden-

sation unit 60. In particular, the recovered steam 31 is conveyed through the heat exchanger 65 in which the thermal energy of the recovered steam 31 is used to heat water or steam coming from the source 11a such that this water or steam can be used as treatment medium 11 in the treatment unit 12. The recovered steam 31 may be collected in the storage unit 80 in order to be reused in the reactor unit 30 or for other purposes, for example. However, this embodiment provides an efficient usage of the recovered steam 31 from the steam separation unit 300. The steam or water from the source 11a heated in the heat exchanger 65 is used as treatment medium 11 in the treatment unit 12, wherein an interaction or reaction between the biomass 10 and the treatment medium 11 takes place.

[0066] The pre-treated biomass 10a, which in this case is a pre-steamed biomass, is fed into the separation unit 20 comprising the screw press 18 for separating the filtrate 21 from the pre-treated biomass 10a. The pre-treated biomass 10a is fed into the reactor unit 30 after it has been discharged from the separation unit 20, wherein the steam treatment takes place in the reactor unit 30. Steam 110 is added into the reactor unit 30. The treated biomass 10b coming from the reactor unit 30 is then fed into the steam separation unit 300 which may be a cyclone or a mechanical steam separation system. The treated biomass 10b may then be fed into a drying unit 70 downstream of the steam separation unit 300 in order to dry the treated biomass 10b for further processing.

[0067] Fig. 4 shows another embodiment of the device 1 for treating biomass 10. This embodiment shows the impregnation of the biomass 10 in the treatment unit 12 by means of an impregnation liquid 13 which is filled into the treatment unit 12 up to a predetermined fill level 16. A screw conveyor 14a is provided in order to transfer the biomass 10 through the impregnation liquid 13 during the interaction or reaction between the biomass 10 and the impregnation liquid 13 within the treatment unit 12. A plug screw or a screw conveyor 14b may be provided in order to feed the biomass 10 into the treatment unit 12. In this embodiment, the pre-treatment of the biomass 10 in the treatment unit 12 is an impregnation of the biomass 10 such that the pre-treated biomass 10a is represented by impregnated biomass. Before the impregnated biomass or pre-treated biomass 10a is fed into the separation unit 20, it may be transferred through a bin or buffer tank 15.

[0068] The pre-treated biomass 10a is then fed into the separation unit 20 which comprises a screw press 18 in which the filtrate 21 is separated from the pre-treated biomass 10a. The filtrate 21 is then divided within the filtration unit 40 into a first filtrate portion 41a and a second filtrate portion 41b. The first filtrate portion 41a may be used as the treatment medium in the treatment unit 12. The second filtrate portion 41b may be further refined in a refining unit 50, for example by a chemical reaction, a thermal reaction, a biochemical reaction or a combination thereof.

[0069] The pre-treated biomass 10a is then fed from

the separation unit 20 into the reactor unit 30 where a steam treatment of the pre-treated biomass 10a takes place. Steam is added into the reactor unit 30. After the steam treatment, the treated biomass 10b is first steam exploded and is then fed into the steam separation unit 300 which may be a cyclone or a mechanical steam separation system. The treated biomass 10b may then be fed into the drying unit 70 in which the treated biomass 10b is dried and prepared for further processing, in particular for producing biocoal. Recovered steam 31 from the steam explosion process in the steam separation unit 300 is for instance fed back or recirculated back to the treatment unit 12 in order to pre-steam the impregnated biomass in the treatment unit 12. Furthermore, fresh steam as treatment medium 11 may be introduced into the treatment unit 12 from a steam source 11a. In this embodiment, the impregnation liquid 13 may represent the treatment medium 11. However, it is also possible that both the impregnation liquid 13 and the recovered steam 31 may represent the treatment medium 11 introduced into the treatment unit 12 in order to pre-treat the biomass 10.

[0070] The recovered steam may also be condensated in a condensation unit not shown in Fig. 4 wherein condensated products from the condensation process of the recovered steam 31 may be stored in a storage unit 80.

[0071] Fig. 5 shows a part of the device 1 for treating biomass 10 using an impregnation of the biomass 10. Therein, all the components shown in Fig. 5 are the same components as shown in Fig. 4 except the fact that the recovered steam 31 is condensed in a condensation unit 60 wherein condensated products 32 provided by the condensation of the recovered steam 31 in the condensation unit 60 is stored in the storage unit 80. In particular, Fig. 5 shows an embodiment in which the recovered steam 31 is at least partly converted into condensated products 32 and another part of the recovered steam 31 is recirculated back to the treatment unit 12. The recovered steam 31 which is recirculated back to the treatment unit 12 may be used for pre-steaming the impregnated biomass in the treatment unit 12.

[0072] Fig. 6 shows a part of the device 1 for treating biomass 10 using an impregnation of the biomass 10. Therein, all the components shown in Fig. 6 are the same components as shown in Fig. 5 except that a heat exchanger 65 is provided in which the recovered steam 31 transfers thermal energy to the water or steam from the source 11a. The steam or water from the source 11a may be used as treatment medium 11 in the treatment unit 12 for pre-steaming the biomass 10 during or after the impregnation of the biomass 10 with the impregnation liquid 13. In this embodiment, both the steam and the impregnation liquid 13 may represent the treatment medium 11. Valuable components of the recovered steam 31 may be collected in the storage unit 80 after the recovered steam 31 has passed the heat exchanger 65. In particular, the thermal energy of the recovered steam 31 is transferred to the water or fresh steam from the source 11a in the

heat exchanger 65.

[0073] Fig. 7 shows a flow diagram for a method for treating biomass 10. In a step S10 of the method, the biomass 10 and a treatment medium 11 are fed into the treatment unit 12 such that the treatment medium 11 interacts with the biomass 10 in order to provide pre-treated biomass 10a. In another step S11, a pressure is controlled within the treatment unit 12 such that the interaction between the treatment medium 11 and the biomass 10 takes place under pressurized conditions. In another step S12 of the method, a controlling of a temperature within the treatment unit 12 is carried out such that the interaction between the treatment medium 11 and the biomass 10 takes place under heated conditions. In another step S20, the pre-treated biomass 10a is filtrated in a separation unit 20 arranged downstream the treatment unit 12, wherein a filtrate 21 is separated from the pre-treated biomass 10a in the separation unit 20. In another step S21 of the method, the separated filtrate 21 is divided within a filtration unit 40 into a first filtrate portion 41a with a solid matter content that is lower than a predetermined threshold value and a second filtrate portion 41b with a solid matter content that is higher than the predetermined threshold value. In step S22, a recirculation of the first filtrate portion 41a back to the treatment unit 12 is carried out such that the first filtrate portion 41a is reused for pre-treating the biomass 10 in the treatment unit 12. In step S23 of the method, the second filtrate portion 41b is screened for determining a composition of the second filtrate portion 41b before feeding the second filtrate portion 41b into a refining unit 50. In step S24, the second filtrate portion 41b is fed into the refining unit 50 for further processing the second filtrate portion 41b by means of one of a chemical reaction, a thermal reaction and a biochemical reaction. In step S30, the pre-treated biomass 10a is fed into a reactor unit 30 arranged downstream the separation unit 20 wherein a steam treatment of the pre-treated biomass 10a takes place within the reactor unit 30. In step 30a, the steam treated biomass 10b is discharged from the reactor unit 30. In step S31 of the method, steam is recovered, wherein the recovered steam 31 is discharged from a steam separation unit 300. In another step S32 of the method, the recovered steam 31 is fed into the treatment unit 12, wherein the recovered steam 31 is used for pre-steaming the biomass 10 in the treatment unit 12. In a step S32', which may be carried out simultaneously or alternatively to step S32, at least a part of the recovered steam 31 is condensed in a condensation unit 60 such that thermal energy is provided during condensation of the recovered steam 31 by means of the condensation unit 60.

[0074] While the invention has been illustrated and described in detail in the drawings and the foregoing description, such illustration and description are to be considered illustrative and exemplary and not restrictive; the invention is not limited to the disclosed embodiments. Other variations to the disclosed embodiments can be understood and effected by those skilled in the art and

practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims the term "comprising" does not exclude other elements, and the indefinite article "a" or "an" does not exclude a plurality. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope of protection.

Claims

1. Method for treating biomass (10), comprising:

Feeding the biomass (10) and a treatment medium (11) into a treatment unit (12) such that the treatment medium (11) interacts with the biomass (10) in order to provide pre-treated biomass (10a, S10);

Filtrating the pre-treated biomass (10a) in a separation unit (20) arranged downstream of the treatment unit (12), wherein a filtrate (21) is separated from the pre-treated biomass (10a) in the separation unit (20, S20); and

Feeding the pre-treated biomass (10a) into a reactor unit (30) arranged downstream of the separation unit (20), wherein a steam treatment of the pre-treated biomass (10a) takes place within the reactor unit (30, S30).

2. Method according to claim 1, comprising:

Dividing the separated filtrate (21) within a filtration unit (40) into a first filtrate portion (41a) with a solid matter content that is lower than a predetermined threshold value and a second filtrate portion (41b) with a solid matter content that is higher than the predetermined threshold value (S21).

3. Method according to claim 2,

wherein the solid matter content of the first filtrate portion (41a) represents a content of hemicellulose and/or a content of ash in the first filtrate portion (41a); and

wherein the solid matter content of the second filtrate portion (41b) represents a content of hemicellulose and/or a content of ash in the second filtrate portion (41b).

4. Method according to any one of claims 2 to 3, comprising:

Recirculating the first filtrate portion (41a) back to the treatment unit such that the first filtrate

portion (41a) is reused for pre-treating the biomass (10) in the treatment unit (12, S22); and wherein both the recirculated first filtrate portion (41a) and the fed treatment medium (11) interact with the biomass (10) within the treatment unit (12) in order to provide the pre-treated biomass (10a).

5. Method according to any one of claims 2 to 4, comprising:

Feeding the second filtrate portion (41b) into a refining unit (50) for further processing the second filtrate portion (41b) by means of one of a chemical reaction, a thermal reaction and a biochemical reaction (S24).

6. Method according to claim 5, comprising:

Screening the second filtrate portion (41b) for determining a composition of the second filtrate portion (41b) before feeding the second filtrate portion (41b) into the refining unit (50, S23).

7. Method according to any one of the preceding claims, comprising:

Recovering steam from the steam treatment of the pre-treated biomass (10a) in a steam separation unit (300) arranged downstream of the reactor unit (30) and discharging the recovered steam (31) from the steam separation unit (300, S31).

8. Method according to claim 7, comprising:

Feeding the recovered steam (31) into the treatment unit (12), wherein the recovered steam (31) is used for pre-steaming the biomass (10) in the treatment unit (12, S32); and/or
Condensing at least a part of the recovered steam (31) in a condensation unit (60) such that condensated products (32) are provided during condensation of the recovered steam (31) by means of the condensation unit (60, S32').

9. Method according to any one of the preceding claims,

wherein the treatment medium (11) is steam fed into the treatment unit (12) for pre-steaming the biomass (10) within the treatment unit (12) such that a pre-steamed biomass is provided representing the pre-treated biomass (10a).

10. Method according to any one of claims 1 to 8,

wherein the treatment medium (11) is an impreg-

nation liquid (13) fed into the treatment unit (12) for impregnating the biomass (10) within the treatment unit (12) such that an impregnated biomass is provided representing the pre-treated biomass (10a).

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11. Method according to claim 10,

wherein the impregnation liquid (13) is filled into the treatment unit (12) up to a predetermined fill level such that the impregnation of the biomass (10) takes place during a transfer of the biomass (10) through the treatment unit (12).

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12. Method according to any one of the preceding claims, comprising:

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Controlling a pressure within the treatment unit (12) such that the interaction between the treatment medium (11) and the biomass (10) takes place under a pressurized condition (S11).

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13. Method according to any one of the preceding claims, comprising:

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Controlling a temperature within the treatment unit (12) such that the interaction between the treatment medium (11) and the biomass (10) takes place under a heated condition (S12).

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14. Method according to any one of the preceding claims,

wherein the reactor unit (30) is a continuous reactor or a batch reactor.

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15. Device (1) for treating biomass, comprising:

a treatment unit (12);
a separation unit (20) arranged downstream of the treatment unit (12);
a reactor unit (30) arranged downstream of the separation unit (20);

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wherein biomass (10) and a treatment medium (11) is fed into the treatment unit (12) such that the treatment medium (11) can interact with the biomass (10) in order to provide pre-treated biomass (10a);
wherein the pre-treated biomass (10a) is filtrated in the separation unit (20) such that a filtrate (21) is separated from the pre-treated biomass (10a); and
wherein the pre-treated biomass (10a) is fed into the reactor unit (30) and a steam treatment of the pre-treated biomass (10a) takes place in the reactor unit (30).

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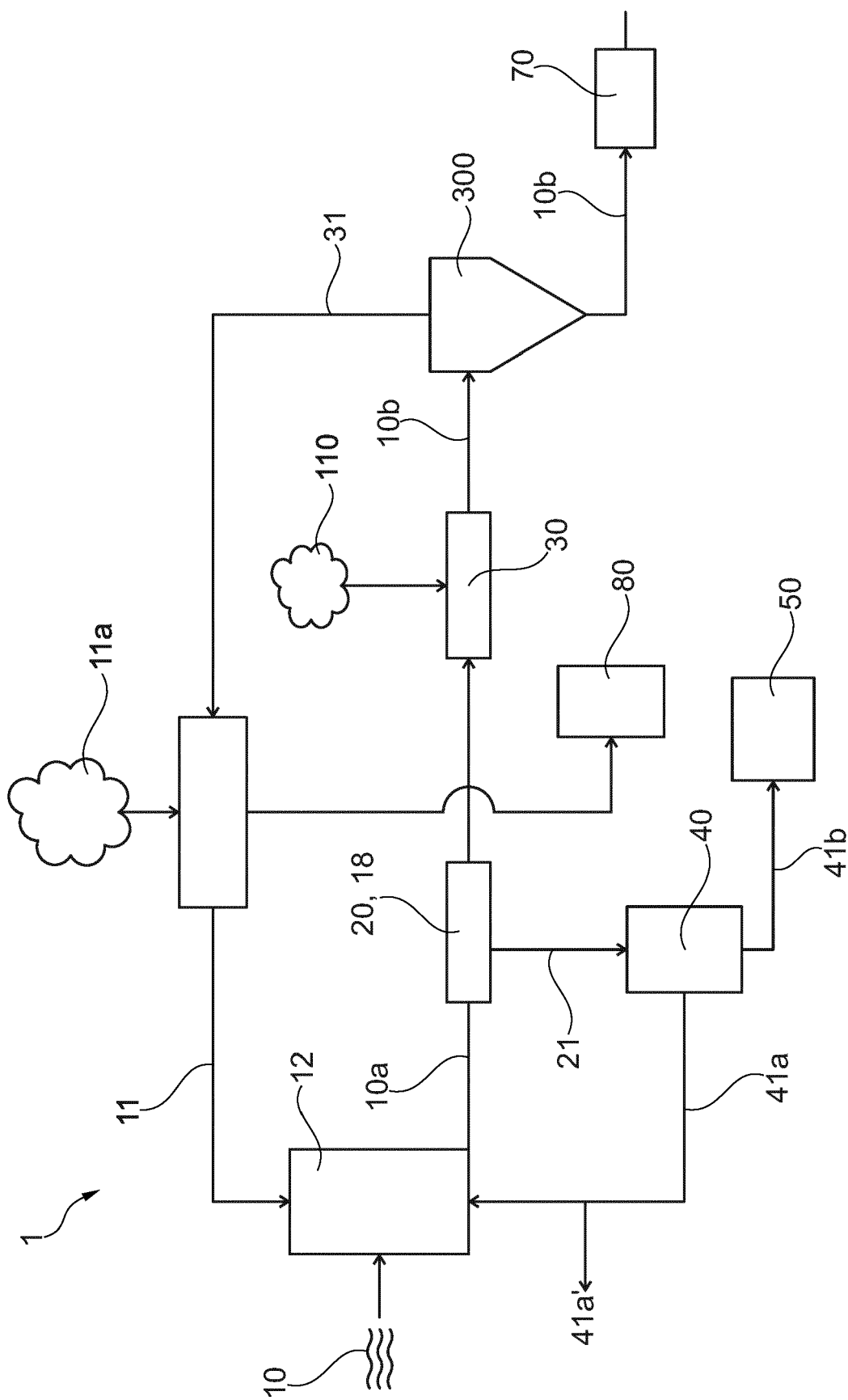


Fig. 1

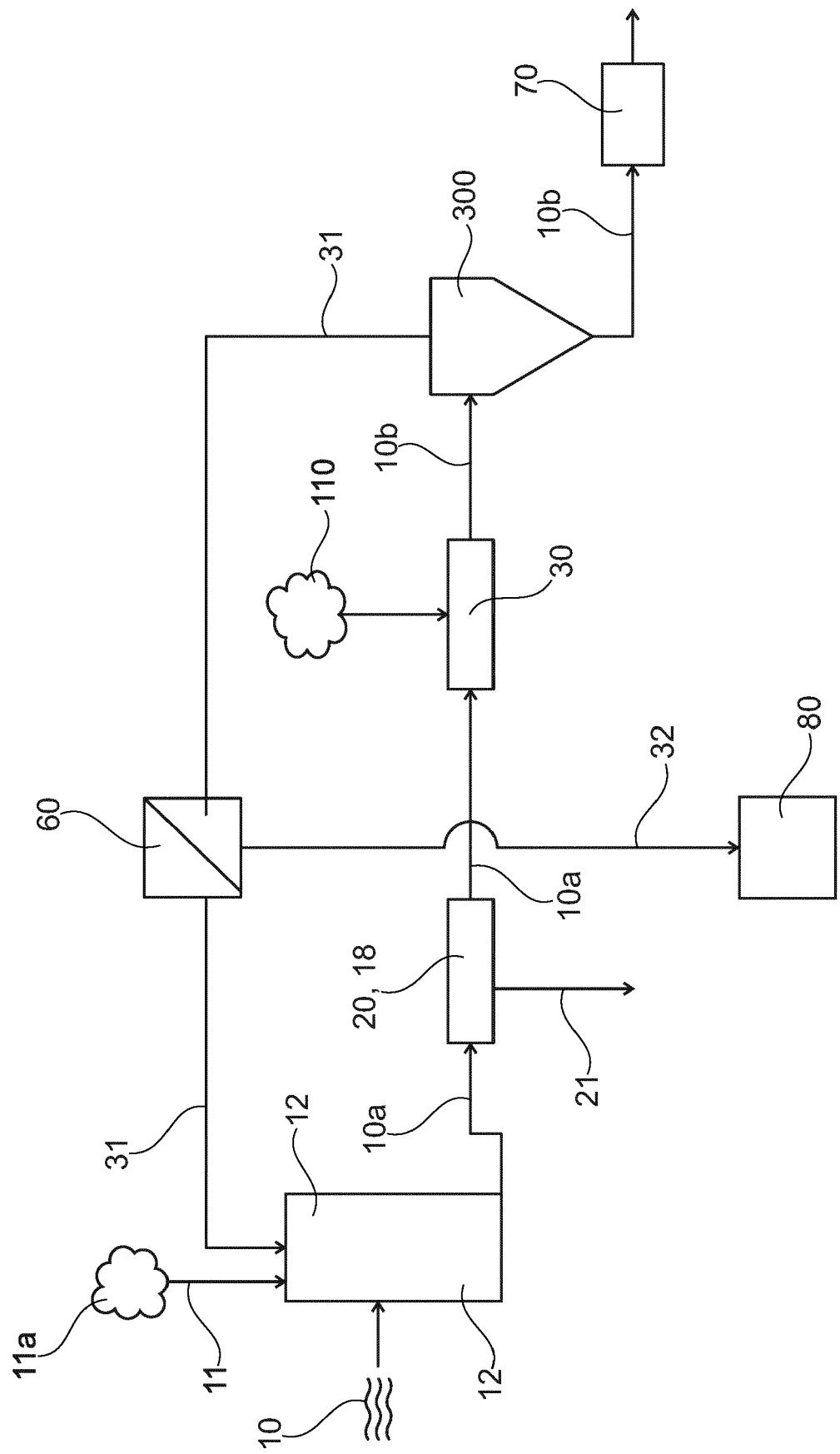


Fig. 2

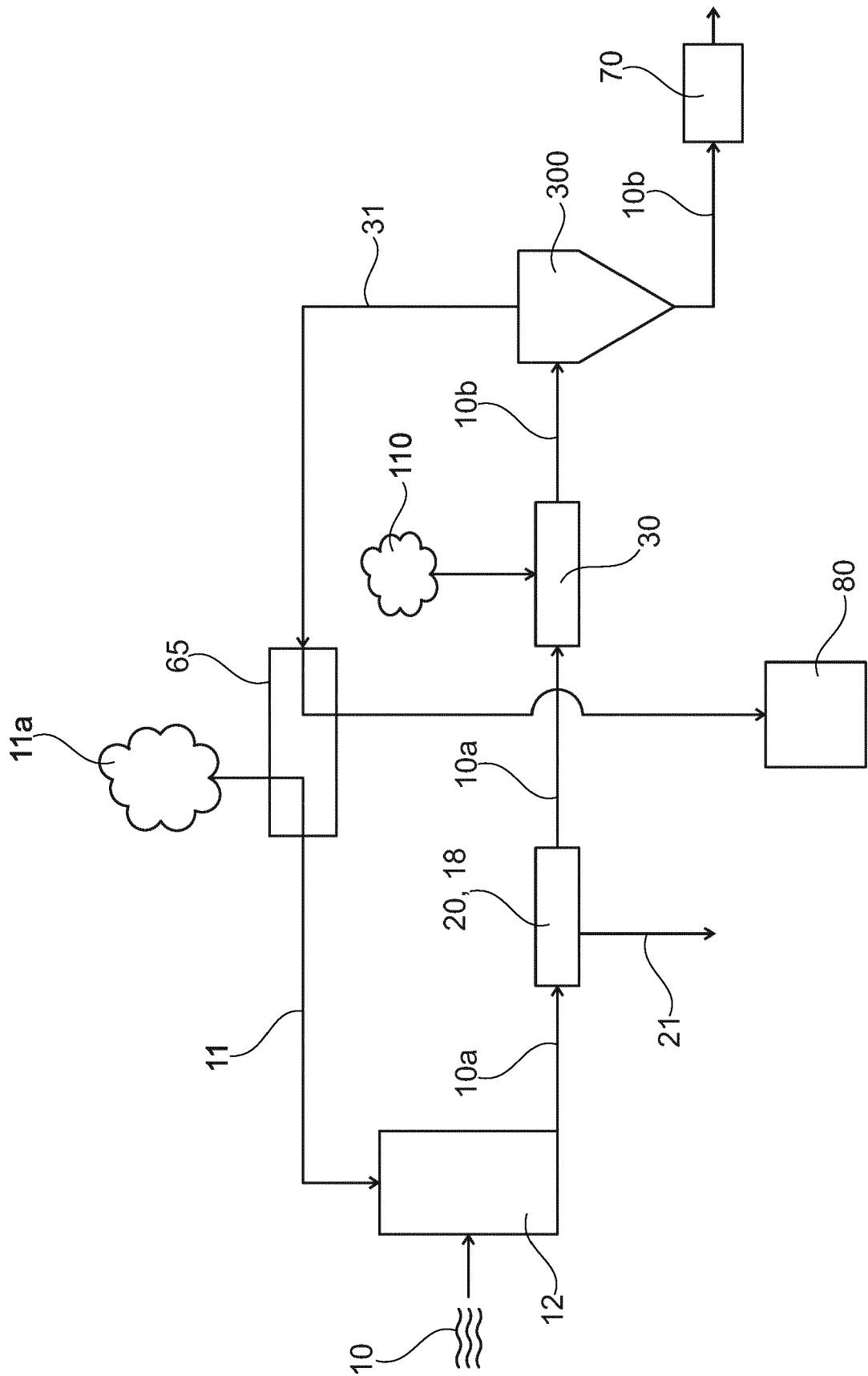


Fig. 3

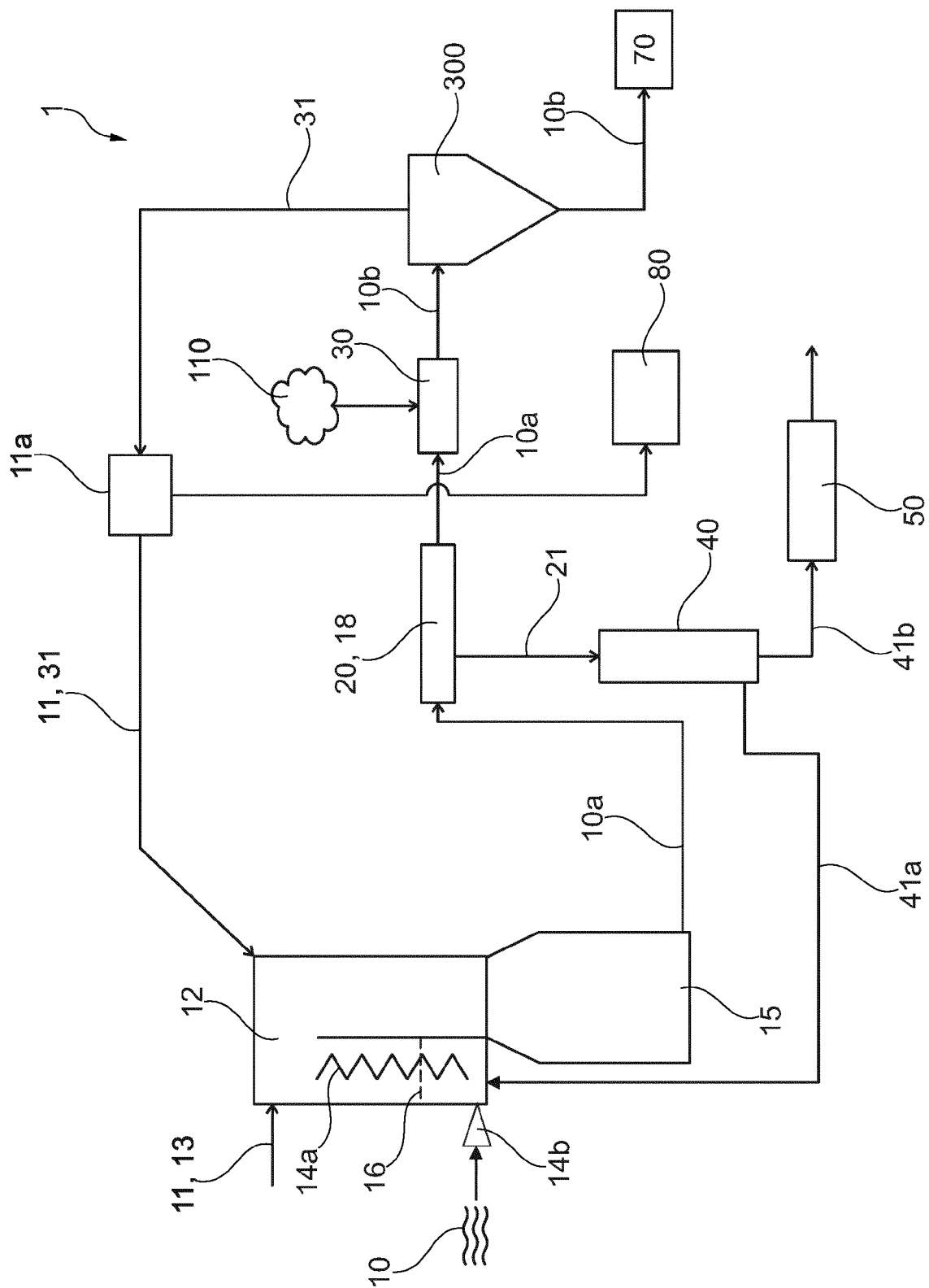


Fig. 4

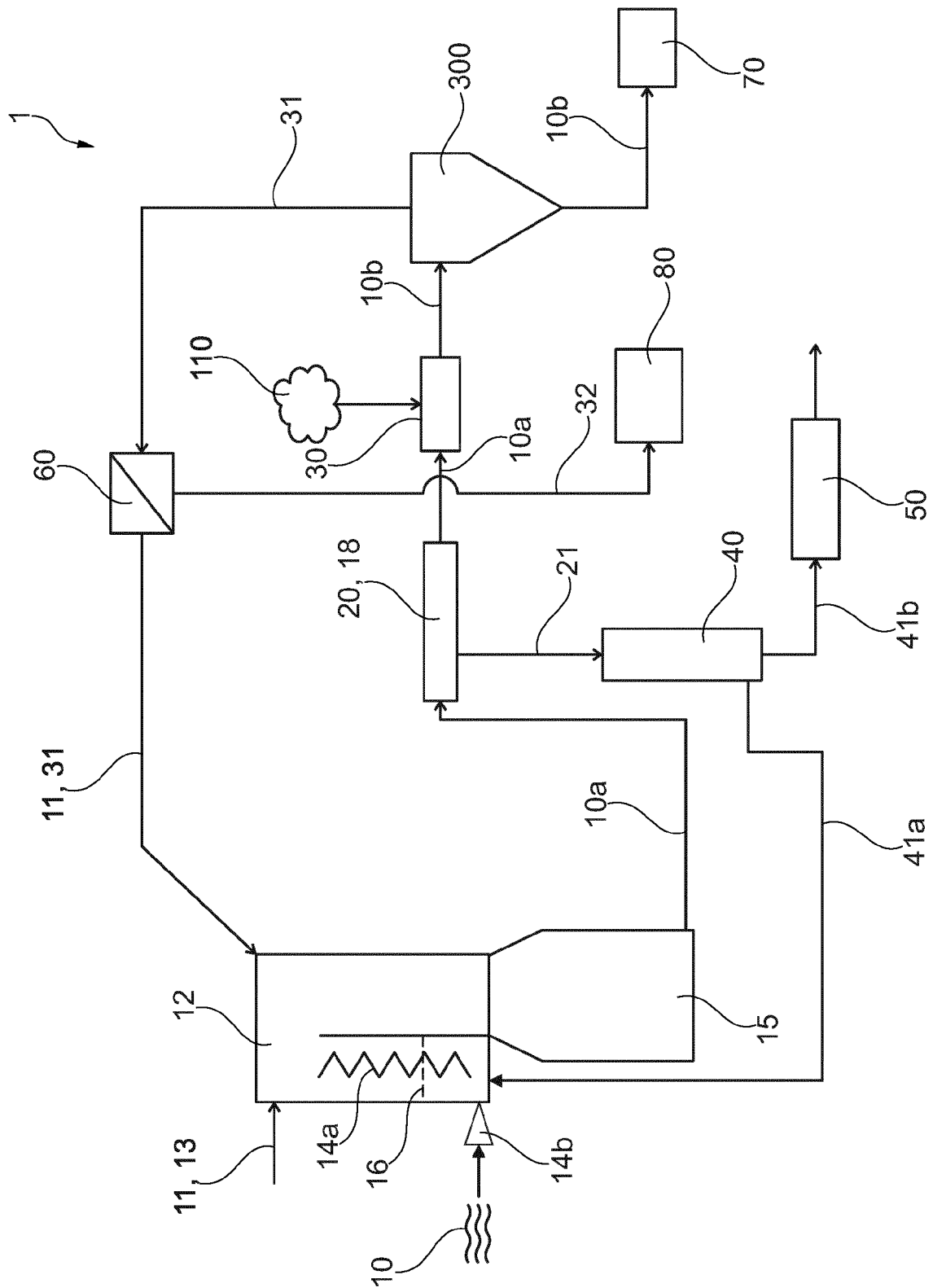
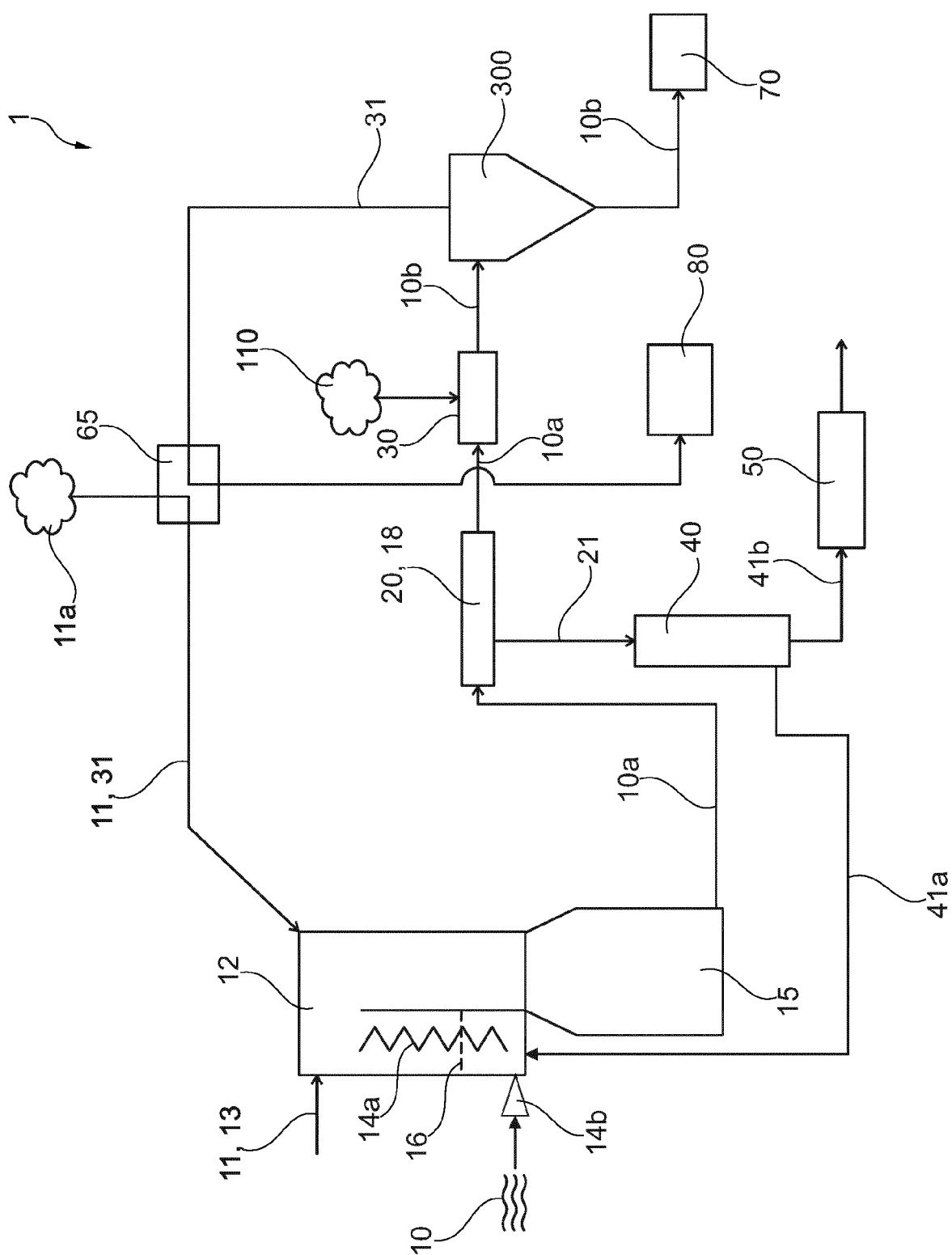


Fig. 5



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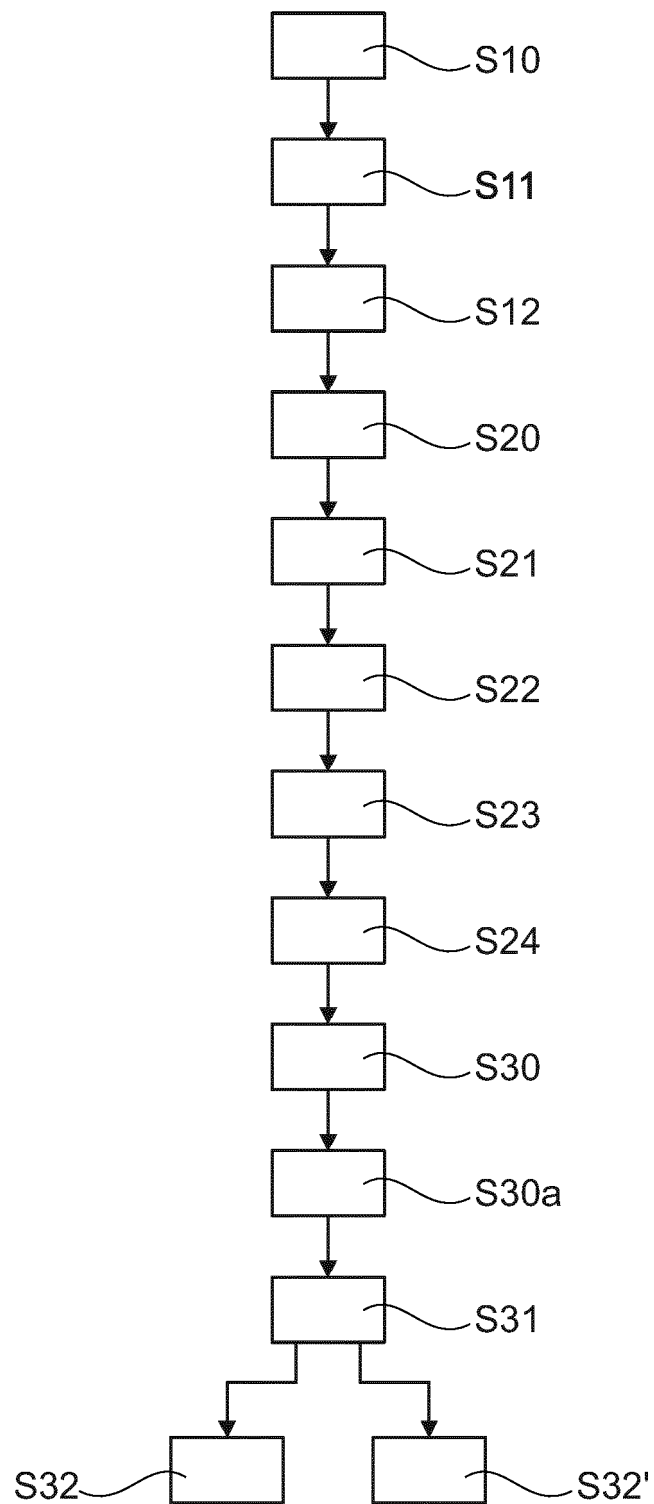


Fig. 7



EUROPEAN SEARCH REPORT

Application Number
EP 16 20 2925

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2007/009463 A2 (HOLM CHRISTENSEN BIOSYSTEMER A [DK]; HOLM CHRISTENSEN BOERGE [DK]; HOL) 25 January 2007 (2007-01-25) * claim 1 * * page 24, line 22 - line 28 *	1-15	INV. D21C1/00 D21C1/02 D21B1/22
X	WO 2011/039635 A2 (NOVA PANGAEA TECHNOLOGIES LTD [GB]; NORTH PETER HERBERT [IE]) 7 April 2011 (2011-04-07) * claims 1-35; figure 1 *	1,15	
X	WO 2013/098789 A1 (BETA RENEWABLES SPA [IT]) 4 July 2013 (2013-07-04) * Page 19, Experiment 1 *	1-15	
X	WO 2012/042497 A1 (CHEMTEX ITALIA SPA [IT]; OTTONELLO PIERO [IT]; FERRERO SIMONE [IT]; TO) 5 April 2012 (2012-04-05) * Page 7, 4th full paragraph; claim 1; figure 1 *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			D21C
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 5 April 2017	Examiner Ponsaud, Philippe
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 P : intermediate document 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 16 20 2925

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

05-04-2017

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2007009463 A2	25-01-2007	AU 2006272198 A1	25-01-2007
		BR PI0613681 A2	13-07-2010
		BR PI0622271 A2	09-08-2011
		CA 2615844 A1	25-01-2007
		CA 2831082 A1	25-01-2007
		CA 2959268 A1	25-01-2007
		CN 101268121 A	17-09-2008
		CN 101798584 A	11-08-2010
		DK 1910448 T3	02-01-2017
		EP 1910448 A2	16-04-2008
		EP 2172568 A1	07-04-2010
		EP 2520608 A1	07-11-2012
		EP 2520609 A1	07-11-2012
		EP 2657275 A1	30-10-2013
		HR P20161565 T1	10-03-2017
		NZ 565629 A	30-06-2011
		NZ 592233 A	31-08-2012
		NZ 601075 A	31-01-2014
		UA 100662 C2	25-01-2013
		US 2010041119 A1	18-02-2010
		US 2012138246 A1	07-06-2012
		US 2013143263 A1	06-06-2013
		US 2015232579 A1	20-08-2015
		US 2016153010 A1	02-06-2016
WO 2011039635 A2	07-04-2011	WO 2007009463 A2	25-01-2007
		ZA 200801439 B	26-11-2008
		-----	-----
		AP 3563 A	27-01-2016
		BR 112012007026 A2	01-03-2017
		CA 2775656 A1	07-04-2011
		EP 2483331 A2	08-08-2012
US 201100359 A1	05-05-2011	US 201100359 A1	05-05-2011
		US 2014123973 A1	08-05-2014
		US 2016068920 A1	10-03-2016
		WO 2011039635 A2	07-04-2011
		ZA 201202754 B	26-06-2013
		-----	-----
WO 2013098789 A1	04-07-2013	AU 2012360035 A1	21-08-2014
		CA 2859495 A1	04-07-2013
		CL 2014001746 A1	21-11-2014
		CN 104169429 A	26-11-2014
		CO 7101227 A2	31-10-2014
		CU 20140077 A7	26-12-2014
		DK 2610346 T3	03-11-2014
		EP 2610346 A1	03-07-2013
		EP 2798073 A1	05-11-2014

EPO FORM P0459

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

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

EP 16 20 2925

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

05-04-2017

10

15

20

25

30

35

40

45

50

55

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		ES 2518218 T3	04-11-2014
		JP 2015506171 A	02-03-2015
		KR 20140127223 A	03-11-2014
		MA 35862 B1	01-12-2014
		PE 19502014 A1	20-12-2014
		PH 12014501510 A1	08-10-2014
		RU 2014125902 A	20-02-2016
		SG 11201403549P A	30-07-2014
		US 2013168602 A1	04-07-2013
		WO 2013098789 A1	04-07-2013

WO 2012042497 A1	05-04-2012	AR 083122 A1	30-01-2013
		AU 2011309706 A1	02-05-2013
		BR 112013007088 A2	14-06-2016
		CA 2810973 A1	05-04-2012
		CL 2013000840 A1	05-07-2013
		CN 103097605 A	08-05-2013
		CO 6660454 A2	30-04-2013
		CU 20130049 A7	31-05-2013
		EP 2622126 A1	07-08-2013
		ES 2573411 T3	07-06-2016
		IT 1402200 B1	28-08-2013
		JP 2013539976 A	31-10-2013
		KR 20130121100 A	05-11-2013
		MA 34616 B1	02-10-2013
		PE 05752014 A1	24-05-2014
		RU 2013119378 A	10-11-2014
		SG 188567 A1	30-04-2013
		TN 2013000096 A1	25-06-2014
		US 2013146049 A1	13-06-2013
		WO 2012042497 A1	05-04-2012
		ZA 201303031 B	25-06-2014

EPO FORM P0459

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