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(54) **Title:** IMPREGNATION SYSTEM AND ITS USE

(57) **Abstract:** The invention relates to impregnation system for treating wood chips in mechanical production of pulp or alkaline peroxide mechanical production of pulp. The system comprises at least 5 weight-% of a non-ionic surfactant, which is a reaction product of a vegetable oil and sugar, based on the total weight of the system, and optionally an enhancer agent, comprising at least a polymer formed from monomers comprising at least one unsaturated carboxylic acid monomer. The system is used for treating wood chips in mechanical production of pulp or alkaline peroxide mechanical production of pulp.



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IMPREGNATION SYSTEM AND ITS USE

The present invention relates to an impregnation system and its use according to the preambles of the enclosed independent claims.

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TECHNICAL FIELD

Mechanical pulp may be produced by using different well-known processes. Mechanical pulping processes use electrical energy for separation of wood chips into single fibres and have normally a high fibre yield in the range 80 – 97 %.

10 Depending on the production process the mechanical pulp is called ground wood (GW), refiner mechanical pulp (RMP), chemithermomechanical pulp (CTMP) or bleached chemithermomechanical pulp (BCTMP). Wood chips may be impregnated with alkaline/alkaline peroxide before or during refining, whereby the pulp is called as alkaline peroxide mechanical pulp (APMP). In general,
15 mechanical pulp provides high bulk and good opacity.

The drawback in production of any mechanical pulp is the high energy consumption of the production process. Normally in mechanical pulp mills, large amounts of energy, mostly electricity, are consumed in the refining process carried
20 out with a refiner. Pulp producers have been sometimes compelled to sacrifice some of the fibre yield in order to reduce the energy consumption. Also different chemicals, enzymes and fungi have been used in some applications to pre-treat the chips before refining in order to reduce the energy consumption in the refining process. However, the energy consumption is still one of the major concerns in
25 production of mechanical pulp and there exists a constant need to find new effective ways to reduce the energy consumption of the mechanical pulping process.

It is an object of the present invention to reduce or even eliminate the above-
30 mentioned problems appearing in prior art.

An object of the invention is to provide an impregnation system with which wood chips may be pre-treated before refining in order to reduce the energy needed in refining.

- 5 In order to realise the above-mentioned objects, among others, the invention is characterised by what is presented in the characterising parts of the enclosed independent claims.

Some preferred embodiments according to the invention are disclosed in the
10 dependent claims presented further below.

Typical impregnation system according to the present invention for treating wood chips in mechanical production of pulp or alkaline peroxide mechanical production of pulp comprises

- 15 - at least 5 weight-% of a non-ionic surfactant, which is a reaction product of a vegetable oil and sugar, based on the total weight of the system.

The system may optionally comprise an enhancer agent, which comprises at least a polymer formed from monomers comprising at least one unsaturated carboxylic acid monomer or a derivative thereof.

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Typical use according to the present invention is the use of an impregnation system comprising a non-ionic surfactant, which is a reaction product of a vegetable oil and sugar, for treating wood chips in mechanical production of pulp or alkaline peroxide mechanical production of pulp.

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Typical method according to the present invention is the method for treating wood chips in mechanical production of pulp or alkaline peroxide mechanical production of pulp by addition of an impregnation system, which comprises at least 5 weight-% of a non-ionic surfactant, which is a reaction product of a vegetable oil and
30 sugar, based on the total weight of the system.

Now it has been surprisingly found out that when an impregnation system comprising a non-ionic surfactant, which is product of a vegetable oil and sugar,

and optionally an enhancer agent, which comprises at least a polymer formed from monomers comprising at least one unsaturated carboxylic acid monomer or a derivative thereof is used for treating wood chips before refining, the final pulp freeness is unexpectedly increased. Increase in pulp freeness promotes reduced energy consumption of the refining stage.

According to one embodiment of the invention the non-ionic surfactant is a reaction product of C6 – C14 fatty alcohol derived from a vegetable oil and glucose, derived for example from starch or glucose syrup. Preferably the non-ionic surfactant is C8 – C14 alkyl polyglycoside, sometimes C8 – C10 alkyl polyglycoside. The average degree of polymerisation, DP, may be in the range 1.4 – 1.6. Fatty alcohols may be derived from a vegetable oil, such as coconut, palm kernel, palm, rapeseed or tallow oil, by splitting or trans-esterification and turned into fatty alcohols by catalytic high pressure hydration. The non-ionic surfactant may be produced by direct synthesis from fatty alcohol and glucose in the presence of acid catalysts at elevated temperatures.

According to one embodiment of the invention the amount of non-ionic surfactant in the impregnation system is at least 10 weight-%, preferably at least 30 weight-%, more preferably at least 50 weight-%, based on the total weight of the system. According to another preferred embodiment the amount of non-ionic surfactant in the system is 10 – 99.9 weight-%, preferably 30 – 90 weight-%, more preferably 50 – 80 weight-%, based on the total weight of the system.

Preferably, the impregnation system comprises in addition to the non-ionic surfactant an enhancer agent, comprising at least a polymer formed from monomers comprising at least one unsaturated carboxylic acid monomer or a derivative thereof. The derivative of unsaturated carboxylic acid may be an amide or ester.

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According to one embodiment of the invention the enhancer agent is a copolymer of an unsaturated carboxylic acid and a C1 – C10 sulphonic acid or its alkyl ester; an anionic polyacrylamide; or any of their mixtures.

According to one embodiment of the invention the unsaturated carboxylic acid is acrylic acid, methacrylic acid, maleic acid, itaconic acid, crotonic acid or any of their mixtures. This means that the enhancer agent comprises at least one
5 polymer, which is formed by copolymerising monomers of acrylic acid, methacrylic acid, maleic acid, itaconic acid, crotonic acid or any of their mixtures together with other monomers, such as acrylamide or sulphonic acid.

Based on the total weight of the system, the amount of enhancer agent in the
10 system may be < 90 weight-%, preferably < 70 weight-%, more preferably < 50 weight-%. According to one embodiment, based on the total weight of the system, the amount of the enhancer is in the range of 0.1 – 90 weight-%, 10 – 70 weight-%, more preferably 20 – 50 weight-%.

15 It is possible to mix the non-ionic surfactant and the enhancer agent together to form a composition or a mixture, which is added to the wood chips. Alternatively the non-ionic surfactant and the enhancer agent may be added to the wood chips simultaneously, but as separate feed streams. This means that a first feed stream comprising the non-ionic surfactant is added to the wood chips at the same time
20 as a second feed stream comprising the enhancer agent. The feed streams may be mixed prior or after they are added to the wood chips. According to one preferable embodiment of the invention the impregnation system is a single liquid composition comprising both the non-ionic surfactant and the enhancer agent.

25 The enhancer agent may be a copolymer of an unsaturated carboxylic acid and a C1 – C10, preferably C2 – C8, sulphonic acid or its alkyl ester. According to one preferred embodiment of the invention the enhancer agent is a copolymer of an unsaturated carboxylic acid, such as acrylic acid, methacrylic acid, maleic acid or itaconic acid, and 3-allyloxy-2-hydroxypropanesulphonic acid. The weight average
30 molecular weight of the copolymer may be in the range of 500 – 20 000 000 g/mol, preferably 1000 – 1 000 000 g/mol, more preferably 2000 – 500 000 g/mol, even more preferably 3000 – 250 000 g/mol.

According to another embodiment of the invention the enhancer agent is anionic polyacrylamide. According to one embodiment anionic polyacrylamide may be formed by copolymerising acrylamide together with unsaturated carboxylic acid monomers. Also other anionic monomers, such as vinylsulphonic acid, 2-
5 acrylamide-2-methylpropanesulfonic acid, styrene sulfonic acid, vinyl phosphonic acid or ethylene glycol methacrylate phosphate, may be included. It is also possible that non charged monomers may be included, as long as the net charge of the formed polymer is anionic and the polymer has an acrylamide/methacrylamide backbone. Anionic polyacrylamide may have an
10 average molecular weight (MW) in the range of 2000 – 20 000 g/mol, more preferably 3000 – 15 000 g/mol, still more preferably 4000 – 8000 g/mol. In this application the value “average molecular weight” is used to describe the magnitude of the polymer chain length. Average molecular weight values are calculated from intrinsic viscosity results measured in a known manner in 1N NaCl
15 at 25 °C by using an Ubbelohde capillary viscometer. The capillary selected is appropriate, and in the measurements of this application an Ubbelohde capillary viscometer with constant $K=0.005228$ was used. The average molecular weight is then calculated from intrinsic viscosity result in a known manner using Mark-Houwink equation $[\eta]=K \cdot M^a$, where $[\eta]$ is intrinsic viscosity, M molecular weight
20 (g/mol), and K and a are parameters given in Polymer Handbook, Fourth Edition, Volume 2, Editors: J. Brandrup, E.H. Immergut and E.A. Grulke, John Wiley & Sons, Inc., USA, 1999, p. VII/11 for poly(acrylamide-co-N,N,N-trimethyl aminoethyl chloride acrylate), 70 % acrylamide. Accordingly, value of parameter K is 0.0105 ml/g and value of parameter a is 0.3. The average molecular weight range given
25 for the parameters in used conditions is 450 000 – 2 700 000 g/mol, but the same parameters are used to describe the magnitude of molecular weight also outside this range. For polymers having a low average molecular weight, typically around 1 000 000 g/l or less, the average molecular weight may be measured by using HPLC size exclusion chromatography, using PEO for calibration. HPLC size
30 exclusion chromatography is used especially if no meaningful results can be obtained by using intrinsic viscosity measurement.

The system may further comprise a chelating agent, which is selected from a group consisting of polyaminopolycarboxylic acids; polyaminopolymethylene-phosphonic acids; hexamethylenediamine tetra(acetic acid); tetramethylenediamine tetra(methylenephosphonic acid); 1-hydroxyethylidene-1,1-diphosphonic acid (HEDP); *N*-bis- and tris-[(1,2-dicarboxy-ethoxy)ethyl]amines, such as *N*-bis[2-(1,2-dicarboxy-ethoxy)-ethyl]-amine; *N*-bis[2-(1,2-dicarboxy-ethoxy)-ethyl]-aspartic acid; *N*-tris[2-(1,2-dicarboxy-ethoxy)-ethyl]-amine, and *N*-[2-(1,2-dicarboxy-ethoxy)-ethyl]-(*N*-2-hydroxyethyl)aspartic acid. The chelating agent may be added directly to the impregnation system or it may be included to the enhancer. In the latter case the enhancer is a mixture of a chelating agent and a polymer. Preferred polyaminopolycarboxylic acids are diethylenetriaminepentaacetic acid (DTPA), triethylenetetraamine hexaacetic acid (TTHA), ethylenediaminetetraacetic acid (EDTA), hydroxyethylethylenediamine triacetic acid (HEDTA) and ethylenediamine-*N,N'*-disuccinic acid (EDDS). Preferred polyaminopolymethylene-phosphonic acids are diethylenetriaminepenta(methylenephosphonic acid) (DTPMPA), triethylenetetraaminehexa(methylenephosphonic acid) (TTHMPA) and ethylenediaminetetra(methylenephosphonic acid) EDTMPA. Even if the chelating agents are here given as acids, they are normally available as alkali salts, mainly as the sodium salts and the chelating agents here are understood to include both the free acids and their salts.

Preferably the system comprises a chelating agent when the enhancer is a copolymer of 3-allyloxy-2-hydroxypropanesulphonic acid and an unsaturated carboxylic acid, such as acrylic acid, methacrylic acid, maleic acid or itaconic acid.

According to one embodiment of the invention the system further comprises a polymeric substance selected from a group comprising poly-alpha-hydroxyacrylic acid (PHAA) or its alkaline salt and a polylactone of poly-alpha-hydroxyacrylic acid (PHAA). The polymeric substance may have a molecular weight of at least 5000, preferably at least 10000, and more preferably at least 15000. As the polylactone is insoluble in water the molecular weights have been measured for the corresponding sodium salt obtained by alkaline hydrolysis of the polylactone.

- According to one embodiment the impregnation system may further comprise, in addition to the above described enhancer agent, a polycarboxylic acid polymer, which is a homopolymer of acrylic acid or methacrylic acid or a copolymer of (meth)acrylic acid and another unsaturated carboxylic or dicarboxylic acid. The polycarboxylic acid polymer may be prepared by homopolymerisation of acrylic acid or methacrylic acid or by copolymerization of acrylic acid and/or methacrylic acid with an unsaturated carboxylic acid or dicarboxylic acid, such as maleic or itaconic acid. According to one embodiment of the invention the polycarboxylic acid polymer is a copolymer of acrylic and/or methacrylic acid with maleic acid, wherein the molar ratio of acrylic acid and/or methacrylic acid to maleic acid is from 80:20 to 20:80, preferably from 70:30 to 50:50. The polycarboxylic acid polymer may have a molecular weight of at least 4000 g/mol, preferably at least 10000 g/mol, more preferably at least 30000 g/mol.
- According to one embodiment of the invention the impregnation system may comprise additive agents, such as preservatives or pH regulating agents. For example, glutaraldehyde may be added to the system in order to inhibit microbial activity during storage.
- The impregnation agent may be used to pre-treat wood chips, which are used for making alkali peroxide mechanical pulp (APMP) or bleached chemithermomechanical pulp (BCTMP). The impregnation system may be added 1 – 6 kg/ton produced pulp. The wood chips may be hardwood chips, softwood chips or a mixture of hardwood and softwood chips.
- The impregnation system is preferably added before the refining stage. More preferably the impregnation agent is added to the first impregnations stage, but it may also be added to the first and the second, and any successive, impregnation stage if needed. The impregnation system may be mixed with the alkaline or added separately into the mixing tray. According to one preferred embodiment the interaction time between the wood chips and the impregnation system is 30 – 50 minutes, and the impregnation temperature 70 – 80 °C.

The present invention further relates to a method for treating wood chips in mechanical production of pulp or alkaline peroxide mechanical production of pulp by addition of an impregnation system, which comprises at least 5 weight-% of a non-ionic surfactant, which is a reaction product of a vegetable oil and sugar,
5 based on the total weight of the system.

In an embodiment of the method according to the present invention, the system further comprises an enhancer agent, comprising at least a polymer formed from monomers comprising at least one unsaturated carboxylic acid monomer or a
10 derivative thereof.

In an embodiment of the method according to the present invention, the non-ionic surfactant and the enhancer agent are added to the wood chips as a mixture or simultaneously as separate feed streams.

15

EXPERIMENTAL

Some embodiments of the invention are disclosed more closely in the following non-limiting examples.

20

Following chemicals are used in Examples 1 and 2:

Non-ionic surfactant: Alkyl polyglucoside APG from BASF

Enhancer agent: FennoBrite 590 from Kemira

Chelating agent: diethylenetriaminepentaacetic acid

25

EXAMPLE 1

Example 1 is a laboratory study, which is carried out to study the effect of impregnation system on final brightness and freeness (Canadian standard freeness, CSF).

30

Preparation of Pulp

Pulp is obtained from a pilot trial, where wood chips are washed with hot water, temperature 60 – 70 °C, after which the chips are steamed for 10 minutes. After

steaming the chips are pressed at a compression ratio of 1:4 with MSD Impressafiner (Andritz AG, Austria) and impregnated with alkali and peroxide for 20 minutes of retention at 75 °C. The impregnated chips are refined at the atmospheric pressure in high consistency. Impregnation conditions are shown in

5 Table 1.

Table 1. Chemicals dosage and conditions used in the laboratory study.

| Chemical/Condition | Dosage/Value |
|--|--------------|
| H ₂ O ₂ , kg/tp (100%) | 30 |
| NaOH, kg/tp (100%) | 25 |
| Chelating agent, kg/tp (as prod.) | 2.5 |
| Temperature, °C | 75 |
| Time, min | 20 |
| Consistency, % | 25 |

Pulp Bleaching & Treatment

- 10 The reaction is carried out for 40 min under 20% pulp consistency at 85°C. Each experiment is carried out based on 20 g of dry pulp, which is pre-heated in a microwave oven under high power for 1 min. The chemicals are mixed in sequence and quickly added into the pulp, so that they are sufficiently mixed with the pulp in a 1 L beaker. The mixture is then put into a water bath for bleaching.
- 15 Used chemicals and conditions are listed in Table 2.

Table 2. Used chemicals in pulp bleaching and treatment.

| | Sample 1 | Sample 2 | Sample 3 | Sample 4 |
|--|----------|----------|----------|----------|
| Fe (II) solution, ppm | 5 | 5 | 5 | 5 |
| H ₂ O ₂ , kg/ ton pulp (100%) | 40 | 40 | 40 | 40 |
| NaOH, kg/ton pulp (100%) | 24 | 24 | 24 | 24 |
| Chelating agent, kg/ ton pulp (as prod.) | 4 | 4 | 2 | 0 |
| Non-ionic surfactant, kg/ ton pulp (as prod.) | 3 | 0 | 2 | 4 |
| Enhancer agent, kg/ ton pulp (as prod.) | 0 | 3 | 3 | 3 |

Residual Peroxide (H₂O₂), Freeness & Brightness Measurements

After pulp bleaching 10 g of dry pulp is diluted to 10 % consistency with 90 °C
 5 distilled water before pressing out the filtrate. The pH of the filtrate is determined
 and the residual hydrogen peroxide is determined by thiosulfate titration.

The filtered pulp is diluted with 2000 ml of hot deionized water, temperature 90 °C.
 The pulp suspension is distinguished with standard defibrizer at 75000 rpm.
 10 Freeness is then determined according to TAPPI standard T227.

The rest of the bleached and treated pulp, ~10 g oven dry, is diluted to 1000 ml
 with tap water and pH adjusted to value in the range of 4.7 – 5.2 by using 20 %
 H₂SO₄ solution. The pulp is filtrated with a Buchner funnel and each sample is
 15 calculated as 2 g dry pulp. The obtained cake is pressed to become flat and air
 dried until next day, after which the optical properties, i.e. ISO brightness, is
 measured according to ISO 2469.

Results

Results for the measurements are given in Table 3.

- 5 Table 3. Measured results for residual peroxide, brightness and freeness.

| | Sample 1 | Sample 2 | Sample 3 | Sample 4 |
|--|----------|----------|----------|----------|
| Final pH | 9.10 | 9.03 | 8.99 | 9.02 |
| Residual H ₂ O ₂ , kg/ton | 3.4 | 7.2 | 7.8 | 5.9 |
| Brightness, % ISO | 77.03 | 78.34 | 78.47 | 78.46 |
| Freeness, ml CSF | 345 | 320 | 345 | 365 |

- From Table 3 it can be seen that the impregnation system does not have negative impact on brightness. On the other hand, there is clear increasing trend in the freeness results. This indicates that the impregnation system according to the invention improves the freeness, which may reduce the energy consumption during refining step.
- 10

EXAMPLE 2

- 15 Example 2 is a pilot trial study, which is carried out to study the effect of different impregnation systems on pulp properties, such as freeness.

Raw materials, preparation and pre-treatment

- Wood chips of poplar are obtained on-site in a pulp mill. Chips are screened in order to remove bark and other impurities, washed manually by using hot water, dewatered and pre-steamed at 105 °C for 10 minutes.
- 20

Impregnation of Chips

- Pre-treated chips are pressed with MSD Impressafiner (Andritz AG, Austria) with a compression ratio of 1:4. After that the impregnation is performed as two-step procedure. Both impregnation steps are performed at temperature 80 °C, duration
- 25

30 minutes and 30 % pulp consistency. The chemicals used in the impregnation steps are shown in table 4.

Table 4. Chemicals used in impregnation steps of chips.

| | Reference | Sample A | Sample B | Sample C | Sample D |
|---|-----------|-------------|-------------|-------------|-------------|
| 1st impregnation | | | | | |
| H ₂ O ₂ , kg/ton pulp (100%) | 25 | 25 | 25 | 25 | 25 |
| NaOH, kg/ton pulp (100%) | 20 | 20 | 20 | 20 | 20 |
| Chelating agent, kg/ton pulp (as prod.) | 2 | 2 | 2 | 2 | 2 |
| Enhancer agent, kg/ton pulp (as prod.) | 2 | 2 | 2 | 2 | 2 |
| Non-ionic surfactant, kg/ton pulp (as prod.) | 0 | 1 | 2 | 4 | 2 |
| 2nd impregnation | | | | | |
| H ₂ O ₂ , kg/ton pulp (100%) | 80 | 80 | 80 | 80 | 80 |
| NaOH, kg/ton pulp (100%) | 40 | 40 | 40 | 40 | 40 |
| Chelating agent, kg/ton pulp (as prod.) | 4 | 4 | 4 | 4 | 4 |
| Enhancer agent, kg/ton pulp (as prod.) | 3 | 3 | 3 | 3 | 3 |
| Non-ionic surfactant, kg/ton pulp (as prod.) | 0 | 0 | 0 | 0 | 2 |

High consistency refining

After impregnation chips are homogenized for moisture measurement and refined at atmospheric pressure in high pulp consistency of 25 % – 35 % for diverse freeness grades. Refiner energy consumption is recorded at the same time.

5

Bleaching and pulp properties measurement

After the refining step, the pulp is bleached in a plastic bucket, temperature 90 – 95 °C, 40 min, consistency 25 – 30 %. Bleaching chemical charges are: H₂O₂ 55 kg/ton pulp, NaOH 24 kg/ton pulp, chelating agent (DTPA) 2 kg/ton pulp (as commercial product). NaOH is used as 10% solution; DTPA is diluted to 1:10 with deionized water. Mixing of the bleaching chemicals into pulp is done simultaneously but separately. After mixing the pulp is transferred into plastic bag which is sealed and placed in a heated water bath.

10

15 After bleaching, the pulp is diluted with hot water to 4 – 5 % consistency for latency removal and pH is adjusted by acidification to 4.7 – 5.2. Final pulp is obtained by centrifuging the washed pulp and hand-sheets are made.

Canadian standard freeness of the pulp is measured according to TAPPI standard
20 TAPPI T227. The physical and optical properties of the formed hand-sheets are measured according to TAPPI standard T220, ISO 2469 (Brightness), TAPPI standard T425.

Results

25 Results of Example 2 are given in Table 5.

Table 5. Results of Example 2.

| Sample | Freeness ml CSF | Refining Energy consumption kWh/bdt | Tensile Nm/g | Bulk cm ³ /g | Tear mN.m ² /g | Burst, kPa.m ² /g | Brightness ISO % | Opacity% |
|----------|--------------------|---|-----------------|----------------------------|------------------------------|---------------------------------|---------------------|----------|
| Ref. | 550 | 820 | 14.39 | 2.95 | 2.12 | 0.53 | 80.96 | 82.88 |
| | 440 | 1097 | 17.99 | 2.67 | 2.29 | 0.72 | 80.52 | 83.57 |
| | 360 | 1343 | 22.03 | 2.45 | 2.46 | 0.92 | 80.47 | 83.93 |
| | 275 | 1672 | 24.97 | 2.27 | 2.74 | 1.16 | 80.74 | 83.83 |
| Sample A | 550 | 788 | 15.69 | 2.82 | 2.34 | 0.58 | 80.25 | 81.64 |
| | 460 | 1057 | 18.56 | 2.62 | 2.54 | 0.76 | 80.72 | 82.24 |
| | 330 | 1420 | 24.27 | 2.37 | 2.75 | 1.07 | 80.44 | 82.87 |
| | 260 | 1699 | 26.99 | 2.26 | 2.92 | 1.31 | 80.54 | 83.12 |
| Sample B | 560 | 774 | 15.88 | 2.79 | 2.37 | 0.58 | 80.51 | 80.88 |
| | 475 | 987 | 19.21 | 2.61 | 2.59 | 0.78 | 80.61 | 81.55 |
| | 355 | 1320 | 23.96 | 2.41 | 2.83 | 1.06 | 81.25 | 82.27 |
| | 250 | 1689 | 28.06 | 2.26 | 3.05 | 1.32 | 81.05 | 82.45 |
| Sample C | 545 | 768 | 16.16 | 2.79 | 2.43 | 0.67 | 80.48 | 81.06 |
| | 410 | 1077 | 21.92 | 2.46 | 2.75 | 0.95 | 80.98 | 81.63 |
| | 345 | 1281 | 24.98 | 2.35 | 2.91 | 1.14 | 81.01 | 81.97 |
| | 250 | 1603 | 29.52 | 2.21 | 3.13 | 1.39 | 81.21 | 82.14 |
| Sample D | 580 | 714 | 14.83 | 2.83 | 2.39 | 0.57 | 80.35 | 80.86 |
| | 465 | 987 | 19.63 | 2.62 | 2.64 | 0.79 | 80.72 | 81.62 |
| | 372 | 1236 | 24.12 | 2.39 | 2.87 | 1.02 | 80.64 | 82.05 |
| | 272 | 1580 | 27.88 | 2.23 | 3.11 | 1.31 | 80.38 | 82.29 |

From Table 5 it can be seen that there is a clear decline of the refiner energy consumption when the impregnation system is used. The energy consumption decreases when the amount of non-ionic surfactant in the impregnation system is increasing. For example energy savings of 8.8 % may be obtained at 300 ml Canadian freeness (comparison between the reference and Sample B). It is concluded that the impregnation agent enhances the fibrillation and improves the absorption and penetration of chemicals, especially when used in the 1st impregnation step.

Further, the strength properties of the final paper, especially tensile, tear and burst strength properties may also be improved when using impregnation agent according to the present invention.

- 5 It is apparent to a person skilled in the art that the invention is not limited exclusively to the embodiments and examples described above, but that the invention can vary within the scope of the claims presented below.

CLAIMS

1. Impregnation system for treating wood chips in mechanical production of pulp or alkaline peroxide mechanical production of pulp, the system comprising
- 5 - at least 5 weight-% of a non-ionic surfactant, which is a reaction product of a vegetable oil and sugar, based on the total weight of the system, and
- optionally an enhancer agent, comprising at least a polymer formed from monomers comprising at least one unsaturated carboxylic acid monomer or a derivative thereof.
- 10
2. System according to claim 1, **characterised** in that the non-ionic surfactant is a reaction product of C6 – C14 fatty alcohol derived from a vegetable oil and glucose.
- 15
3. System according to claim 1 or 2, **characterised** in that non-ionic surfactant is C8 – C14 alkyl polyglycoside.
4. System according to any of claims 1 – 3, **characterised** in that the amount of non-ionic surfactant is at least 10 weight-%, preferably at least 30 weight-%, more
- 20 preferably at least 50 weight-%, based on the total weight of the system.
5. System according to claim 4, **characterised** in that the amount of non-ionic surfactant is 10 – 99.9 weight-%, preferably 30 – 90 weight-%, more preferably 50 – 80 weight-%, based on the total weight of the system.
- 25
6. System according to claim 1, **characterised** in that the enhancer agent is
- a copolymer of an unsaturated carboxylic acid and a C1 – C10 sulphonic acid or its alkyl ester,
- an anionic polyacrylamide, or
- 30 - any of their mixtures.

7. System according to any of preceding claims 1 – 6, **characterised** in that the enhancer agent is a copolymer of an unsaturated carboxylic acid and 3-allyloxy-2-hydroxypropanesulphonic acid.

5 8. System according to any of preceding claims 1 – 7, **characterised** in that the unsaturated carboxylic acid is acrylic acid, methacrylic acid, maleic acid, itaconic acid, crotonic acid or any of their mixtures.

9. System according to claim any of preceding claims 1 – 8, **characterised** in that
10 the amount of enhancer agent is < 90 weight-%, preferably < 70 weight-%, more preferably < 50 weight-%, based on the total weight of the system.

10. System according to any of preceding claims 1 – 9, **characterised** in that the system is a composition comprising both the non-ionic surfactant and the
15 enhancer agent.

11. System according to any of claims 1 – 10, **characterised** in that the system further comprises a chelating agent, which is selected from a group consisting of polyaminopolycarboxylic acids; polyaminopolymethylenephosphonic acids;
20 hexamethylenediamine tetra(acetic acid); tetramethylenediamine tetra(methylenephosphonic acid); 1-hydroxyethylidene-1,1-diphosphonic acid (HEDP); *N*-bis- and tris-[(1,2-dicarboxy-ethoxy)ethyl]amines, such as *N*-bis[2-(1,2-dicarboxy-ethoxy)-ethyl]-amine; *N*-bis[2-(1,2-dicarboxy-ethoxy)-ethyl]-aspartic acid; *N*-tris[2-(1,2-dicarboxy-ethoxy)-ethyl]-amine, and *N*-[2-(1,2-dicarboxy-ethoxy)-ethyl]-(*N*-2-hydroxyethyl)aspartic acid.
25

12. System according to any of claims 1 – 11, **characterised** in that the system further comprises a polymeric substance selected from poly-alpha-hydroxyacrylic acid (PHAA) or its alkaline salt and a polylactone of poly-alpha-hydroxyacrylic acid
30 (PHAA).

13. Use of an impregnation system comprising a non-ionic surfactant, which is a reaction product of a vegetable oil and sugar for treating wood chips in mechanical production of pulp or alkaline peroxide mechanical production of pulp.

5 14. Use according to claim 13, **characterised** in that the impregnation system comprises an enhancer agent, comprising at least a polymer formed from monomers comprising at least one unsaturated carboxylic acid monomer or a derivative thereof.

10 15. Use according to claim 13 or 14, **characterised** in that the wood chips are used for making alkali peroxide mechanical pulp (APMP) or bleached chemithermomechanical pulp (BCTMP).

15 16. Use according to any of preceding claims 13 – 15, **characterised** in that the impregnation system is added 1 – 6 kg/ton produced pulp.

20 17. Method for treating wood chips in mechanical production of pulp or alkaline peroxide mechanical production of pulp by addition of an impregnation system, which comprises at least 5 weight-% of a non-ionic surfactant, which is a reaction product of a vegetable oil and sugar, based on the total weight of the system.

25 18. Method according to claim 17, **characterised** in that the system further comprises an enhancer agent, comprising at least a polymer formed from monomers comprising at least one unsaturated carboxylic acid monomer or a derivative thereof.

19. Method according to claim 17, characterised in that the non-ionic surfactant and the enhancer agent are added to the wood chips as a mixture or simultaneously as separate feed streams.

INTERNATIONAL SEARCH REPORT

International application No

PCT/FI2014/050696

A. CLASSIFICATION OF SUBJECT MATTER

INV. D21C1/00 D21C9/16
ADD.

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)

D21C

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

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

EPO-Internal, WPI Data

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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

28 November 2014

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