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(54) Title: METHOD AND ARRANGEMENT FOR CLEANING OF LIGNOCELLULOSIC MATERIALS DURING IMPREGNATION

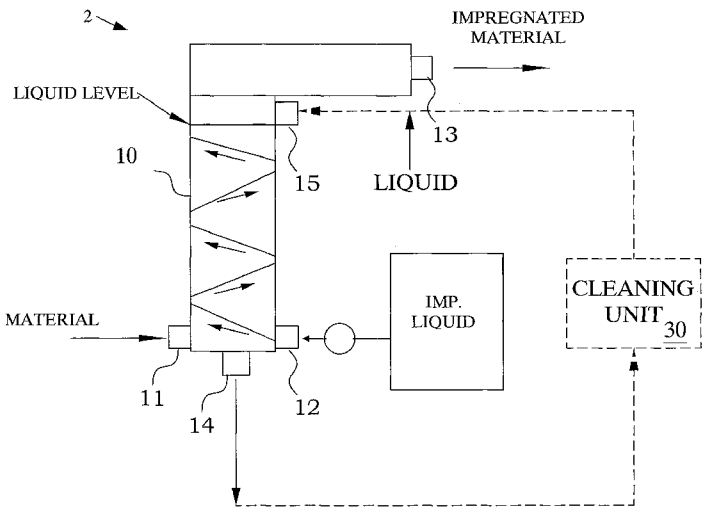


Fig. 2

(57) Abstract: An impregnation arrangement (1) includes a vertically arranged impregnator chamber (10), a first inlet (11) arranged at a bottom end of the chamber configured for introducing material to be impregnated into the chamber, a conveyor arrangement (20) configured for moving the introduced material in a direction from the bottom end of the chamber to a top end of the chamber, at least one outlet (12) arranged at the top end for extracting the impregnated material from the chamber, and a second inlet (13) configured for introducing impregnation liquid into the chamber. Further, the impregnator arrangement includes a second outlet (14) at the bottom end configured for extracting liquid from the chamber (10) during operation, to provide a liquid flow in the chamber (10) in a counter-current or opposite direction of the direction of the introduced material. Further, the arrangement (1) includes a third inlet (15) for introducing liquid into the chamber (10) at the top end and a cleaning arrangement (30) connected between the third inlet (15) and the second outlet (14) to clean the extracted liquid.

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METHOD AND ARRANGEMENT FOR CLEANING OF LIGNOCELLULOSIC MATERIALS DURING IMPREGNATION

TECHNICAL FIELD

The present invention relates to treatment of lignocellulosic material in general and in particular to improved cleaning of lignocellulosic materials e.g. wood chips before further treatment, e.g. a refining step.

BACKGROUND

The separation of fibers from each other in a lignocellulosic material can be achieved in several ways. The preparation of pulp typically comprises a multitude of process steps that serve to transform lignocellulosic material such as wood chips to a wet pulp, i.e. a fiber suspension, suitable for manufacture of various paper products or the like. Pulping processes may be mainly chemical, wherein the lignin keeping the fibers connected to each other is at least partly removed by adding chemicals and applying process conditions dissolving the lignin, or mainly mechanical, wherein the fibers are separated from each other mechanically, e.g. by grinding or refining. The processes are commonly referred to as chemical and mechanical pulping processes, respectively. There are also dry processes where separated fibers are utilized for making fiberboard products.

A typical mechanical pulping process can be summarized as cleaning of the wood chips, preheating, impregnation, and subsequently refining. The preheating aims to warm the chips and equalize the moisture content of the chips before refining. It is also possible to fine-tune the pulp properties with the temperature. Subsequently, the chips are conveyed to an impregnator where they are impregnated with water or sodium sulfite solution, or other impregnation liquid. Finally, the impregnated chips are introduced into the final refining steps. The same basic processing is also utilized in the manufacture of fiberboard, up until the refining steps, which differ due to

the different end use of the fibers. For fiberboard products it is of interest to separate the fibers without fibrillation (i.e. without any unraveling of the fiber wall from the fiber surface) while for mechanical pulp intended for papermaking, the fibrillation is needed in order to achieve adequate bonding properties. The refining equipment for fiberboard is foremost a defibration equipment, accomplishing separation into individual fibers while the refining equipment for mechanical pulp achieves defibration and fibrillation both.

Present impregnators for mechanical pulping typically comprise adding impregnation liquid at the bottom of a container before refining [1]. During the impregnation, process contaminants and impurities such as pin-chips and larger contaminants as well as fine sand, dust and smaller particles are released into the impregnation fluid, thereby reducing the efficiency of the impregnation process. In addition, the contaminants that remain in the chips that are ejected from the impregnator process will cause abrasive wear of the process equipment.

Therefore, there is a need for an improved cleaning during an impregnation process, which removes the impurities to increase the purification process, which will improve the product as well as reduce the abrasive wear on the process equipment.

SUMMARY

The present invention aims to obviate some of the above-mentioned problems with prior art impregnators.

A first aspect of the present disclosure presents an impregnation arrangement comprising a vertically arranged impregnator chamber, a first inlet arranged at a first end of the chamber configured for introducing material to be impregnated, such as a lignocellulosic material e.g. wood chips, into the chamber, a conveyor arrangement configured for moving the introduced material in a direction from the first end to a second end of the chamber. Further, the arrangement includes an outlet arranged at the

second end of the chamber for extracting the impregnated material from the chamber, and a second inlet configured for introducing impregnation liquid into the chamber. The first end corresponds to a bottom end of the chamber, and the second end corresponds to a top end of the chamber. Further, the arrangement includes a second outlet located at the bottom end configured for extracting liquid from the chamber during operation, to provide a liquid flow in the chamber in an opposite direction of the direction of the introduced material, and a third inlet configured for introducing a liquid into the chamber at the top end. Finally, the arrangement includes a cleaning arrangement connected between the third inlet and the second outlet, which includes at least one filtering unit and is configured for cleaning the extracted liquid and providing it to the third inlet to provide the liquid flow in the chamber.

A second aspect of the present disclosure presents a method of impregnating material, such as lignocellulosic material e.g. wood chips, comprising introducing material to be impregnated at a first end of a vertically arranged impregnator chamber, and conveying the introduced material in a direction from the first end towards a second end of the chamber. Subsequently, the disclosure presents introducing impregnation liquid/chemicals into the chamber, and extracting the impregnated material from the chamber at the second end. The first end corresponds to a bottom end of the chamber and the second end corresponds to a top end of the chamber. Further, the method includes extracting liquid from the bottom end of the chamber during operation, to provide a liquid flow arranged in an opposite direction of the direction of the introduced material in the chamber. Finally, the disclosure includes cleaning the extracted liquid and re-introducing the cleaned extracted liquid into the chamber to provide a flow of the liquid in the chamber.

Advantages of the present invention include improved cleaning of lignocellulosic material e.g. wood chips, and as a direct consequence thereof, reduced abrasive wear of the process equipment.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention, together with further objects and advantages thereof, may best be understood by referring to the following description taken together with the accompanying drawings, in which:

Fig. 1 is an illustration of a known impregnator arrangement;

Fig. 2 is an illustration of an embodiment of an arrangement according to the present disclosure;

Fig. 3 is a further embodiment of an arrangement according to the present disclosure;

Fig. 4 is a schematic flow chart of an embodiment of a method according to the present disclosure.

DETAILED DESCRIPTION

The present disclosure relates to fiber process equipment for lignocellulosic material e.g. wood chips, in particular to improved cleaning of the material in or before impregnator arrangements in such equipment. The disclosure will be presented with reference to wood chip processing, but is equally suitable for other lignocellulosic materials e.g .suitable for fiberboard products.

An impregnator is utilized to equalize the moisture content of the lignocellulosic material e.g. wood chips or to reduce the extractives content of the lignocellulosic material e.g. wood chips. A widely used system is the so-called PREX-impregnator system. Chips from a chip washing system are preheated at atmospheric pressure before the PREX plug screw feeding to the impregnator. The water squeezed out from the chips has a high content of dissolved and colloidal substances and therefore is led to the effluent. The pressed chips are fed to a vertical screw impregnator where the chips are impregnated with water or sodium sulfite solution. A level controller adjusts the flow of the liquid to the impregnator. The amount of water impregnated is about 0.5-1.0 m^3 per ton of wood chips. The moisture content of the chips

increases about 6 %-7 % units. The screws are available with two different compression ratios, 2:1 or 3:1 respectively.

Inside the impregnator, a conveyor e.g. two counter-rotating screws are arranged to elevate and mix the material, such as a lignocellulosic material e.g. wood chips, with an impregnation fluid, e.g. a mixture of chemicals and water added at or near the chip inlet of the vessel. Each screw is typically driven by an AC-motor via a shaft mounted gear reducer and a v-belt drive. The screw shafts are replaceable shaft ends journaled by grease-lubricated bearings at the top and by bearing bushings at the lower end. An example of an impregnator is the so-called IPAXXX, which consists of a shell with an inlet with a back-flow protection device at the lower end and outlet chute at the upper end, and the aforementioned twin feeding screws. The impregnated material, e.g. wood chips, is then transferred into a screw conveyor to a retention bin before being further processed in a refiner.

With reference to Fig. 1, a simplified illustration of a prior art impregnator in which the present disclosure can be implemented will be described. The impregnator 1 includes an impregnator chamber 10 with a chip inlet 11 arranged at a first end e.g. bottom end of the chamber 10, and a chip outlet 13 arranged at a second end e.g. top end of the chamber 10. A conveyor unit 20 e.g., screw conveyor is arranged in the chamber 10 to convey chips from the chip inlet 11 towards the chip outlet 13. Additionally, the impregnator 1 includes an impregnation liquid inlet 12 for introducing impregnation liquids into the chamber. Consequently, the introduced impregnation liquid will form a more or less stagnant volume of liquid at the bottom of the impregnation chamber. The addition of impregnation fluids is controlled to maintain the level of impregnation liquid inside the chamber at a certain level or within a certain interval.

As illustrated above, the prior art impregnators for mechanical pulping are with impregnator liquid typically added as a stagnant liquid volume at the bottom of the impregnator chamber. As for today, this is only an

impregnation step before refining. By adding the teachings of this disclosure, this can be improved with a cleaning step as well.

The inventors have identified the benefits of providing a counter-current liquid flow opposite the transport direction of the lignocellulosic material e.g. wood chips, in the impregnator chamber, and optionally to circulate the liquid via a filtering arrangement i.e. after passing the wood chips. By introducing a liquid flow in a direction opposite of the conveyed material e.g. wood chips in the impregnator chamber, impurities e.g. sand and dust particles, will be prevented from exiting the chamber together with the chips. Instead, the impurities will be washed away from the chips by the introduced flow, and optionally the flowing liquid can be extracted from the chamber, cleaned, and re-introduced into the chamber. The general idea is to improve the process such that the impregnator liquid is added at the upper part (directed water stream) and overflow liquid is discharged through the bottom of the impregnator chamber. The liquid is then, according to a further embodiment, re-circulated in a closed loop through a filtering device. The filtering device can, according to a particular embodiment, include a screen for removal of pin-chips and large contaminants. This can be followed by a filtration device to separate fine sand, dust and smaller impurities.

With reference to Fig. 2, a basic embodiment of the present disclosure will be described. The same reference numerals are used for the corresponding units of Fig. 1. The impregnator arrangement 2 includes an impregnator chamber 10, an inlet 11 for introducing material to be impregnated into the chamber arranged at a first end e.g. bottom end of the chamber for introducing material e.g. chips into the chamber, a conveyor arrangement 20 configured for moving introduced material e.g. chips in a direction from the first end e.g. bottom end to the second end e.g. top end of the chamber. Further, the impregnator includes at least one outlet 13 arranged at the top end for extracting the impregnated material from the chamber, and at least one inlet 12 for introducing impregnation liquid into the chamber. In addition, the arrangement includes a second outlet 14 located at the bottom

end of the chamber for extracting liquid from the chamber during operation, to provide a liquid flow in an opposite direction of the direction of the chips moving on upwards on the conveyor 20. By providing an extraction outlet 14, it is possible to induce a counter current e.g. opposing flow of liquid in the chamber, which aids in cleaning the moving chips from any impurities and transporting the impurities towards the bottom of the chamber and out through the outlet 14. The rate of extraction and the rate of addition of impregnation liquid are controlled to maintain a predetermined level of impregnation liquid in the chamber.

Although the present embodiment is described with relation to a substantially vertically arranged impregnator arrangement, it can be equally implemented in an impregnator with some other orientation. In addition, the embodiments of the present disclosure can be easily adapted to provide an improved cleaning process in other parts of the pulp manufacture process. The important consideration is to introduce an opposing liquid flow into a chamber in which chips are transported.

Also with reference to Fig. 2, a further embodiment of an arrangement according to the present disclosure will be presented. In order to further improve the cleaning efficiency of the arrangement, increase the liquid flow in the chamber, and reduce the amount of consumed impregnation liquids, it would be beneficial to reuse or re-cycle the impregnation liquids. This is enabled by a cleaning unit 30 externally arranged between the outlet 14 and a second inlet 15 of the chamber. The second inlet 15 can, according to one embodiment be co-located with the inlet 13 for introducing impregnation liquid into the chamber. According to a preferred embodiment, the two inlets 13, 15 are separate entities located at a respective bottom and top end of the chamber e.g. opposite ends. Thereby, impregnation fluids as well as any impurities can be extracted from the chamber 1 through the outlet 14, be cleaned in the cleaning unit 30, and subsequently be reintroduced into the chamber 10 through the inlet 15. According to a further embodiment, a unit

for providing liquid in addition to the impregnation liquid can be provided to the inlet 15.

With reference to Fig. 3, a further embodiment of an impregnation arrangement 3 according to the present invention will be described. The same reference numerals are used for same or similar components as for the previous drawings. In this embodiment, the cleaning unit 30 comprises at least one filtering arrangement or unit 31, 32, which is configured for filtering out any particles larger than a predetermined particle size from the liquid. According to a particular embodiment, the cleaning unit 30 includes a first screening or filtering unit 31 for filtering out particles larger than 0.2 mm, and a second filtering unit 32 for filtering out particles in the interval from 0.05 mm to 0.2 mm. However, any arrangement suitable for removing the impurities can be utilized, and can be configured for any size of particles as well depending on the specific needs of the process. The filtered liquid is then re-introduced into the chamber through inlet 15. It is evident that any number of filter arrangements, and any method of filtering can be applied and specifically tailored for particular sizes of impurities. Likewise, the cleaning arrangement could be provided with chemical or mechanical cleaning functionality depending on the particular process parameters. In addition, functional units such as pumps can be included to further improve the efficiency of the process.

With reference to Fig. 4, an embodiment of a method of cleaning and impregnating material such as lignocellulosic material e.g. wood chips according to the present disclosure will be described. The method includes introducing S11 material to be impregnated, such as wood chips, at a first end of an impregnator chamber, conveying S20 the introduced material in a direction from the first end towards a second end of the chamber. Typically, the material is conveyed from a bottom end towards a top end of the chamber. Subsequently, impregnation liquid/chemicals are introduced S12 into the chamber, and the impregnated material is extracted S13 from the chamber at the second end. In addition, liquid is extracted S14 from the first

end of the chamber during operation, to provide a liquid flow in an opposite direction of the direction of the introduced material in the chamber. Thereby, the counter-current or opposing flow of liquid enables cleaning any impurities from the introduced material and effectively prevents conveying the impurities further in the process.

According to a further embodiment, the method includes introducing S15 a further liquid into the chamber at the second end, and extracting liquid S14 at the first end, and optionally cleaning S30 the extracted liquid and re-introducing S40 at least the cleaned extracted liquid into the chamber to provide a flow of the liquid in the chamber.

The technique can be used for processing of water – and chip washing in the chip-washing equipment. Although the present disclosure mainly described chip cleaning within an impregnator arrangement, the same basic method can be applied for other parts of the chip processing line, and for other types of lignocellulosic materials. In particular, the disclosure can be easily adapted to the already existing chip cleaning equipment in a pulp processing plant. By introducing an opposing flow of liquid e.g. water in a chip cleaning tank, which aids in removing impurities from the chips, and enabling extracting and cleaning the water before reintroducing it into the chamber, the chips can be cleaned more efficiently.

In summary, the main idea of the present disclosure is to change the process such that the impregnation liquid and potentially any added liquid is added at the upper part of the chamber and overflow liquid is discharged at the bottom. The liquid is then circulated in a closed loop through a screen (or equal) for removal of pin-chips and larger contaminants. This is followed by a filtration device (NimClear™ or equal) to separate fine sand, dust and smaller impurities.

The main benefit of the present disclosure is improved cleaning of chips prior to refining in order to minimize abrasive wear in the process equipment.

Improved refining is closely connected to better pulp and paper quality. The process optimization is tailored for each customer in order to reach higher energy savings and to be a sustainable competitor on the market. Further benefits could be more effective liquid uptake in impregnation.

5

REFERENCES

[1] Mechanical pulping, Papermaking Science and Technology, Book 5, pages 166-168,

CLAIMS

1. An impregnation arrangement (2;3), comprising a vertically arranged impregnator chamber (10), a first inlet (11) arranged at a first end of said chamber configured for introducing material to be impregnated into said chamber, a conveyor arrangement (20) configured for moving introduced material in a direction from said first end of said chamber to a second end of said chamber, at least one outlet (12) arranged at said second end for extracting impregnated material from said chamber, and a second inlet (13) configured for introducing impregnation liquid into the chamber, **characterized by**

said first end corresponding to a bottom end of said chamber, and said second end corresponding to a top end of said chamber.

a second outlet (14) located at said bottom end of said chamber (10) and configured for extracting liquid from said bottom end of said chamber (10) during operation, to provide a liquid flow in said chamber (10) in an opposite direction of the direction of said introduced material, and

a third inlet (15) configured for introducing a liquid into the chamber (10) at said top end of said chamber, and

a cleaning arrangement (30) connected between said third inlet (15) and said second outlet (14), wherein said cleaning arrangement (30) comprising at least one filtering unit (31, 32) and is configured for cleaning said extracted liquid and providing the cleaned extracted liquid to said third inlet (15) to provide said liquid flow in said chamber (10).

2. The arrangement according to claim 1, **characterized by** said second inlet (13) and said third inlet (15) being arranged at separate locations.

3. The arrangement according to claim 2, **characterized by** said second inlet (13) being located at said bottom end of said chamber, and said third inlet (15) being located at said top end of said chamber.

4. The arrangement according to claim 1, **characterized by** said second inlet (13) and said third inlet (15) being co-located.

5. The arrangement according to any of claims 1-4, **characterized by** said cleaning unit (30) comprising a first filtering unit (31) and a second filtering unit (32).

6. The arrangement according to any of claims 1-5, **characterized by** by said arrangement (2;3) being configured for impregnating lignocellulosic material.

7. The arrangement according to claim 6, **characterized by** said arrangement (2; 3) being configured for impregnating wood chips.

8. A method of impregnating lignocellulosic material, comprising introducing (S11) material to be impregnated at a first end of a vertically arranged impregnator chamber, conveying (S20) said introduced material in a direction from said first end towards a second end of said chamber, introducing (S12) impregnation liquid/chemicals into said chamber, and extracting (S13) impregnated material from said chamber at said second end, **characterized by** said first end corresponding to a bottom end of said chamber, and said second end corresponding to a top end of said chamber, and extracting liquid (S14) from said bottom end of said chamber during operation, to provide a liquid flow arranged in an opposite direction of said direction of said introduced material in said chamber, and cleaning (S30) said extracted liquid and re-introducing (S40) at least the cleaned extracted liquid into said chamber to provide a flow of said liquid in said chamber.

9. The method according to claim 8, **characterized by** said method being adapted for impregnating wood chips.

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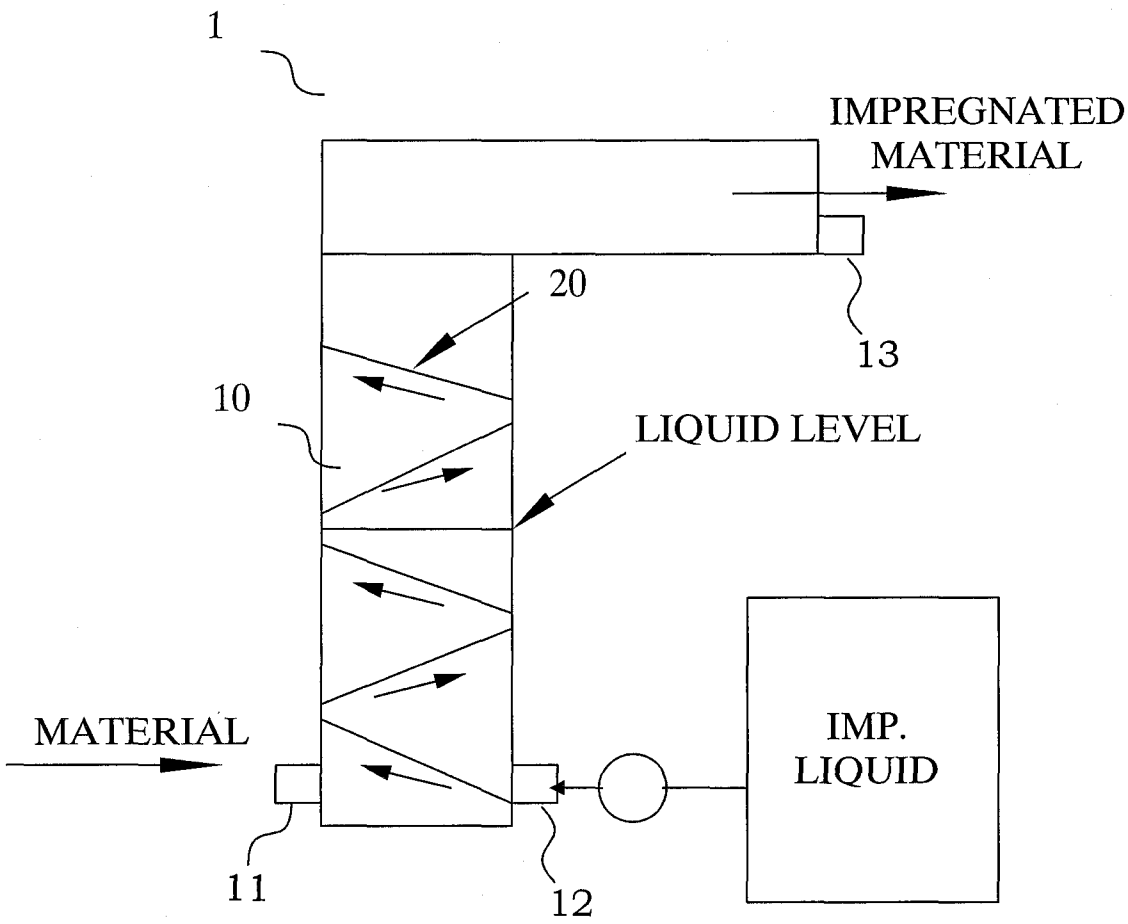

1
IMPREGNATED
MATERIAL
20
13
10
LIQUID LEVEL
MATERIAL
IMP.
LIQUID
11
12

Fig. 1

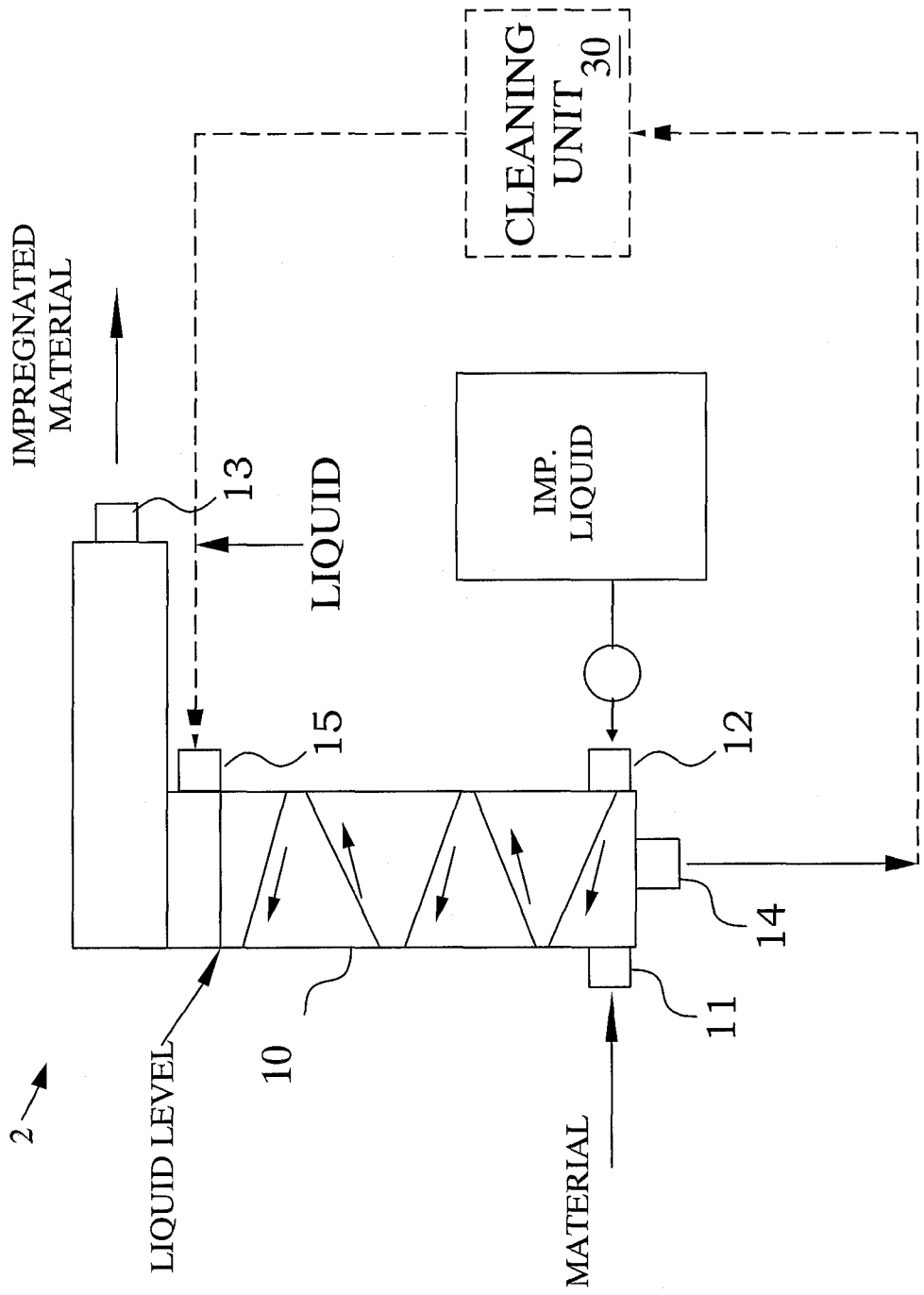

CLEANING UNIT 30
IMPREGNATED MATERIAL
13
LIQUID
IMP. LIQUID
15
12
14
11
10
LIQUID LEVEL
MATERIAL
2

Fig. 2

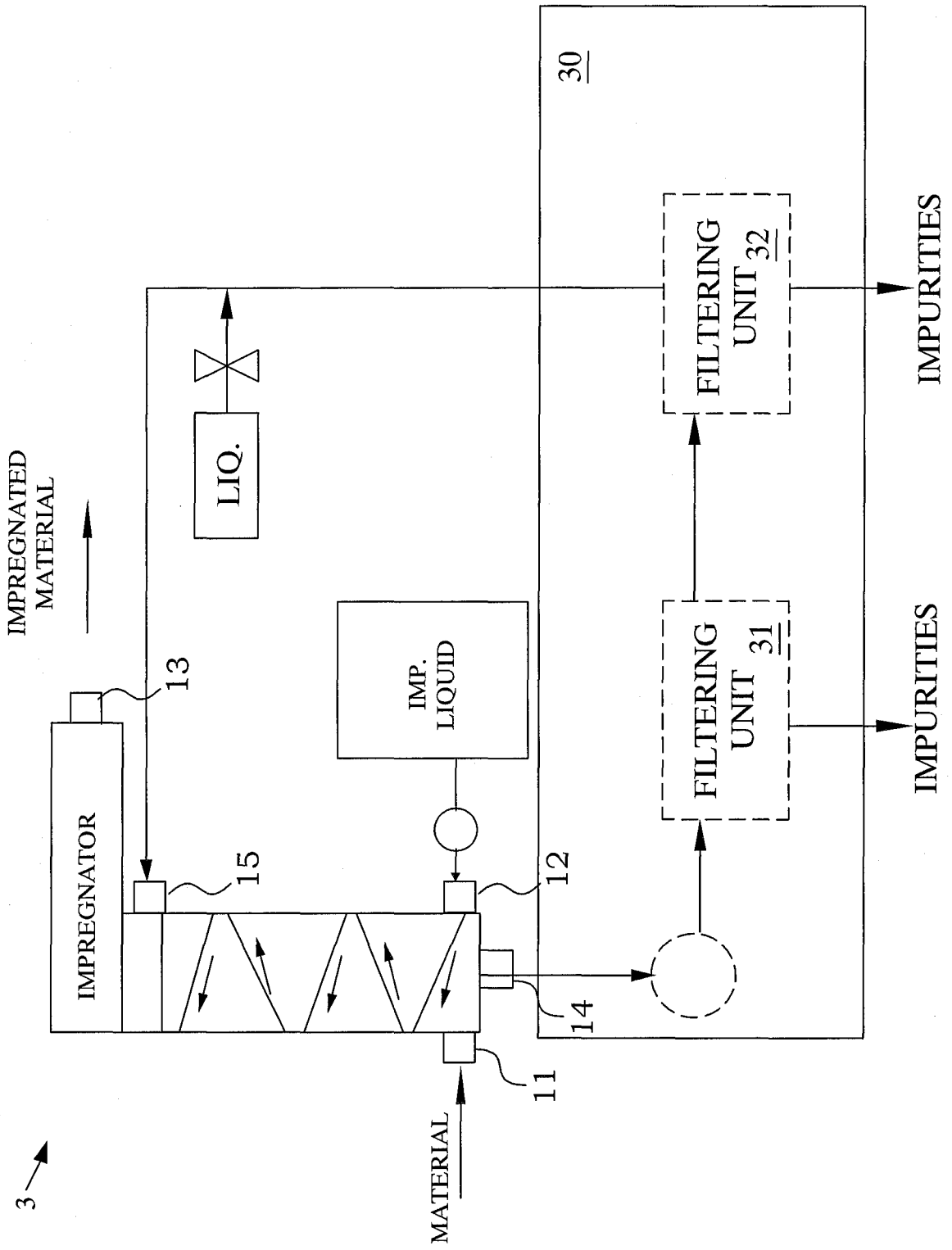

30
FILTERING UNIT 32
FILTERING UNIT 31
IMPURITIES
IMPURITIES
LIQ.
IMP. LIQUID
IMPREGNATED MATERIAL
IMPREGNATOR
13
15
12
14
11
MATERIAL
3

Fig. 3

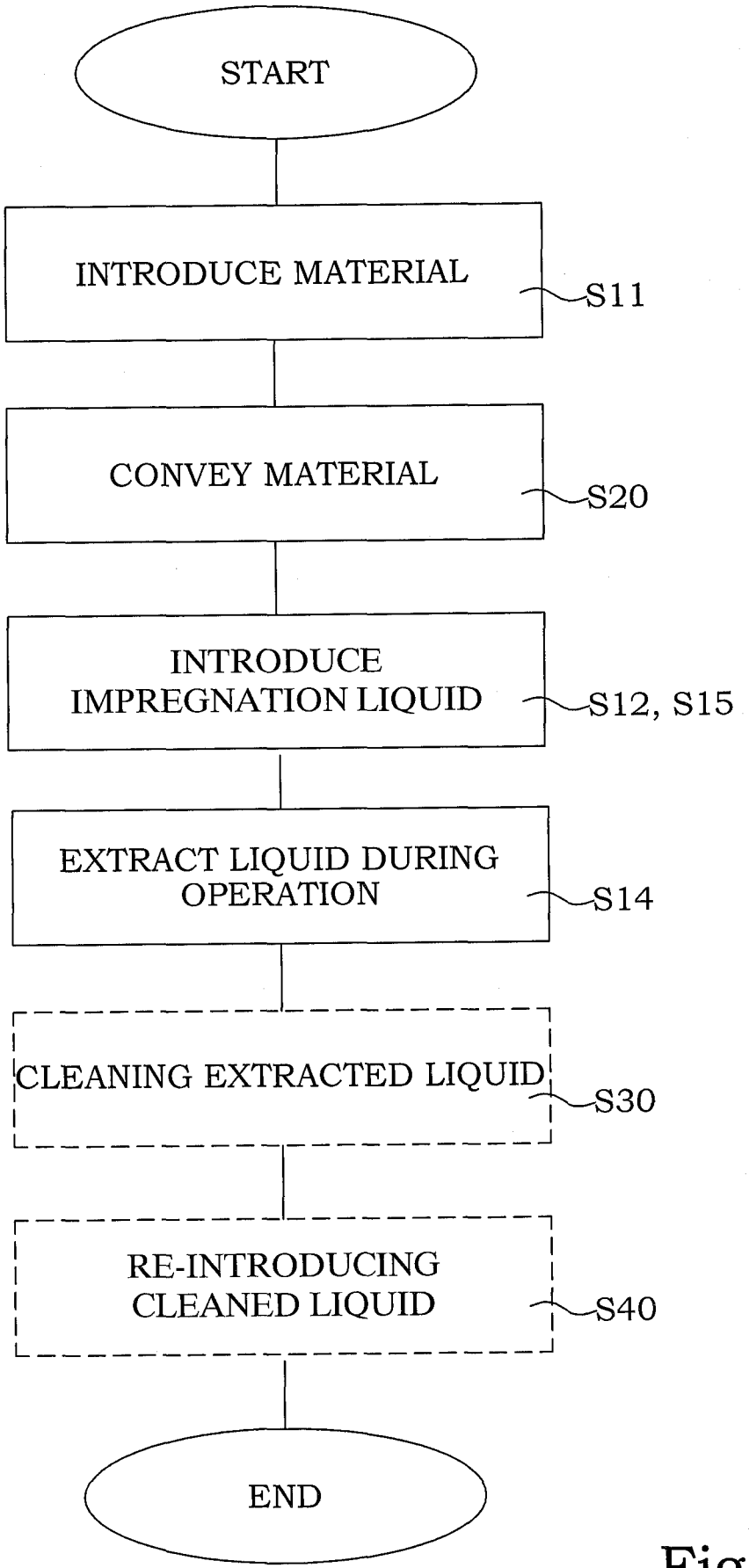

START
INTRODUCE MATERIAL
S11
CONVEY MATERIAL
S20
INTRODUCE IMPREGNATION LIQUID
S12, S15
EXTRACT LIQUID DURING OPERATION
S14
CLEANING EXTRACTED LIQUID
S30
RE-INTRODUCING CLEANED LIQUID
S40
END

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2013/050117

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: D21B, D21C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	EP 0138484 A2 (KAMYR AB), 24 April 1985 (1985-04-24); abstract; page 2, line 8 - line 19 --	1-9
Y	US 6364999 B1 (SPEAKS JERRY R ET AL), 2 April 2002 (2002-04-02); column 12, line 51 - line 67; figure 3b --	1-9
Y	US 4599138 A (LINDAHL JONAS A I), 8 July 1986 (1986-07-08); figures 1,2 --	1-9

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

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"P" document published prior to the international filing date but later than the priority date claimed

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
03-07-2013	03-07-2013

Name and mailing address of the ISA/SE	Authorized officer
Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Karin Bengtsson Telephone No. + 46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2013/050117

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9106700 A1 (SVENSKA TRAEFORSKNINGSINST), 16 May 1991 (1991-05-16); whole document --	1-9
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International application No.
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Continuation of: second sheet

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D21B 1/02 (2006.01)
D21C 1/10 (2006.01)

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