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[54] **METHOD FOR IMPREGNATION OF CELLULOSIC FIBER MATERIAL WITH DIGESTING LIQUOR WHILE PREVENTING DILUTION OF SAID LIQUOR**

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[51] **Int. Cl.** **D21c 3/24**

[58] **Field of Search** 162/19, 237, 33, 18

[56] **References Cited**

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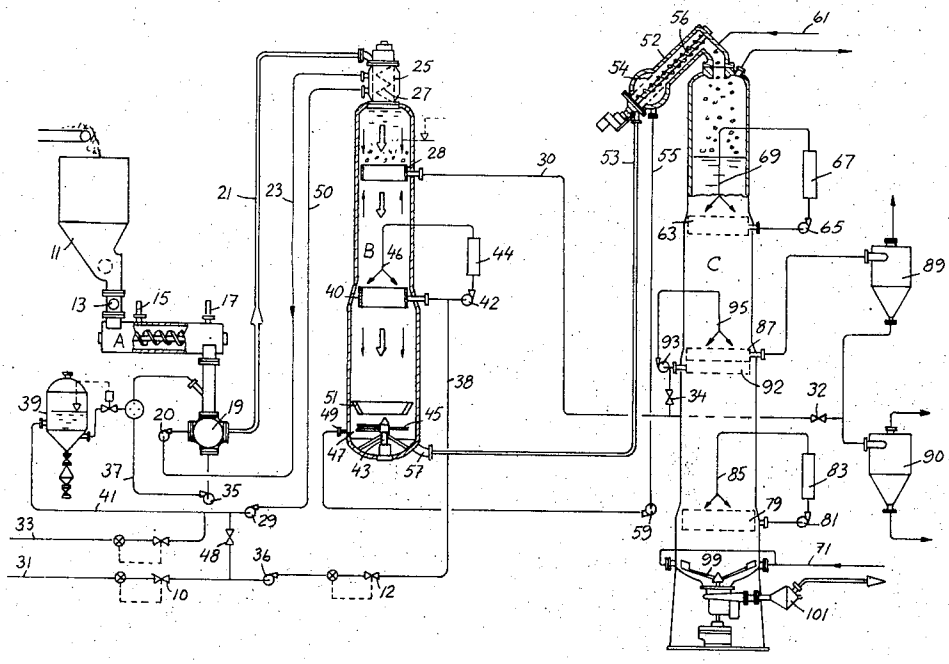
[57] **ABSTRACT**

The digestion of cellulosic fiber material in a continuous digester is preceded by impregnation of the fiber material with digesting liquor in a separate vessel. In said impregnation vessel where the fiber material moves continuously from the top to the bottom, digesting liquor is supplied and spread at the middle portion of the length of the vessel. A portion of said liquor moves in countercurrent to the fiber material and displaces, at least partly, the liquid introduced into the vessel together with the fiber material and consisting of chips moisture, steam condensate and black liquor, thereby preventing dilution of the liquor with which the fiber material is impregnated in the lower part of the vessel. The displaced liquid is withdrawn through a strainer in the upper part of the vessel and removed from the impregnation vessel.

7 Claims, 1 Drawing Figure



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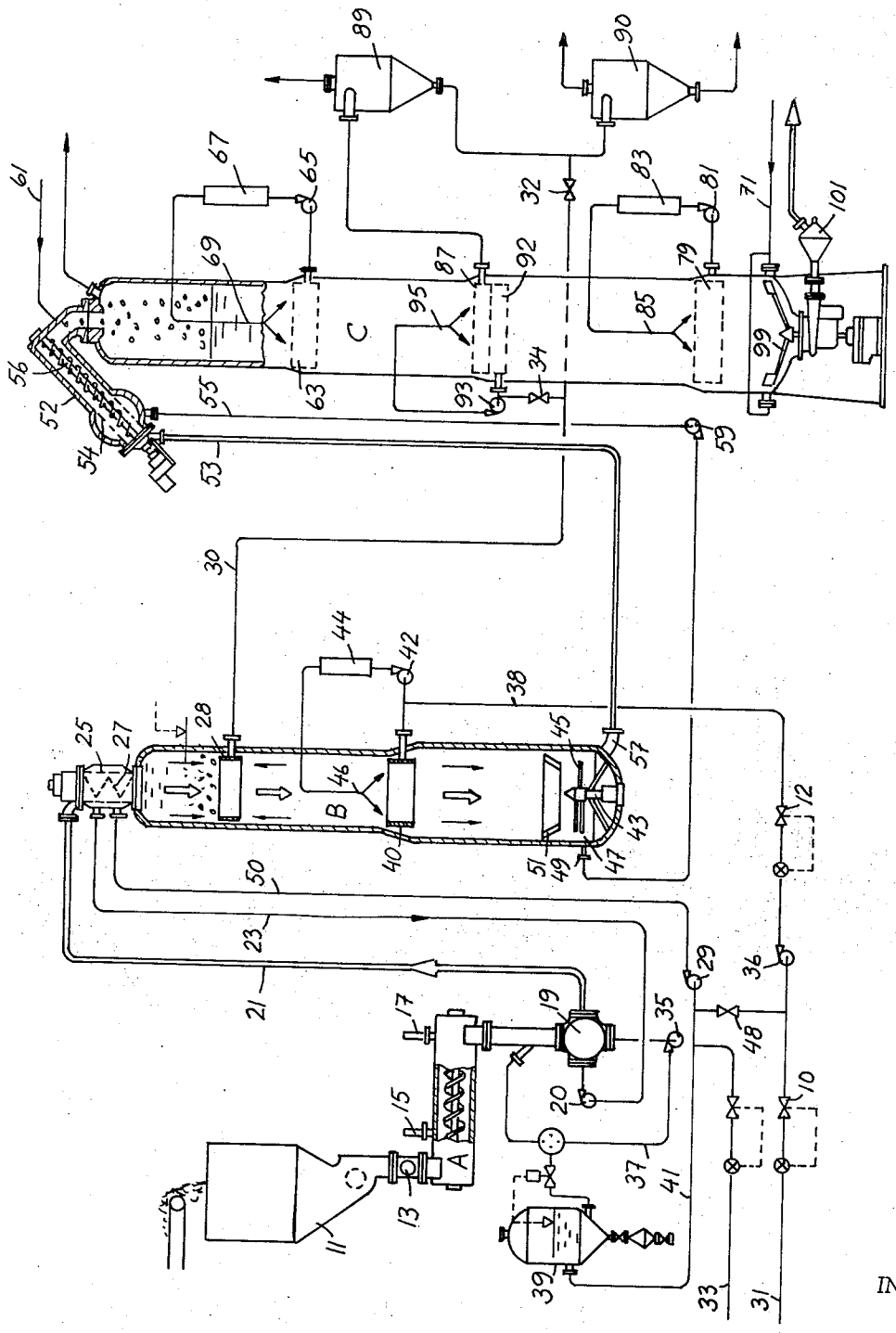

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METHOD FOR IMPREGNATION OF CELLULOSIC FIBER MATERIAL WITH DIGESTING LIQUOR WHILE PREVENTING DILUTION OF SAID LIQUOR

The invention relates to cellulose digestion, wherein wood chips or similar cellulosic fibre material before being introduced in a digester are impregnated with digesting liquor in a separate impregnation vessel.

The object of the invention is to raise the concentration of the digesting liquor with which the fibre material is impregnated in said vessel, in order to shorten the time required for the subsequent digestion and to obtain a more uniform pulp quality and other advantages. Ordinarily, the digesting liquor is diluted with the moisture present in the untreated chips and, as the impregnation step usually is preceded by steaming of the chips, also with condensed steam. Therefore, the chips can hardly absorb a sufficient quantity of liquor to impregnate them with the total amount of active chemicals required for the subsequent digestion, but an additional amount of active chemicals must be supplied during the digestion period by diffusion into the fibre material from liquor surrounding the chips in the digester.

In order that the fibre material before the start of the digestion period shall have absorbed the amount of active chemicals required for the lignin dissolution, it has already been proposed to use digesting liquor with an extremely high concentration. However, in sulphate digestion the white liquor usually does not contain more than 130–150 grams per litre of active alkali, NaOH + Na_2S. It has been proposed to evaporate the white liquor partly in order to raise its concentration before the chips are impregnated therewith. However, certain operational problems are connected therewith, such as risk of crystallization, incrust accumulation etc., and an evaporation unit is also quite costly.

According to an other known proposal the liquid to wood ratio during the digestion is lowered by withdrawing liquid in steam form from the vessel in which the fibre material is impregnated with digesting liquor. Said method also requires the use of special equipment for the evaporation of the digesting liquor and is comparatively difficult to control.

The present invention relates to a new and simpler method of concentrating the digesting liquor in connection with the impregnation of chips therewith. The essential feature of said method consists in that digesting liquor is supplied to and spread over a zone of the impregnation vessel situated distantly from the bottom as well as from the top of said vessel, said liquor being driven partly upwards in counter-current to the fibre material so as to displace liquid introduced into the impregnation vessel together with the fibre material, and partly downwards towards the bottom of the impregnation vessel in co-current to the fibre material. Other features of the invention will appear from the following claims.

The invention will now be closely described with reference to the accompanying drawing which diagrammatically shows its application to a sulphate digestion plant chosen as an example. The general design of the plant will first be described.

The shown plant comprises three treatment vessels, viz. a steaming vessel A, an impregnating vessel B, and a digester C. The fibre material which usually consists

of wood chips (but also may consist of straw, bagasse, reed or other cellulosic plant materials) is supplied from a chips bin **11** through a rotary low-pressure valve **13** to the steaming vessel A. Steam of low pressure, e.g., 1 atmosphere overpressure, is supplied to said vessel through a conduit **15**, and air is driven off through the conduit **17**. The chips pass through the steaming vessel in about 2–5 minutes and then drop down into a rotary high-pressure valve **19** of the kind wherein a rotor having pockets or diametrical passages turns in a stationary casing. From said valve the chips are pumped to the top of the impregnation vessel B by means of circulating liquid which is forced by the pump **20** to flow through the conduits **21, 23.** The liquid flushes chips out of the valve **19** and the suspension of chips is driven through the conduit **21** to the space inside a strainer girdle **25** inserted in the top of the impregnation vessel, from where the chips are passed on downwardly by a feeding screw **27.** Liquid passing through the strainer girdle **25** is recirculated to the valve **19** through the return conduit **23.** The chips are filled into the pockets of the high-pressure valve **19** by means of liquid held in circulation in the loop **37** by a pump **35.** Liquid let out to the low-pressure side of the valve flows from said loop to a level tank **39** and is returned therefrom through the conduit **41** and the pump **29** to the high-pressure side.

The impregnation vessel B consists of a longish upright container of a cross-section which is circular and uniform throughout its length or which widens slightly toward the lower end. Provided at the bottom thereof is a device for the continuous discharge of chips which have been impregnated with digesting liquor during their continuous movement downwardly through the vessel. Said device comprises a disc or table **45** supported by a rotary vertical shaft **43.** Said table extends over the greater part of the cross-section of the impregnation vessel and is formed with one or more radially extending slots through which the chips can pass to the lower side thereof. Preferably, the table is made in accordance with the U.S. Pat. No. 2,960,161. When the table is turned, chips will be loosened from the chips column resting upon the table and passed through said slots to the space **47** at the bottom of the impregnation vessel, where they are suspended in liquid supplied through nozzles **49.** By means of a collar **51** attached to the shell of the vessel, chips are prevented from reaching the edge of the rotary table where they might get stuck. The impregnation requires a time of 10–60 minutes.

From the bottom of the impregnation vessel B the chips suspension is transferred to the top of the digester C by means of liquid (digesting liquor) circulating in the conduits **53, 55.** The conduit **53** is connected directly to an outlet **57** at the bottom of the impregnation vessel. A pump **59** is inserted in the return conduit **55** connected to the nozzles **49.** The pump **59** maintains such a heavy flow in the conduits **53, 55** and in the space **47** that chips entering said space are brought along and flushed out through the outlet **57.** The table **45** serves as a screen that retains the chips column so that the same does not block the outlet, and consequently the chips will be diluted and suspended merely in the immediate vicinity of the outlet **57.**

At the digester top the conduits **53, 55** are connected to a separation device **52.** The supply conduit **53** opens out inside a cylindrical strainer **54** in the separation de-

vice, and the return conduit **55** is connected to the space outside of said strainer. The chips retained by the strainer and drained of free liquor are fed by a motor-driven conveyer screw **56** up through the obliquely slanting casing of the separation device and are delivered at its upper end into the top of the digester C.

In the upper part of the digester high-pressure steam is supplied by the conduit **61** in such a quantity that a pressure of the order of **10** atmospheres and a temperature of the order of 160°–180° C are maintained in the digester. For additional heating which may be required in some cases, there is provided a circulation loop for the digesting liquor, consisting of the strainer girdle **63**, the pump **65**, the heat exchanger **67** and the central return conduit **69**. In the lower end part of the digester the digested fibre material is washed in counter-current by means of washing liquid supplied by the conduit **71** and pumped into the lower end of the digester in a quantity controlled so as to maintain the digester filled with liquid to a predetermined level. The washing liquid is heated indirectly by steam in a circulation loop comprising the strainer girdle **79**, the pump **81**, the heat exchanger **83** and the central supply conduit **85**. Heated washing liquid is driven in counter-current up through the slowly descending chips column and displaces its content of spent digesting liquor which departs through the strainer girdle **87** and is transferred to two blow tanks **89, 90** connected in series. By means of the strainer girdle **92**, the pump **93** and the central conduit **95** a strong horizontal and radial flow of liquid is maintained at a level somewhat below the strainer girdle **87**, whereby the washing effect is improved. The digested fibre material is discharged at the lower end of the digester by means of a rotary scraper **99** and a throttling device 101.

The application of the present invention to the above described plant requires a modified design of the impregnation vessel B. The main feature of said modification is the provision of a strainer girdle **28** for separation of liquid from the chips column. Said strainer girdle is inserted in the wall of the upper part of the impregnation vessel at a distance from the top of the vessel preferably lying between a fifth and a third of the height of the vessel. Connected to said strainer girdle is a conduit **30** through which the liquid strained off can flow to the recovery plant (not shown) to which the spent liquor from the digester C is sent. To said end the conduit **30** is connected either via the valve **32** to the blow tank **90** or via the valve **34** to the conduit **95** so that the effluent from the impregnation vessel is mixed with the spent liquor already inside the digester and a possible alkali content thereof is utilized.

The entire quantity or the greater part of the white liquor required for the digestion of the fibre material is supplied to and distributed over a zone of the impregnation vessel located distant from its ends and preferably somewhere on the middle third of its length. White liquor supplied by the conduit **31** is pumped by the high pressure pump **36** into the conduit **38** which is connected to a circulation loop consisting of the strainer girdle **40** inserted in the shell of the vessel at the level of the above-mentioned zone, the circulation pump **42**, the heat exchanger **44** and the central inlet tube **46**. In the heat exchanger the liquor is heated to such a high temperature that the chips-liquor-mixture in almost the entire impregnation vessel or in any case in the space located below the strainer girdle **28** is maintained at a temperature of 50°–150° C, preferably 90°–130° C. In the impregnation vessel substantially the same pressure prevails as in the digester, the connection conduit **53** not comprising any pressure lock and having only an inconsiderable flow resistance.

The white liquor supplied by the conduit **46** and spread in all radial direction over the cross-section of the vessel is divided into one part passing in co-current to the chips towards the bottom of the impregnation vessel and from there further on to the digester C, and another portion flowing in counter-current to the chips upwardly towards the strainer **28**. Said last-mentioned portion displaces the liquid entering the impregnation vessel together with the chips. Said liquid consists of chips moisture, condensed steam and black liquor. The black liquor is supplied through the conduit **33** and serves as a conveying medium for flushing chips out of the valve **19** for their transfer to the top of the impregnation vessel. Said displaced liquid which contains very little of active digesting chemicals, is separated from the chips by the strainer **28** and departs through the conduit **30**, the pores and interspaces of the chips instead being filled up with white liquor. Of course, the total quantity of the liquid previously accompanying the chips cannot be driven off completely and the new liquid content of the chips cannot reach quite the same high concentration of alkali as that of the white liquor supplied by the conduit **38**. However, the concentration of active alkali gets considerably higher than if the white liquor were simply mixed into the fibre suspension, i.e., without any orderly flow relatively thereto and without the withdrawal of a fraction having a low alkali content.

During the flow of the white liquor in counter-current to the chips upwardly towards the strainer **28**, the same diffuses into the fibre material and a great part of the alkali thereof is spent while dissolving hemicellulose etc. Also said spent or weakened liquor together with reaction products may be withdrawn through the strainer **28** and carried off for recovery, this requiring a heavy upward flow of liquor which may involve a certain waste of alkali.

In some cases it may be advantageous to supply black liquor to the charging circulation in such a quantity that an excess thereof is driven together with moisture and steam condensate toward the strainer **28** in the extreme top end of the impregnation vessel, i.e., in co-current to the chips. Another modification consists in replacing the black liquor wholly or partly with white liquor. This can be performed by introducing white liquor from the conduit **31** via the valve **48** into the conduit **50** connected to the top of the impregnation vessel. The total quantity of white liquor and the portions thereof supplied to various points of the impregnation vessel can be set by the valves **10** and **12** controlled by flow regulators. The amount of white liquor supplied to the top should be so adjusted that it is almost entirely spent by the wood in the upper part of the vessel, so that no or merely a small amount of active alkali reaches the strainer **28** and goes lost.

By the above-described method of raising the alkali concentration of the white liquor absorbed by the chips in the impregnation vessel, after having been drained of free liquor in the device **52** the chips will retain in their pores a quantity of alkali sufficient for the subsequent digestion which therefore can be performed in steam phase. Thus, if desired, the liquid level in the digester

can be placed immediately above the strainer girdle **87**. However, as an alternative, a certain amount of free liquor can be allowed to flow over from the separating device **52** to the digester and the liquid level may be placed so high (e.g., at the level shown by the drawing) that the digestion takes place wholly or partly in liquid phase. Also in this case an advantage is gained consisting in that the lignin dissolution takes place with a comparatively great liquor concentration which involves a shortened digestion time period.

The amount of liquid withdrawn through the strainer **28** is determined by the liquid to wood ratio desired during the digestion and by the total liquid flow to the impregnation vessel. The liquid balance of the impregnation vessel may e.g. be the following:

water in the chips (moisture)	1.0 m^3/ton bone dry wood
condensed steam	0.3 m^3/ton bone dry wood
supplied black liquor	0.7 m^3/ton bone dry wood
supplied white liquor	1.5 m^3/ton bone dry wood
total quantity of supplied liquid	3.5 m^3/ton bone dry wood
liquid quantity withdrawn from the impregnation vessel	1.5 m^3/ton bone dry wood

The chips discharged from the impregnation vessel will then contain 2 m^3 liquor per ton bone dry fibre. Said quantity can be almost completely absorbed by the pores of the chips when they consist of soft wood with a density of 0.40.

In this example, if the supplied quantity of white liquor is supposed to contain 165 kgs effective alkali ($NaOH + \frac{1}{2} Na_2S$) per ton bone dry wood, and 90 kgs effective alkali are spent during the impregnation, the concentration of the liquid transferred to the digester together with the chips is equal to $165 = 90/2.0 = 37$ grams effective alkali per litre. Such a good result is obtained under the provision that the liquid quantity withdrawn by the strainer **28** does not contain any significant quantity of effective alkali. In the practice, this has proved possible to realize, so that the withdrawn liquid merely contains chips moisture, steam condensate, black liquor, and a small amount of white liquor out of which the chips have absorbed substantially all effective alkali.

Within the scope of the invention the above described embodiment may be modified as to its details, particularly in respect of the location and the arrangement of the withdrawal strainer **28** and the liquor supply. Thus, for instance, the withdrawal may take place at the top of the impregnation vessel, e.g., by connecting the conduit **30** to the space outside of the top strainer **25**. Then the strainer **28** is no longer required.

In the foregoing the invention has been described in connection with sulphate digestion but it may also be used in any other alkalic digestion or in sulphite digestion, provided that the operational conditions are modified accordingly.

I claim:

1. A method for digestion of cellulosic fiber material by impregnation of the fiber material with digesting liquor in an impregnation vessel and continuous transfer of the impregnated fiber material from the bottom of the impregnation vessel to the top of a digester comprising the steps of: supplying and spreading digesting liquor over a zone of the impregnation vessel, the zone being located distant from the bottom and top of the impregnation vessel, driving the digesting liquor from said zone, partly upwards countercurrent to the fiber material while displacing the impregnating liquid introduced into the impregnation vessel together with the fiber material, and partly downwards co-current through the fiber material towards the bottom of the impregnation vessel, straining off the liquid displaced upwardly by the digesting liquor from the fiber material at a point which, measured in the vertical direction, is situated between the top of the impregnation vessel and the zone where the digesting liquor is supplied to the impregnation vessel and discharging the separated displaced liquid from the impregnation vessel.

2. Method according to claim **1** comprising the further steps of supplying digesting liquor centrally in the impregnation vessel and spreading radially in all direction and distributing over the cross-section of the fiber material column, draining off a corresponding amount of liquor at the periphery of said column and recirculating said liquor.

3. Method according to claim **1**, comprising the further steps of introducing digesting liquor into the impregnation vessel also at the top thereof, together with the fiber material, and straining off and discharging a corresponding liquid quantity containing wholly or partly spent digesting chemicals together with the liquid displaced by the digesting liquor supplied farther down in the vessel.

4. Method according to claim **1** comprising the further step of: combining liquid withdrawn from the fiber material in the impregnation vessel with spent liquor obtained by the digestion, for common recovery of chemicals therein.

5. Method according to claim **1** wherein the impregnation is performed at substantially the same pressure as the digestion.

6. Method according to claim **1** wherein the digesting liquor is sulphate liquor.

7. Method according to claim **1** wherein the impregnation takes place at a temperature of the order of 50°–150° C, preferably 90°–130°C, whereas the digestion takes place at a temperature of the order of 160°–180° C.

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