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(71) Applicant *(for all designated States except US)*: AB KLIPPANS FINPAPPERSBRUK [SE/SE]; Västergatan 1, S-352 30 Växjö (SE).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: KLEINHENZ, Kilian [DE/SE]; Videslund, S-360 50 Lessebo (SE). LINDQVIST, Göran [SE/SE]; Dalen, Videslund, S-360 50 Lessebo (SE).

(74) Agent: AWAPATENT AB; P.O. Box 45086, S-104 30 Stockholm (SE).

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(54) Title: A PULP PRODUCTION PROCESS

(57) Abstract

A process for the production of a waste-based cellulosic pulp useful for the manufacture of paper and paperboard whether used in admixture with virgin pulp or as the sole pulp component, comprising the steps: a) digesting a waste cellulosic material in an aqueous cooking liquor having a pH lower than about neutral and containing free and/or bound SO_2 and a base; b) carrying out digestion with the exclusion of atmospheric oxygen at an elevated temperature, such as within the range about 120 to 160 °C and at a correspondingly increased pressure; and c) recovering the resulting cellulosic pulp.

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A pulp production process

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates to a process for the production of a cellulosic pulp useful for the manufacture of paper and paperboard. More in particular, the invention is concerned with a process which enables the recycling of various waste cellulosic materials, such as used and printed or unprinted newspaper, graphic paper and board, waste packaging and corrugated paperboard materials, for the production of a cellulose fiber pulp suitable as the sole fiber component or in admixture with virgin pulp in the production of paper and paperboard.

Background art

During the last decade the need for recycling raw materials has grown at an extreme pace, especially within the paper and board manufacturing industry. Within the EEC, guidelines and even legislatory measures are presently taken to enforce the useage of secondary fibers at specified blend-in amounts in the manufacture of most paper and paperboard grades, including high-bright fine-papers.

The dominating technology employed up to now for separating fibrous from non-fibrous materials, to render the reclaimed pulp suitable for recycling in new paper products, entails the removal of printing ink-components and other contaminants such as polymer coatings, plastic materials, fillers, etc. either by flotation or washing or a combination of the two in so-called "deinking processes". Fundamentally, these technologies are concerned with the separation of undesired pulp-components by either incorporating them in a phase of stabilized foam with the help of finely dispersed air, and/or by washing the pulp with certain chemicals and thereafter subjecting the pulp to rigorous screening. Such processes are under constant development, whereby the main focus is presently on more efficient screening and fractionating techniques. The main drawbacks of said deinking technology is the relative high consumption of deinking chemicals, high installation costs of a plant, relatively high energy consumption, high organic freight in the effluent, and the need of dumping contaminant-sludge onto tips, as landfills, etc.

Fibers which are recovered using the techniques described above are often, as far as strength and optical properties are concerned, severely inferior to virgin pulp fibers and can generally only be used in admixture with high-quality virgin fibers in the production of paper products. Furthermore, the said recycled deinked fibers can cause serious production failures on the paper/board machine in the form of sticky, thermoplastic residues; insufficient fiber-length; microbiological infection of the paper machine's white-water system; entrapment of foreign materials such as metal shavings, paper clips, etc. Paper products manufactured using a high percentage of the said recycled fibers are generally lower in brightness, dirtier in the way of specks and less uniform in formation (see-through) than their virgin fiber-based counterparts. It would therefore be difficult to market such papers as high-quality fine-papers.

Other techniques known to be employed for the recycling of secondary cellulosic materials involve high-consistency disperging, whereby the ink particles and contaminants are reduced to such a size that the human eye no longer can distinguish them. Such recycled pulps are usually dull and low in strength properties and contain relative high amounts of residual fillers, organic trash and foreign matter.

SUMMARY AND OBJECTS OF THE INVENTION

The main object of the invention is to provide a process for the production of a cellulosic pulp using as a starting material waste cellulosic materials, such as printed or unprinted papers e.g. newspaper, tissue, coated or uncoated paper and paperboard, packaging paper-/paperboard including corrugated paperboard, solid fiber-board, millbroke, chipboard, sawmill waste etc. or blends of any of these cellulosic materials in appropriate pro-portions.

Another object of the invention is to provide a pro-cess for the manufacture of bleached or unbleached recyc-led pulp, which can be used in admixture with or as the sole pulp component in the production of paper and paper-board. Among such products there may be mentioned writings and printings, newspaper, tissue, packagings, uncoated graphics, coated graphics, etc.

A further object of the invention is to provide a process, wherein energy and chemical values can be reco-vered and reused within the process and wherein any sur-plus energy resulting from the process is converted to heat energy to be used within the said process or e.g. as drying energy in for example an integrated papermill or the like.

Yet another object of the invention is to provide a process for the production of a cellulosic fiber pulp which is practically void of any foreign organic substan-ces, such as printing ink carrier-vehicles, polymeric coatings, glues, pastes, etc.

For these and other purposes which will be clear from the following disclosure the present invention provides a process for the production of a cellulosic pulp useful for the manufacture of paper and paperboard, whether used in admixture with virgin pulp or as the sole pulp component. The process according to the invention involves the fol-lowing steps:

a) digesting a waste cellulosic material in an aque-ous cooking liquor having a pH lower than about neutral and containing free and/or bound SO_2 and a base;

b) carrying out digestion with the exclusion of atmospheric oxygen at an elevated temperature, such as within the range about 120° to 160°C and at a correspondingly increased pressure; and

c) recovering the resulting cellulosic pulp.

In such process waste cellulosic materials of any origin and in any blend is digested in a cooking liquor having a pH from acidic up to about neutral containing free and/or bound SO_2 and a base, such as bases involving magnesium, sodium, calcium or ammonium.

After completion of the delignification and/or dissolution of organic substances derived from printing inks, glues, coatings etc., a brownstock fiber pulp and spent liquor are produced. The cooking time depends on the composition of the waste material and the cooking temperature used, the degree of delignification, retained hemicellulose, as well as the desired strength and optical properties of the pulp and the cooking time may vary from between about 1 and about 10 hours.

In accordance with a preferred embodiment of the process according to the invention there is used as a starting material an admixture of a waste cellulosic material and raw wood in a suitable digestable form. Such raw wood is preferably of coniferous origin.

Although the ratio between waste cellulosic material and raw wood in such admixture is not critical it is preferred to operate within the range of from about 5 to about 90% by weight of raw wood. It is particularly preferred that the raw wood constitutes a minor part of said admixture, i.e. constitutes less than about 50% of the admixture. It is especially preferred that said admixture contains from about 10 to about 30% by weight of raw wood based on the total of raw wood and waste cellulosic material.

The addition of raw wood to waste cellulosic material to be used as a starting material results in a cellulosic pulp, which is delignified to a higher degree at given process parameters than the same waste material without the wood chip addition. Thus, a kappa number of from about 10 to about 30 can be easily reached as compared to kappa numbers of from about 30 to about 60 without the addition of raw wood. The raw wood is preferably in the form of wood chips, although other materials are conceivable, such as ground wood or sawmill waste of different types, such as saw dust, shavings etc.

The cellulosic pulp produced by the process according to the invention is, in a conventional manner, washed with water to produce brownstock pulp and a brownstock washing liquor, which contains organic substances formed during digestion, and inorganic chemicals, derived partly from the digestive raw-materials and partly from the cooking liquor. The washed brownstock can be used in the manufacture of paper products directly or is passed on to a bleaching facility, where bleaching with any or a combination of bleaching substances commonly employed within the pulp industry for virgin-fiber pulp can be carried out.

A major part of the brownstock washing liquor is concentrated by evaporation to produce a concentrate containing combustible organic substances and incombustible inorganic chemical values. The organic substances are combusted to produce heat energy which is recovered, and the inorganic chemicals are recovered to produce new cooking liquor for the process.

According to another aspect of the invention a minor amount of the cooking liquor or the brownstock washing liquor can be recycled in the process instead of or in addition to the added raw wood. This minor amount of liquor is preferably from about 1 to about 10% of the total amount thereof. The process according to the invention provides a waste-based cellulosic pulp which has been delignified to a kappa number lower than the mean kappa number of the blend of waste recyclable cellulose materials. The kappa number is preferably within the range of about 10 to about 30, which makes the pulp fully bleachable. However, the bleaching of the pulp produced constitutes an optional step.

As indicated above it is preferred according to the present invention to use an admixture of a waste cellulosic material and raw wood in a digestible form. Such addition of raw wood, such as in the form of wood chips results in a waste-based cellulosic pulp which can be delignified to a higher degree at given process parameters than when using the same waste material without the addition of raw wood. Although the present invention is not to be restricted to any particular theory or mechanism it would seem that certain extractives from the raw wood enhance the condensation of lignin, whilst others act as protective compounds towards the decomposition of hemicellulose, which means that the pulp produced in this manner retains a high degree of its strength properties. It is also to be noted, that with no addition of raw wood to the starting material the pulp produced in the same manner will not be bleachable to the same brightness range, about 65 to about 85, using a simple two-stage hydrogen peroxide bleaching sequence as compared to the situation when raw wood has been added.

Thus, the present invention provides the possibility of producing a cellulosic pulp from cellulosic waste materials, optionally in admixture with raw wood, in a single cooking operation. Depending on the strength/optical properties required of a paper product produced with such pulp, it is possible to use the pulp as the sole fiber-component in a wide variety of paper and paperboard grades ranging from tissue, through unbleached packagings to highly bleached speck-free fine papers. When using the optional step of bleaching the pulp kappa numbers below about 30 will generally result in a brightness of about 65 and substantially higher. It is particularly conceivable to obtain such good results by using an admixture with raw wood.

In this disclosure all brightness values are given in ISO-brightness, according to ISO 2470, coinciding with SCAN-P 3:75, AFNOR Q 03-039, ATICEL-CA MC 12-68, BS

4432:2, CPPA E.IP and cSN 50 0241. All percentages refer to percent by weight if not otherwise stated.

DESCRIPTION OF PREFERRED EMBODIMENTS

In the appended drawing there is diagramatically shown a plant useful in the production of cellulosic pulp in accordance with the process of the present invention.

The illustrated plant will be briefly described in the following.

The plant outlined in the drawing includes a pulper 1 for waste cellulosic material, further including a cleaning unit 5 and a press 7. The plant also includes a reactor or digester 11, a pulp vessel 19, and knotscreen apparatus 14,15,17,18, a brownstock washer 20 and a fine screen apparatus 23 to 30. The plant also includes a recovery system consisting of an evaporation plant 107 and a recovery boiler for a burning thickener liquor to produce steam that can be used in the process.

To the pulper 1 there is supplied cooking liquid so that together with the waste cellulosic material there is obtained the appropriate concentration of fiber material, such as from 2 to 4%. A conduit 4 connects the pulper 1 with the cleaning unit 5 which is optional and a conduit 6 further connects to the press 7 wherein the solids content is increased to 25 to 30% depending on the quality of the starting materials. A conduit 8 recycles the excess of liquor from press 7 to the pulper 1. Through conduit 9 the press 7 is connected with the reactor or digester 11. Wood chips and/or brownstock washing liquor is added to the reactor or digester 11 through conduits 10 and 64, respectively. A conduit 101 connects any of the liquor vessels 94,96,98,100 with the digester or reactor 11 depending on the cooking liquor quality desired in the process and is used for filling up the reactor 11 with acid cooking liquid before the cooking process is initiated. After sealing the charged reactor the cooking liquor is heated, preferably by indirect heating over a heat exchanger with steam, to an appropriate temperature, normally between 120 and 160°C, preferably 125 to 135°C.

A conduit 66 connects the reactor 11 with the primary liquor vessel 67 and is used for dumping the cooking liquor, thereby completing the digesting process. The pulp is slushed out of the reactor 11 to the brownstock vessel 12 with brownstock washing liquor (slush liquor) being taken from the slush liquor vessel 63 using conduit 64.

A conduit 13 connects the brownstock vessel 12 with the primary and secondary knotscreens 14,15. The reject from the primary knotscreen 14 constitutes inject of the secondary knotscreen 15. The accept from the secondary screen 15 is collected in a vessel 17 for accept from the secondary screen and is in turn connected via a conduit 18 to the inject of the primary knotscreen 14. The conduit 16 carries the accept from the primary knotscreen 14 to the brownstock washer 19. The washwater used in the brownstock washer emerges from thickener 33 as an eluate, the connection being indicated by conduit 71. The brownstock washer 19 is connected to a buffer vessel 21 connected to the primary fine screen 23 via conduit 22. Conduit 24 connects the primary fine screen 23 with the reject screen 25 from which the accept follows conduit 26 back to buffer vessel 21. The reject is taken to a deposit for further transportation to another production unit. A conduit 27 carries the accept from the primary fine screen 23 to the buffer vessel 28, which is connected to the secondary fine screen 30 by conduit 29. The reject from the secondary fine screen 30 is passed over to the reject screen 25 via a conduit 31. After screening the pulp passes through another set of washing thickeners 33,39,41. The number of thickeners depends on how thorough the washing of the pulp need to be with a given amount of water determined by the evaporator capacity which is limiting for the amount of water used for washing.

After washing and screening the pulp it can, if desired, be bleached in any bleaching sequence such as the sequence P/E, P/E. Hydrogen peroxide and sodium hydroxide are added to the pulp in a frotapulper 43. The pulp and the chemical mix are transported through a steam mixer thereby heated to a temperature in the range of 65 to 90°C, preferably 75-85°C. The mixture descends from the steam mixer into a downstream tower 45, and after a retention time of 2 to 4 hours the pulp leaves the tower and is pumped to a filter 47, where it is washed. After the washing the pulp is diluted in slightly acidified water and pumped to a neutralization tower 49, at the end of which the pH is adjusted once again with SO_2-water to approximately pH 7. After the neutralization tower 49 the pulp is washed and dewatered on a filter 51. To the dewatered pulp another dose of hydrogen peroxide and sodium hydroxide is added and the pulp is pumped to bleaching tower 54.

Brownstock washing liquor is pumped through a conduit 62 to a vessel called slush liquor vessel 63. Excess liquid from this vessel is mixed with the primary liquor in the primary liquor vessel 67. The mixture of primary liquor and brownstock washing liquor is termed thin liquor. The thin liquor is neutralized in a vessel 69, wherein it is mixed with magnesium oxide from the chemical recovery system. This neutralization has for an object to prevent volatile organic acids from evaporating in the evaporation plant 107. The neutralized thin liquor is concentrated in the evaporation plant to a dry solids content of 50 to 60%, preferably 56 to 60%. The concentrated liquor is called thick liquor and is burned in the recovery boiler 86, thus generating about 2.3 to 2.9 tons of steam per ton of thick liquor. In the ash collected on the electrical filter in the recovery plant 86 after the combustion of the thick liquor the main component is magnesium oxide. This magnesium oxide is washed in luke warm water to dissolve salts of sodium and potassium. After washing the magnesium oxide is mixed into hot water, where it reacts to form magnesium hydroxide which in turn is pumped into a gas absorption system wherein the sulfurdioxide-rich fluegases from the thick liquor combustion are washed with the magnesium hydroxide slurry thus forming new raw acid. This raw acid is pumped from the recovery plant 86 through a sedimentation tank 88, a sandfilter 90 and a heat exchanger 92 into the raw acid vessel 94. The pressure in the raw acid vessel is close to atmospheric, whereas the pressure in the other vessels is higher than atmospheric. Excess gas from the reactor 11 enters in counterstream versus the acid into the acid vessels.

EXAMPLES

The following examples illustrate the invention more in detail but are not to be construed as limiting the scope of the invention except as defined in the appended claims.

EXAMPLE 1

Commercial corrugated waste (kappa number of 87) is cooked with an acidic cooking liquor containing a total SO_2 of 50 g/l and a mill combined SO_2 of 26 g/l, resulting in free SO_2 of 24 g/l. The pH-value is 4.5 and the cation (base) used is magnesium. Cooking is conducted for 6 hours at a temperature of 128°C. The resulting washed pulp has a kappa number of 75.1 and brightness of 28.7. Pulp yield on dry raw material is 70.7%.

EXAMPLE 2

Pulp as produced from Example 1 is bleached in a 2-stage P/EP/E bleaching sequence. Hydrogen peroxide dosage is 2% in stage 1 and 1% in stage 2. Bleaching time is 2.5 h in stage 1 and 3 h in stage 2 at a common temperature of 75°C. The bleached and washed pulp has a brightness of 46.9.

EXAMPLE 3

Commercial corrugated waste obtained according to Example 1 is cooked with an acidic cooking liquor as in Example 1, but the cooking time is increased to 7 hours at a temperatur of 128°C. The pulp has a kappa number of 47.3, a brightness of 29.4 and a yield on waste of 67.6%.

EXAMPLE 4

Pulp resulting from Example 3 bleached as in Example 2. The pulp has a brightness of 47.3.

EXAMPLE 5

The waste used in Examples 1 and 3 is cooked with an acidic cooking liquor containing a total SO_2 of 80 g/l and a mill combined SO_2 of 22 g/l, resulting in free SO_2 of 58 g/l. The pH-value is 1.5 and the cation (base) used is magnesium. Cooking is conducted for 4 hours at a temperature of 128°C. The resulting pulp has a kappa number of 33.7, a brightness of 29.1 and a yield of 59.0%.

EXAMPLE 6

Pulp as produced in Example 5 is bleached as in Examples 2 and 4. The bleached pulp has a brightness of 46.2.

EXAMPLE 7

A mixture of 50% commercial corrugated waste as per Example 1 and 50% spruce wood chips is cooked with an acidic cooking liquor according to Example 1. Cooking is conducted for 6 hours at a temperature of 128°C as in Example 1. The resulting pulp has a kappa number of 60.8, a brightness of 38.0 and a yield of 57.8%.

EXAMPLE 8

Pulp produced from Example 7 is bleached as in Example 2. The bleached pulp has a brightness of 43.2.

EXAMPLE 9

The blend of 50% waste and 50% spruce wood chips as used in Example 7 is cooked with the cooking liquor described in Example 5. Cooking is conducted for 6 hours at a temperature of 128°C. The pulp has a kappa number of 24.3, a brightness of 39.7 and a yield of 48.7%.

EXAMPLE 10

The pulp as produced from Example 9 is bleached as in Example 2. The bleached pulp acquires a brightness of 73.6.

EXAMPLE 11

The blend of waste/wood chips described in Example 7 is cooked according to Example 5. The cooking is conducted for 7 hours at a temperature of 128°C. The pulp has a kappa number of 20.5, a brightness of 34.7 and a yield of 42.3%.

EXAMPLE 12

The pulp produced in Example 11 is bleached as described in Example 2. The pulp acquires a brightness of 75.7.

EXAMPLE 13

The waste/wood chip mixture is altered from 50/50% as per Example 7 to 67% waste corrugated paperboard and 33% spruce wood chips. This mixture is cooked according to Example 11 with a cooking liquor according to Example 5. The pulp has a kappa number of 13.1, a brightness of 38.1 and a yield of 53.7%.

EXAMPLE 14

The pulp produced in Example 13 is subjected to bleaching according to Example 2. The pulp acquires a brightness of 71.4.

EXAMPLE 15

A mixture of 50% spruce wood chips, 25% waste corrugated paperboard and 25% waste unsorted, printed newspaper is cooked according to Example 11 with a cooking liquor as in Example 5. The pulp has a kappa number of 13.9, a brightness of 44.7 and a yield of 37.6%.

EXAMPLE 16

The pulp produced in Example 15 is subjected to bleaching as per Example 2. The pulp acquires a brightness of 77.2.

EXAMPLE 17

The mixture of raw materials according to Example 15 is supplemented with extra plastic materials (polyethylene and polyvinylchloride) and metal staples and shavings (iron, copper and bronze). This composition is cooked according to Example 11 with a cooking liquor according to Example 5. The metal contaminants are completely disintegrated and the plastic materials form more or less large agglomerates, which can be screened away easily in the primary and secondary screening equipment commonly employed in conventional cleaning technology. The kappa number of the pulp is 17.6, the brightness 42.8 and the yield 34.0% on total weighted fibrous material plus contaminants.

EXAMPLE 18

A mixture of 25% spruce wood ships, 37.5% waste corrugated paperboard and 37.5% waste assorted, printed newspaper is cooked according to Example 11 with a cooking liquor according to Example 5. The pulp has a kappa number of 10.7, a brightness of 70.2 and a yield of 38.1%.

EXAMPLE 19

The pulp produced from Example 18 is bleached according to Example 2, 4, 6, 8, 10, 12, 14, 16 and 18. The pulp has a brightness of 70.2.

EXAMPLE 20

The bleached pulp from Example 4 is formed into standard hand-sheets according to SCAN-C 26:76 R and the following strength properties are tested: tensile factor is 75 and tear factor is 6.8.

EXAMPLE 21

The bleached pulp from Example 6 is tested according to Example 20. The tensile factor is 51 and the tear factor 3.2.

EXAMPLE 22

The bleached pulp from Example 12 is tested according to Example 20. The tensile factor is 44 and the tear factor 9.3.

EXAMPLE 23

The bleached pulp from Example 16 is tested according to Example 20. The tensile factor is 46 and the tear factor 7.3.

EXAMPLE 24

The bleached pulp from Example 19 is tested according to Example 20. The tensile factor is 61 and the tear factor 6.7.

EXAMPLE 25

A commercial deinked waste-based pulp with a brightness of 54.4 is tested according to Example 20. The tensile factor is 42 and the tear factor 5.9.

CLAIMS

1. A process for the production of a cellulosic pulp useful for the manufacture of paper and paperboard whether used in admixture with virgin pulp or as the sole pulp component, comprising the steps:

a) digesting a waste cellulosic material in an aqueous cooking liquor having a pH lower than about neutral and containing free and/or bound SO_2 and a base;

b) carrying out digestion with the exclusion of atmospheric oxygen at an elevated temperature, such as within the range about 120° to 160°C and at a correspondingly increased pressure; and

c) recovering the resulting cellulosic pulp.

2. A process according to claim 1, wherein step a) is carried out while digesting an admixture of a waste cellulosic material and raw wood in a digestable form.

3. A process according to claim 2, wherein said admixture is constituted by from about 5 to about 90% by weight of raw wood.

4. A process according to claim 3, wherein the raw wood constitutes a minor part of said admixture.

5. A process according to claim 4, wherein the contents of raw wood in said admixture is from about 10 to about 30% by weight.

6. A process according to claim 1, wherein a minor amount of the cooking liquor resulting from the digestion is recycled into step a) instead of or in addition to added raw wood.

7. A process according to claim 6, wherein said minor amount of cooking liquor constitutes about 1 to 10% of the total amount thereof.

8. A process according to any preceding claim, wherein the cooking liquor resulting from the digestion after concentration thereof to a solids content of about 30 to 60% by weight is combusted to produce energy.

9. A process according to any preceding claim, wherein the cellulosic pulp resulting from step c) is subjected to a chemical bleaching step to produce a bleached, delignified pulp for the manufacture of bleached paper or paperboard.

10. A process according to any preceding claim, wherein the kappa number of the produced pulp is lower than that of both the recycled cellulosic waste and the raw wood.

11. The cellulosic pulp produced by the process of any preceding claim.

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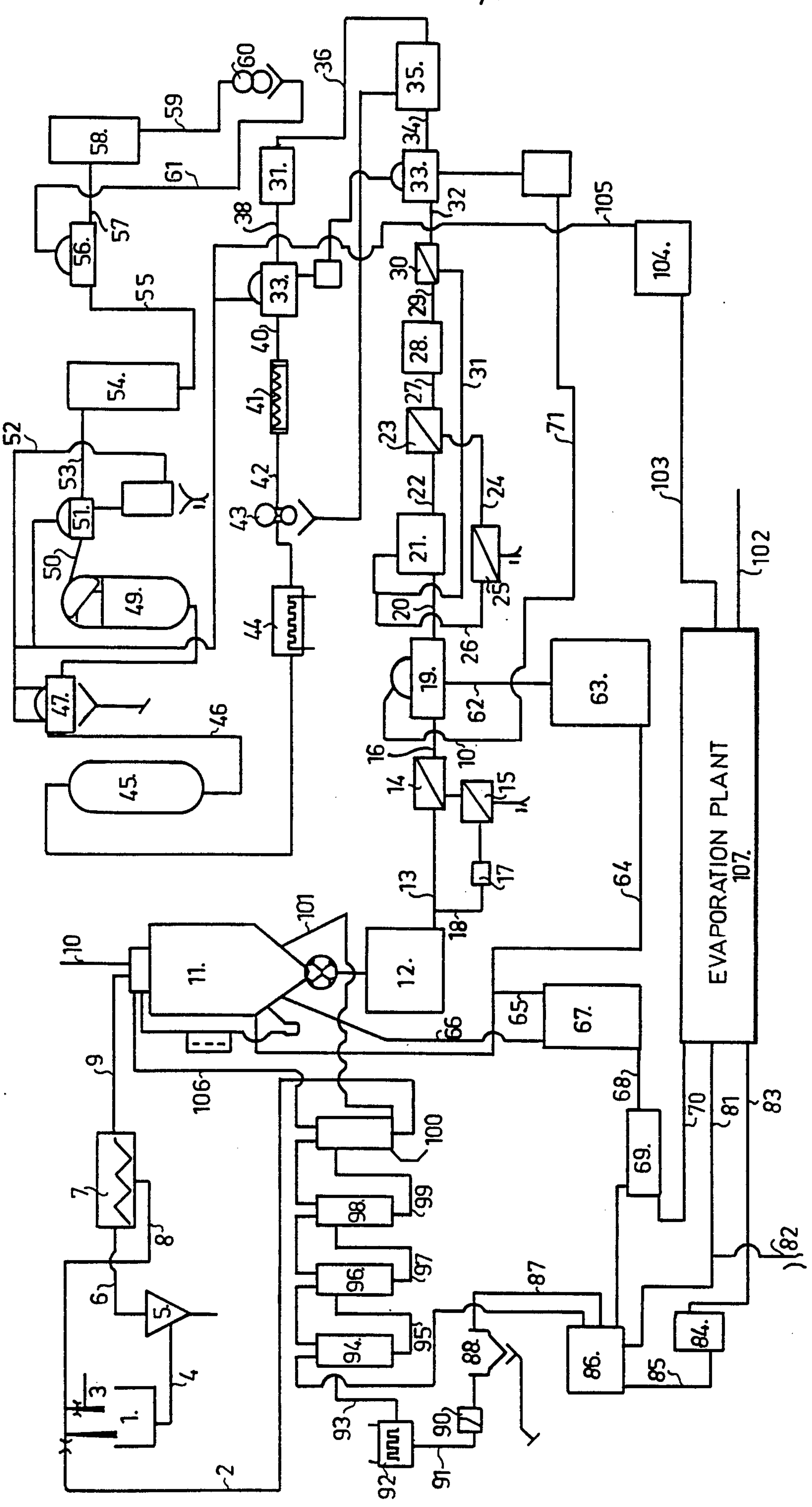

SUBSTITUTE SHEET

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 94/00499

A. CLASSIFICATION OF SUBJECT MATTER

IPC 5: D21C 5/02
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)

IPC5: 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)

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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[X] Further documents are listed in the continuation of Box C.   [X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
2 Sept 1994	08 -09- 1994
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Marianne Bratsberg Telephone No. +46 8 782 25 00

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

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			EP-A-	0573497	15/12/93
EP-A2-	0374057	20/06/90	SE-T3-	0374057	
			CA-A-	2003587	24/05/90
			DE-D,T-	68912543	30/06/94
			ES-T-	2015838	16/03/94
			FR-A-	2639371	25/05/90
			JP-A-	2182985	17/07/90
US-A-	1782382	18/11/30	NONE		