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(71) Applicant: MODO-CHEMETICS AB [SE/SE]; Box 13, S-891 00 Örnsköldsvik (SE).

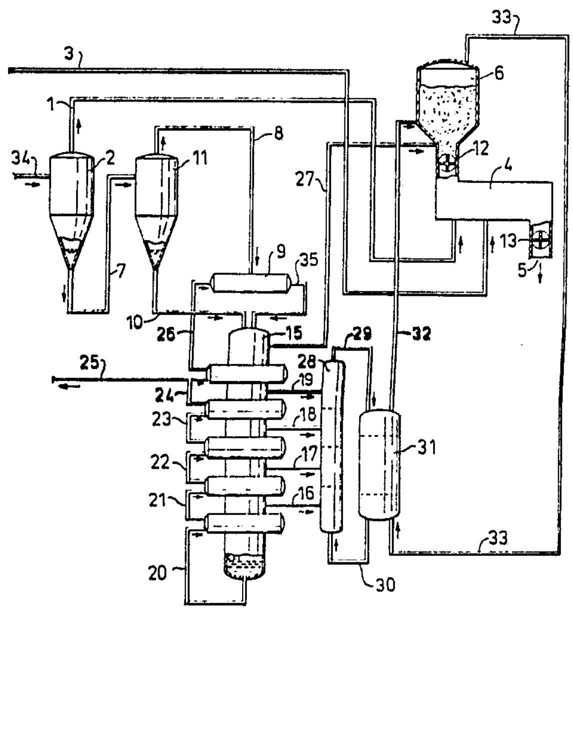
(72) Inventors: CANDOLIN, Carl-Johan; Högbergsgatan 15, S-891 00 Örnsköldsvik (SE). OLSON, Torbjörn; Österalnö, S-890 26 Moliden (SE). OLAUSSON, Lars, Gunnar; Krukväxtgatan 19, S-424 53 Angered (SE).

(74) Agent: TYDÉN, Hans; Mo och Domsjö AB, Patent Department, Box 500, S-891 01 Örnsköldsvik (SE).

(54) Title: A METHOD FOR PREHEATING WOOD CHIPS

(57) Abstract

When manufacturing cellulose pulps from lignocellulosic material in the form of wood chips, the chips are normally steamed, optionally subsequent to being subjected to an introductory washing stage, so as to obtain a homogenous moisture content throughout the whole of the chip bulk and to improve the penetration and diffusion into the chips of chemicals subsequently used in the pulp manufacturing process. At the same time the release of lignin, resins etc. from the chips is facilitated. However, steam and heating of the chips, to temperatures of about 120°C, requires the input of very large quantities of thermal energy, which tends to become more and more expensive. The present invention relates to a method for preheating wood chips in a heat economical manner and therewith a cost saving manner, prior to steaming the chips (3); the preheating process being carried out in one or more stages at progressively higher temperatures. The method is characterized in that heating of the chips during the first preheating stage and the stage or stages immediately following the first stage is effected directly by means of moisture-saturated hot air (32), optionally admixed with inert gas, which has been heated to 55-99°C, preferably 70-90°C. The moisture-saturated hot air (32) used in the process is heated in a contact device (31) or air heaters with hot water (29) or low grade vapors (waste heat), such as vacuum vapors (16-19) drawn at different levels from an evaporator station (15), for example a Lockman-column type pre-evaporator.



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A method for preheating wood chips

Technical field

The present invention relates to a method for preheating wood chips prior to steaming said chips, for the purpose of improving heat economy. By wood chips is meant here and in the following chips which are obtained by chipping wood logs and which are used as a starting material in the manufacture of cellulose pulps using known chemical, semi-chemical, chemi-mechanical, and mechanical processes, such as sulphite, sulphate, refiner and thermomechanical methods. The invention is thus suitable for the preparatory treatment of the starting material, i.e. the wood chips, in cellulose pulp manufacturing processes.

State of the Art

When manufacturing cellulose pulps, the chips are steamed in order to enable chemicals subsequently charged to the process to penetrate and diffuse into the chips more readily, while at the same time facilitating the release of lignin, resins etc. from said chips.

Other pretreatment methods are described in the literature. Thus, the Swedish Patent Specification Serial No 149 053 teaches the simultaneous moistening (moisture equalization) and transportation of wood chips to the top of a digester, or to chip bins or silos, or to a steaming vessel. In this case, the chips are conveyed in water which has been heated to 30-40^{o}C with fresh steam and which may contain a minor quantity of alkali. This method of procedure, however, requires the provision of special apparatus and involves the consumption of expensive fresh steam. Furthermore, the chips become totally saturated, which renders subsequent impregnation of the chips with cooking liquor difficult, and introduces an unnecessary, high quantity of water to the process. This negatively affects the concentration of the waste liquor, and therewith the heat economy and chemical recovery.

The Swedish Patent Publication No 227 648 teaches a method for heating chips stored in outdoor stacks at temperatures around 0°C or lower, in order to produce a more uniform pulp raw material. This is effected by blowing hot air or steam into the bottom of respective stacks so as to initiate a desired enzymatic hydrolysis of the extractive substances of the wood, which hydrolysis, as a result of its exothermic reaction, is able to raise the temperature throughout the whole of the stack. In this way the bottom layer of chips is heated preferably to between 1 and 5°C, at most to 30°C, normally by introducing steam (hot air) into the stack for short repeated periods at given intervals therebetween, through a system of pipes arranged in the bottom of said stack. After storage the chips, however, lose all of their heat while being transported to the digester. Preheating of wood chips in a heat saving manner as intended by the present invention is not gained by this known method.

It is also known to preheat wood chips in one step from about 0°C to 95°C in a chip bin, by blowing into the chips so-called secondary steam having a temperature somewhat in excess of 100°C. This is not satisfactory, however, from the aspect of heat economy, since this kind of steam has a heat economy value which lies close to that of fresh steam. Moreover, the air displaced from the chip bin and the accompanying volatile organic constitutents driven from the wood will be discharged to the surrounding atmosphere, which is environmentally unacceptable, especially as the departing gases also create the risk of fire and explosion.

Disclosure of the invention

Technical problem

Against the background of the high energy costs involved, attempts are being made in the pulp industry to improve the heat economy of the processes employed. In this respect, those operations which include a very high drop in temperature are the first to be tackled, since the greatest amount of energy is to be saved in such operations. One such operation is the preheating of wood chips with fresh steam in a steaming vessel to a temperature of 125°C. In this case, the temperature of the chips is raised from about 0°C to 125°C in a single step, which is wrong both from a thermo-technical and a thermo-economical aspect. In recent years, certain pulp manufacturers have preheated the chips in two stages, using steam at a temperature slightly above 100°C in the first stage and steam at 125°C in the second stage. Although this is an improved solution, it does not result in satisfactory heat economy.

Solution

The aforementioned problems are resolved by means of the present invention, which relates to a method for preheating wood chips prior to steaming said chips, in which method the chips are heated during the preheating process to progressively higher temperatures in one or more stages, after which the chips are finally heated in the steaming vessel to a temperature of about 120°C. The method is characterized in that in the first preheating stage, and in the stage or stages immediately following said first stage, the chips are heated directly with moisture-saturated hot air, optionally admixed with an inert or neutral gas, said hot air having been heated to a temperature of between 55-99°C, preferably 70-90°C.

Preheating of the chips in accordance with the invention is preferably carried out in a chip bin located in the pulp mill and normally placed in front of and above the steaming vessel. The chips are preheated continuously in the bin as they are charged thereinto by means of hot, moisture-saturated air blown into said bin, the temperature of said chips increasing progressively as the chips pass down through the bin. When the chips reach the bottom of the bin and have passed the last air-injection location, at which secondary steam having a temperature of at least 100°C can be blown in, the temperature of the chips has normally reached to about 95°C. Residual heating of the chips to about 120°C is effected in the steaming vessel by means of fresh steam blown thereinto. When the chips are to be used for the manufacture of chemical pulp, the hot chips are fed down from the steaming vessel directly into a digester.

The air used to preheat the chips is suitably heated in a contact device, in which hot water or hot condensate is caused to meet the air in counter-flow. The condensate suitably has a temperature of about 80°C, before delivering its heat to the air passing in counter-flow thereto. The cooled condensate is continuously recycled to a direct condenser, where it is reheated to a temperature of about 80°C, for example using vacuum steam drawn off from different effects in an evaporation station. As the air passes through the contact device in counter-flow with the hot condensate or water it is simultaneously washed, which is of importance in those cases when the air, subsequent to giving off its heat to the chips in the chip bin, is recycled to the contact device, for reheating and reuse in said bin. This recycling of the preheating air is particularly favourable from an environmental aspect, and is normally employed in the method according to the present invention.

In accordance with a preferred embodiment of the invention, which further improves the heat economy of the process, the air used for heating the chips in the chip bin is heated in an air-heating unit which comprises a plurality of indirect condensors built together, and means for supplying spray water to said air such as to saturate the same with moisture. The thermal energy input to the air-heating unit is obtained, for example from an evaporation station, by supplying to the individual condensors low-grade vacuum steam drawn from mutually different effects in said station. In accordance with this embodiment, the saturated hot air is heated to a temperature of about 70°C, before being blown into the chip bin.

In accordance with another suitable embodiment, with which good heat economy is obtained, the air-heating unit is divided into two similar units which work in parallel and to each of which there is fed vacuum steam drawn from the evaporator, in a manner such that one unit is supplied with vacuum steam from the higher levels of the evaporator, i.e. the hottest steam, while the other unit is supplied with vacuum steam from the lower levels of said evaporator. In this way it is possible to obtain two saturated air streams of mutually different temperature, which can be blown or injected into the chip bin at two separate locations, i.e. preheating of the chips can be carried out in three stages, when taking into account the last stage with secondary steam.

The secondary steam used in the last stage of the chip preheating process is preferably blown into the bottom of the chip bin, said steam has a temperature of at least 100°C and, according to the present method, is suitably withdrawn from an evaporation unit with suitable pressure, or from a so-called flash tank, i.e. an expansion vessel, for driving off steam from digester waste liquor. Normally there are from 1 to 3 such expansion vessels per digester, and hereinafter these vessels will be designated flash tank I, flash tank II etc., in the order of sequence from the digester.

The steam used in the steaming vessel is normally taken from flash tank I after the digester and has a temperature of about 125°C. However, steam used in the steaming vessel is preferably taken from flash tank II or from a pre-evaporation effect coupled to flash tank I. Steam charged to the steaming vessel in accordance with this latter alternative is more pure than steam charged in accordance with the former, and also provides the best heat economy.

The surprisingly good heat economy afforded by the method according to the present invention is related to the fact that it has been found possible to cover a high percentage of the heat required to preheat the chips to about 120°C by utilizing air as a carrier medium for waste heat in the form of, for example, low-grade vacuum steam. This is achieved by supplementing the partial pressure of the vacuum steam to atmospheric pressure by means of air. In this way the necessity of handling the chips in a vacuum vessel is avoided while, at the same time, enabling the high heat capacity of vapors having a temperature lower than 100°C to be utilized. In this case, the air mainly only serves as a carrier medium for the steam, which constitutes the heating component. The part played by the air in the transfer of heat is thus relatively small, and is of subordinate significance, except when the hot air has a very low final temperature.

Advantages

When applying the method according to the invention, the energy costs involved are very low, because a great deal of the heat required to heat the chips to about 125°C is covered by waste heat, which is thus given a profitable value, said waste heat suitably being in the form of low-grade vacuum steam taken, for example, from an evaporator station. Vacuum steam having a temperature of 60°C and taken from an evaporator stage is otherwise to be considered as waste heat.

Another advantage is that, in comparison with direct heating of the chips with hot water, the chips treated in accordance with the invention are not saturated with water during the treatment process, which contributes in turn to improved impregnation of the chips in a subsequent stage and to a higher quality of the final pulp. A contributory factor in this connection is that air and volatile organic components are displaced from the chips during the treatment of said chips in accordance with the invention.

A further advantage is that the saving in energy afforded by the method according to the invention leads to a reduction in the amount of fresh steam which need be charged to the steaming vessel.

Brief description of the drawings

Figure 1 illustrates schematically the most common system used today for steaming wood chips. In the illustrated system flash steam having a temperature of about 125°C and taken from a flash tank I, designated 2 in the Figure, is passed through a pipe 1 to a steaming vessel 4. Fresh steam is also passed to the steaming vessel, through a pipe 3. The chips are heated in the steaming vessel 4 to a temperature of about 120°C, whereafter the steamed chips are charged to a digester, as shown by reference 5, through a gate feeder 13.

Hot, thin liquor obtained from the digesters is charged to the flash tank I through a pipe 34. Liquor in the flash tank I is transferred to a flash tank II, here designated 11, through a pipe 7. Chips are fed to the steaming vessel 4 from a chip bin or silo 6 located above said vessel, through a gate feeder 12. Steam from the flash tank II is not used to preheat the chips, but is transferred to a condenser 9 through a pipe 8.

Figure 2 illustrates schematically another known method of procedure, in which chips in the chip bin 6 are heated with secondary steam holding a temperature of about 105°C and passed to said bin through a pipe 14. The secondary steam may, for example, originate from an evaporation stage or from a flash tank. Final heating of the chips (steaming), to about 120°C, is effected in the steaming vessel 4, similar to the Figure 1 system, using flash steam and fresh steam passed to the tank through respective pipes 1 and 3.

Figure 3 illustrates schematically a preferred embodiment of the invention. By withdrawing vacuum steam from a pre-evaporator 15, e.g. a Lockman-column, at mutually different levels through pipes 16, 17, 18 and 19, condensate passed to a direct condenser 28 through a pipe 30 is heated in said condenser from a temperature of about 50°C to a temperature of about 80°C. The resultant hot condensate is then passed through a pipe 29 to an air-heater 31, in which relatively cool air introduced into the heater through a pipe 33 is permitted to pass the hot condensate entering the heater 31 through pipe 29 in counter-flow. In this way, the air is heated from about 40°C to about 70°C, while being washed at the same time. The air heater 31 has the form of a counter-flow contact device from which moisture-saturated hot air, taken out through pipe 32, is passed to a chip bin or silo 6 and blown into the lower part thereof. Through condensation and convection the hot, moisture-saturated air is cooled in the chip bin from its input temperature of about 70°C to about 40°C, at the same time as the chips in the bin 6 are heated to a temperature of about 60°C, which constitutes 30-50 % of the total preheating requirement. Residual heating of the chips to a temperature of about 120°C is effected partly in the chip bin or silo 6, by blowing thereinto through a pipe 27 secondary steam having a temperature of about 105°C and taken from the upper part of the evaporator 15, and partly in the steaming vessel 4, with the aid of flash steam introduced through pipe 1 and having a temperature of about 125°C, together with a requisite amount of fresh steam introduced via pipe 3, to impart to the chips a temperature of about 120°C. The air cooled in the chip bin 6 is taken out through the pipe 33 and recirculated to said bin via the air heater 31. Similar to the systems illustrated in Figures 1 and 2, hot, thin liquor taken from the digesters is passed to the first flash tank 2 through the pipe 34. Steam from the second flash tank 11 is passed through pipe 8 to the condenser 9; where said steam is heating pre-evaporated liquor entering the condenser 9 through a pipe 26. The now hot liquor is passed from the condenser 9 to the top of the pre-evaporator 15 through a pipe 35. Thin liquor separated from steam in the second flash tank 11 is similarly passed to the top of the pre-evaporator 15 through the pipe 10. Pre-evaporated liquor obtained in the bottom of the pre-evaporator 15 is lead upwardly stepwise through the heat exchangers of the pre-evaporator, through pipes 20, 21, 22, 23 and 24. A certain amount of pre-evaporated liquor is continuously withdrawn and passed to a final evaporation stage, through a pipe 25.

Best mode of carrying out the invention

There are several suitable and preferred embodiments of the invention, and local conditions and available apparatus are in each individual case decisive to the embodiment elected. The most advantageous embodiment from a thermo-economic aspect is that claimed in claim 3 and set forth in pages 4-6 of this document. A further preferred embodiment will be evident from the following working example.

Example 1

In this example the known processes illustrated in Figure 1 (Comparison method A) and in Figure 2 (Comparison method B) were compared with the embodiment of the present invention illustrated in Figure 3 (Method C).

Similar wood chips having a dry content of 50 % were used in all three methods and the comparisons were made on the basis of the following data:

Pulp production	750 tons per day (90 %)
Cook yield	50 %
Wood dry content	50 %

The amount of dry wood = the amount of water =

$$\frac{750}{24} \cdot \frac{0.90}{0.50} = 56.3 \text{ t/hr}$$

$$Cp_{wood} = 1.45 \text{ kJ/kg}^{o}\text{C}.$$

Thus, the amount of heat required to heat the chips from $0^{o}C$ to $120^{o}C$ is

$$56.3(4.2 + 1.45) \cdot 120 \approx 38200 \text{ MJ/hr}.$$

In comparison method A (illustrated in Figure 1) the chips were preheated in one step in the steaming vessel 4, using flash steam 1 together with fresh steam 3.

In comparison method B (illustrated in Figure 2) the chips were preheated in two stages, firstly in the chip bin 6 with secondary steam 14 to a temperature of about 95°C, and secondly in the steaming vessel 4 with flash steam 1 and fresh steam 3, to a final temperature of about 120°C. It required 30,250 MJ/hr to heat the chips to 95°C in the chip bin, which corresponds to 13.5 tons/hr of secondary steam at a temperature of 105°C. The amount of flash steam 1 and fresh steam 3 required could, in this case, be correspondingly decreased. If the value of the secondary steam 14 is calculated as 80 % of that of the fresh steam, a corresponding saving in fresh steam amounts to 2.7 tons/hr.

In method C (the method according to the invention as illustrated in Figure 3) the chips were heated in three stages, of which the first two were effected in the chip bin 6 and the third in the steaming vessel 4. In the first heating stage the chips were heated with moisture-saturated hot air 32 from the air heater 31 to a temperature of about 60°C. The heat required herefor corresponded to 8.8 tons/hr of fresh steam. Continued heating of the chips to a temperature of about 95°C was effected by blowing secondary steam 27 having a temperature of about 105°C into the bottom of the chip bin. The steam required herefor was 4.7 tons/hr. In this case, the amount of flash steam 1 and fresh steam 3 used in the third heating stage in the steaming vessel 4 could be reduced by 13.5 tons/hr. If the value of the secondary steam 27 is calculated as being 80 % of that of the fresh steam, the corresponding saving of fresh steam in this case is 9.7 tons/hr.

The savings in steam and the corresponding savings in costs afforded by the two methods B and C compared with the conventional technique (method A) have been set forth in Table 1.

Table 1

	Saving in steam ton/hour	Saving in costs Mkr/year
Comparison method A	0	0
Comparison method B	2.7	1.5
Method C according to the invention	9.7	5.4

As will be seen from the Table, considerable savings in steam, and therewith corresponding savings in operational costs, can be made when practising the method according to the invention. These savings are still considerable even when compared with the best known technique (represented by Comparison method B) and the value of the heat-economical method according to the invention increases progressively with the increase in energy costs.

CLAIMS

1. A method for preheating wood chips prior to steaming the chips, said chips during said preheating process being heated in one or more stages to progressively higher temperatures, after which the chips are finally heated in a steaming vessel to a temperature of about 120°C, characterized in that in the first preheating stage, and in the stage or stages immediately following the first preheating stage, the chips are heated directly with moisture-saturated hot air which optionally contains a neutral gas and which has a temperature of 55-99°C, preferably 70-90°C.

2. A method according to Claim 1, characterized in that preheating of the chips is effected in two stages in a chip bin positioned immediately before the steaming vessel, the moisture-saturated hot air used in the first stage being heated to about 70°C with condensate which is introduced into a contact device in counter-flow with said air and which has a temperature of about 80°C.

3. A method according to Claim 1, characterized in that preheating of the chips is effected in three stages in a chip bin positioned immediately before the steaming vessel; that the moisture-saturated hot air used in the first stage is heated to a temperature of about 70°C in a first air-heating unit comprising a plurality of condensers built together, and is blown first into the upper part of the chip bin at a first location as seen in the direction of movement of the chips; and in that the moisture-saturated hot air used in the second stage is heated to a temperature of about 90°C in a second air-heating unit similar to the first air-heating unit, and is blown into the chip bin at a second location which is lower than said first location as seen in the direction of movement of the chips.

4. A method according to Claims 1-3, characterized in that used moisture-saturated hot air is recycled.

5. A method according to Claims 1-4, characterized in that subsequent to said preheating process the chips are further heated with secondary steam having a temperature of at least 100°C.

6. A method according to Claim 5, characterized in that the secondary steam is taken from a pre-evaporator.

7. A method according to Claims 1-6, characterized in that the moisture-saturated hot air used for preheating the chips is heated by passing said air in counter-flow to a hot condensate in a contact device, said condensate being obtained by direct condensation of vacuum steam withdrawn from mutually different effects in an evaporator station or pre-evaporator.

8. A method according to Claims 1-6, characterized in that the moisture-saturated hot air used for preheating the chips is heated by passing said air over indirect condensers for vacuum steam assembled to form an air-heating unit provided with spray-water means for saturating the air with moisture, said condensers being supplied with vacuum steam taken from mutually different effects in an evaporator station or a pre-evaporator.

9. A method according to Claims 1-6, characterized in that the moisture-saturated hot air used for preheating the chips is heated by passing said air in a contact device in counter-flow to hot water having a temperature of 65-100°C and taken from a different heat source in the plant to those recited in Claims 6-7.

Fig. 1

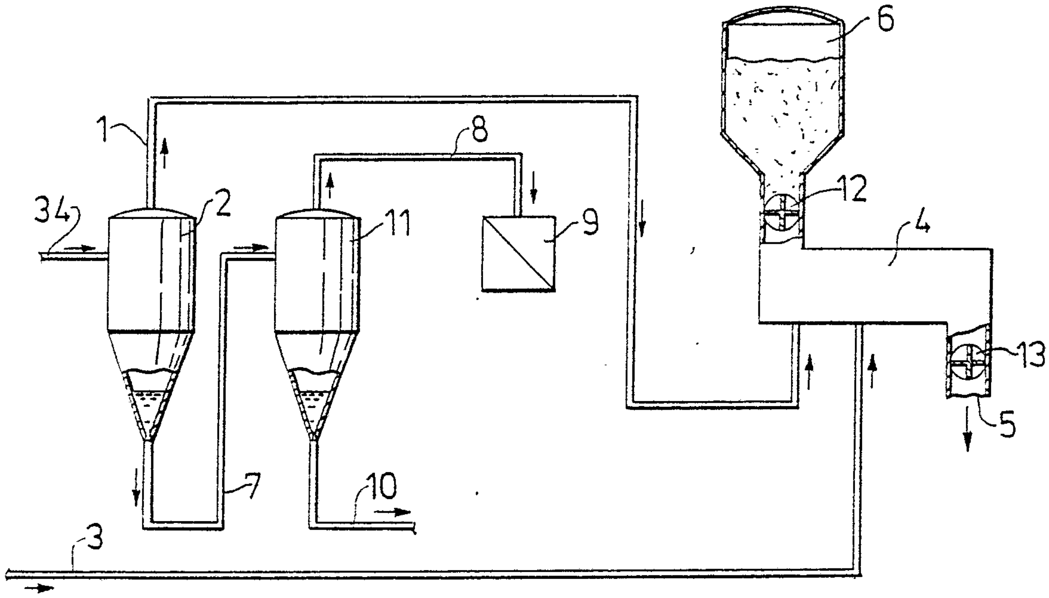


Fig. 2

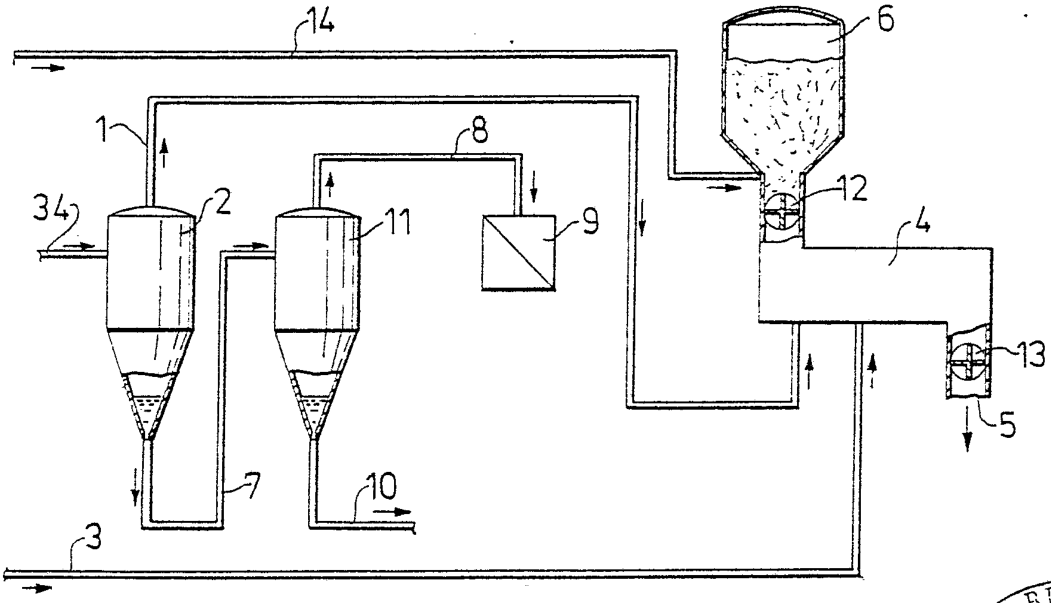
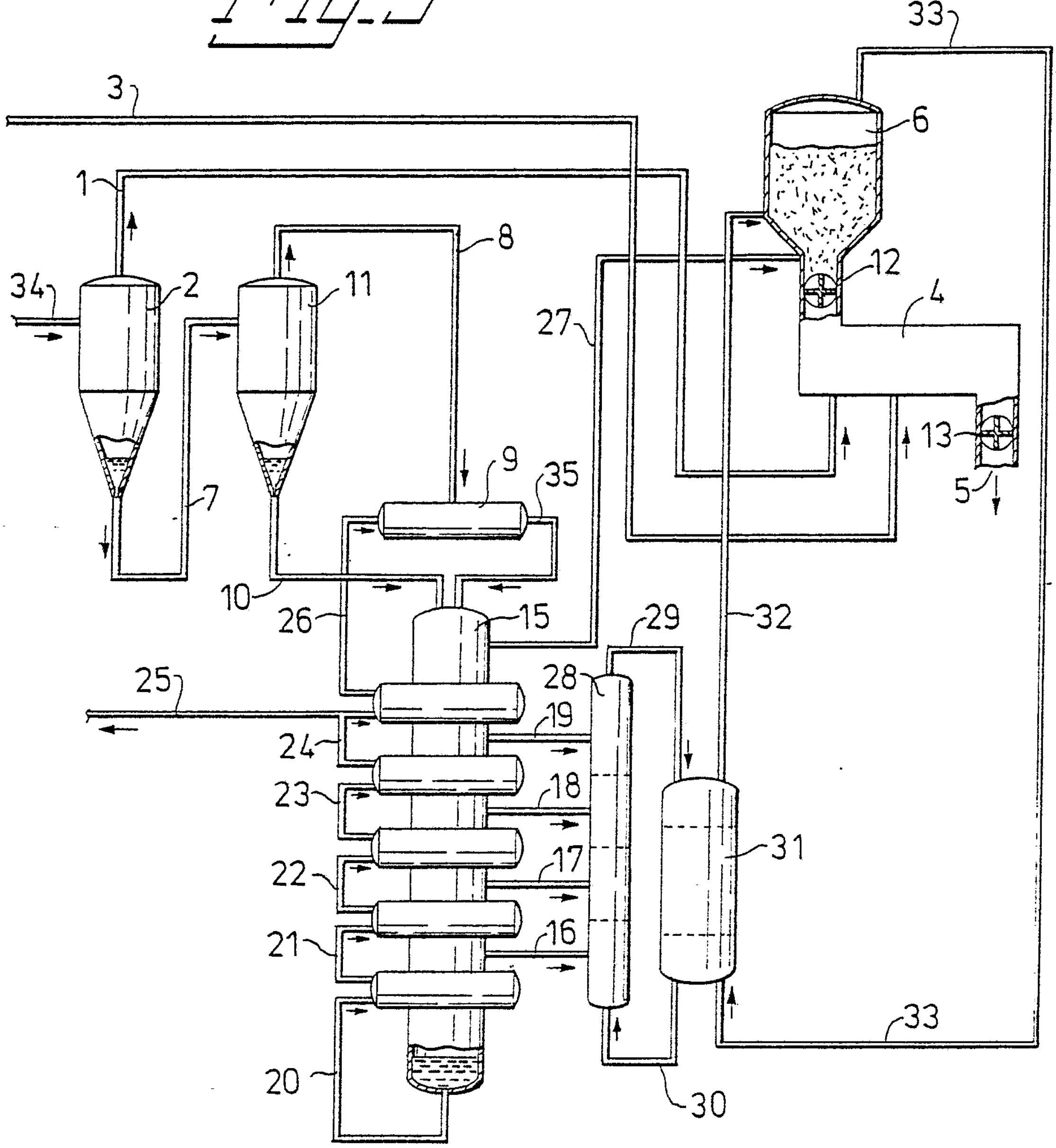


Fig. 3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INTERNATIONAL SEARCH REPORT

International Application No PCT/SE81/00218

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC 3

D 21 C 1/00, D 21 B 1/02

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC 3	D 21 C 1/00,1/02,1/08, D 21 C 3/24, D 21 B 1/00,1/02, 1/04
US Cl	162:17,19,46,63,65,68; 241:17,23,28,65

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [6]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
A	US, A, 1 781 712 published 1930, November 18, Wallace J H	1
A	US, A, 3 215 587 published 1965, November 2, Guerrieri S A	1

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IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
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