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(54) DISINTEGRATABLE BROWN SACK PAPER

ABBAUBARES BRAUNES TÜTENPAPIER

PAPIER D'ENSACHAGE BRUN DÉSINTÉGRABLE

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Description

TECHNICAL FIELD

[0001] The present disclosure relates to the field of manufacturing a sack paper.

BACKGROUND

[0002] During filling and storage of powdery material, such as cement, paper sacks are normally required to meet high standards.

[0003] The paper sacks often need to hold a considerable material weight, which requires high tensile strength and stretchability. For this purpose, Kraft paper is a suitable sack wall material. The sacks typically have two or more walls, i.e. layers of paper material, to further strengthen the sack construction. A wall layer of a sack is often referred to as a ply. Production of ply material (i.e. sack paper) is for example disclosed in WO 99/02772. In the production method disclosed in WO 99/02772, sulphate pulp is subjected to high consistency refining and a charged polymer, e.g. starch, is added to the stock in an amount of at least 8 kg (calculated for starch) per tonne of paper to obtain a paper that is both strong and porous (to allow deaeration during filling) .

[0004] Traditionally, construction workers have opened the cements sacks and added their contents to a mixer. However, some alternative solutions have been suggested.

[0005] GB2448486 discusses a dissolvable bag made from paper or another soluble materials, to contain building materials requiring mixing, such as cement, lime or plaster. It is stated that the dissolvable bag can be directly added to the mixer where the bag rapidly dissolves when water is added, which reduces spillage, wastage, mess and exposure to the building products. The packs are placed together in a waterproof wrapping to ensure the product stays dry whilst stored or in transit.

[0006] WO 2004052746 suggests spray or dip-coating the whole exterior of already filled bags with a non-permeable, waterproof coating. It is further suggested to place the bag in a mixer also containing a quantity of water, wherein resulting ingress of water into the bag causes a water-soluble inner layer of the bag to dissolve, thereby allowing the waterproof exterior of the bag to disintegrate within the mix. WO 2004052746 fails to device any materials for the inner and outer layer of the bag.

[0007] US 2011/0315272 states that a sack that dissolves in a moist environment can be obtained by using a dextrin adhesive for gluing the folded ends of the sack. Folding and gluing patterns for the ends are also discussed. A moisture barrier in the sack is not discussed.

[0008] JP5085565A suggests that a cement sack that can be added directly to a mixer is composed of a water-soluble material, such as PVOH, having a thickness of 20-70 μm. FR2874598 discloses a similar solution.

[0009] WO 2011/000942 relates to a material suitable for a ply of a sack, comprising a porous sheet provided with a coating on at least one of its surfaces, wherein said coating comprises at least one polyolefin. Further, it relates to a sack comprising such a material. It also relates to a method of forming a coating on a porous sheet, comprising the steps of: providing a porous sheet and a dispersion comprising at least one polyolefin; applying said dispersion on at least one surface of said sheet; and optionally, heating said sheet to a temperature above the melting temperature of said at least one polyolefin.

[0010] WO 2015/035434 discloses a water-soluble unbleached sack paper consisting mainly of lignin-containing cellulose. The unbleached sack paper also contains at least one surfactant. The sack paper has a relative wet strength of less than 6% after a 5-minute wetting time.

[0011] WO 01/51702 discloses a method of treating a chemically produced pulp suspension of a material containing lignocellulose after beating of said pulp suspension. The pulp suspension is heated to a treating temperature of at least 60 °C, obtaining a reduced density and/or an increased porosity in a paper or paperboard.

[0012] US 2003/0232211 relates to printable packaging paper for flexible packaging and discloses a flexible overall print coating that makes a first surface suitable for conventional printing. The print coating comprises clay, binder comprising acrylic and optionally PVOH, and microsphere shells, some optionally deformed. A barrier coating comprising PVOH, optionally acrylic, can be on the second surface. A multiple layer packaging structure can comprise such coated substrate and second and third strength layers of paper, and a flexible polyolefin barrier layer, all on the barrier coating side of the substrate, joined to the barrier coating. The flexible print coating can include titanium dioxide. The invention includes methods of making printing paper by applying first and second overlying acrylic or PVOH barrier coatings, calendaring the coated substrate in line, applying a flexible neutral-color print coating onto the first surface, including clay, binder comprising acrylic polymer, and polymeric microsphere shells, and calendaring the substrate a second time.

SUMMARY OF THE PRESENT DISCLOSURE

[0013] Brown (i.e. unbleached) sack paper is often stronger than white (i.e. bleached) sack paper. Further, brown paper may be preferred over white paper as the bleaching process may be associated with significant costs and environmental concerns. Further, bleaching may lower the yield.

[0014] The present inventors have addressed the need for a disintegratable brown sack paper, i.e. a paper for a sack that can be added together with its contents, such as cement, to a mixer and then disintegrates in the mixer.

[0015] Accordingly, it would not be necessary to open such a sack and empty its contents into the mixer. As the sacks are heavy and the contents dusty, the working environment of construction workers could be significantly improved.

[0016] Further, the inventors have realized that brown prior art sack papers, such as the brown sack paper produced according to WO 99/02772 or the brown qualities of BillerudKorsnäs' commercial sack paper QuickFill®, are not sufficiently disintergratable.

[0017] It is thus an object of the present disclosure to provide a brown sack paper that, after being formed into a ply of a sack that is filled with contents and added to a cement mixer together with the contents and water, disintegrates in the cement mixer.

[0018] The inventors have found that the disintegratability of a brown sack paper can be significantly improved by adding bleached pulp to the unbleached pulp used for manufacturing the brown sack paper. The inventors have also found that the disintegratability of a brown sack paper can be significantly improved by reducing the Kappa number and the degree of LC refining of the unbleached pulp used for manufacturing the brown sack paper.

[0019] Accordingly, the present invention is defined in the current claim 1.

[0020] A method of manufacturing a sack paper having a Gurley porosity (ISO 5636-5) of less than 15 s, comprising the steps of:

a) providing a pulp having a Kappa number (SCAN-C 1:00) of 15-40;
b) subjecting the pulp to high consistency (HC) refining and optionally low consistency (LC) refining to obtain refined pulp, wherein the energy supply of the LC refining is less than 120 kWh/ton paper; and
c) forming the sack paper from said pulp mixture,

wherein the amount of starch added in the method is 1-5 kg/ton paper and the amount of hydrophobic size added in the method is less than 2 kg/ton.

[0021] In an embodiment the Gurley porosity (ISO 5636-5) of the sack paper is less than 10 s, such as less than 8 s, such as less than 7 s, such as less than 6 s.

[0022] In an embodiment the Kappa number (SCAN-C 1:00) of the pulp provided in step a) is 20-35.

[0023] In an embodiment the geometric tensile energy absorption index (ISO 1924-3) of the sack paper is at least 2 J/g, such as at least 2.4 J/g, such as at least 2.8 J/g, such as at least 3.2 J/g.

[0024] In an embodiment the grammage (ISO 536) of the sack paper is 50-140 g/m^2, such as 60-120 g/m^2, such as 60-110 g/m^2, such as 70-110 g/m^2, such as 75-100 g/m^2.

[0025] In an embodiment the pulp provided in step a) is a chemical pulp, such as a Kraft pulp.

[0026] In an embodiment at least 50 %, such as at least 60 %, 70 %, 80 % or 90 %, of the dry weight of the pulp provided in step a) is softwood pulp.

[0027] In an embodiment step c) comprises crêping.

[0028] In an embodiment the amount of hydrophobic size is less than 1.5 kg/ton paper, such as less than 1.0 kg/ton paper, such as less than 0.5 kg/ton paper, such as less than 0.3 kg/ton paper, such as 0 kg/ton paper.

[0029] In an embodiment the amount of starch is 2-5 kg/ton paper.

[0030] In an embodiment step a) comprises conversion of wood into a pulp having a Kappa number (SCAN-C 1:00) of 25-40 using Kraft pulping.

[0031] In an embodiment the energy supply of the LC refining is less than 110 kWh/ton paper, such as less than 100 kWh/ton paper.

DETAILED DESCRIPTION

[0032] As a first, non-claimed, aspect of the present disclosure, there is provided a method of manufacturing a sack paper. A "sack paper" is a paper that is intended for a paper sack, such as a paper sack for a hydraulic binder. The hydraulic binder of the present disclosure is for use in a hydraulic composition. Examples of hydraulic compositions are discussed below.

[0033] The paper sack should vent air during filling. In detail, the air that accompanies powdered material shall efficiently vent from the sack as the filling machines that delivers the material run at high throughput rates. Often, the venting capability of the sack is the actual limiting factor for the filling rate. Efficient venting also prevents that air is trapped in the sack and causes under-weight packs, sack rupture and problems when sacks are stacked for transportation. During the filling process, the only way for air to escape from the interior of the sack is, in many sack constructions, through the inner wall/ply of the sack. For the air that has passed the inner wall/ply, the prior art provides various alternatives for the further escape. In some sacks, also the outer ply is porous to facilitate the further escape. From the above, it is understood that the sack paper of the present disclosure, which is primarily intended for an inner ply, but also can be used for an outer ply, has a lower air resistance (or a higher porosity) than many other types of paper.

[0034] Further, it is understood from the discussion above that the sack comprising the sack paper of the first aspect is normally a valve sack.

[0035] The air resistance according to Gurley (ISO 5636-5) is a measurement of the time (s) taken for 100 ml of air to pass through a specified area of a paper sheet. Short time means highly porous paper.

[0036] The sack paper of the present disclosure has a Gurley porosity (ISO 5636-5) of lower than 15 s, such as lower than 10 s, such as lower than 8 s, 7 s or 6 s. A sack paper having a Gurley porosity below 2 or 3 s often has an insufficient strength. Therefore, the Gurley porosity of the sack paper of the present disclosure is preferably at least 2 or 3 s. In some embodiments, it is at least 4 s. Typical Gurley porosity ranges for the present disclosure are thus 3-15 s, preferably 4-10 s, such as 4-8 s, 4-7 s or 4-6.5 s.

[0037] The method of the first aspect comprises the step of:

a) mixing an unbleached pulp with a bleached pulp to obtain a pulp mixture.

[0038] The unbleached pulp is preferably a chemical pulp. The reason for selecting a chemical pulp is that it generally results in stronger paper than recycled pulp or mechanical pulp. The chemical pulp may for example be Kraft pulp or sulfite pulp. Kraft pulp is the most preferred option. As well known by the skilled person, Kraft pulp is produced by the Kraft process.

[0039] Another benefit of selecting a chemical pulp is that it contains much less lignin than mechanical pulps. For example, a chemical pulp may contain less than 5 % lignin before bleaching, compared to about 30 % for a mechanical pulp. The inventors have found that a reduction in lignin content generally improves the disintegratability.

[0040] The Kappa number of the unbleached chemical pulp may for example be 45-60. A benefit of preparing a pulp having such a relatively high Kappa number is a relatively high yield. However, it may be beneficial to increase the duration of the cooking process to produce a pulp having a lower Kappa number, such as a Kappa number of 20-45 or 25-40. Even though longer cooking times decrease the yield, they may still be beneficial as the present inventors have realized that lower Kappa numbers in the unbleached pulp of the method of the first aspect are generally associated with improved disintegratability of the final sack paper. A relatively low Kappa number (i.e. 20-45) of the unbleached pulp may also allow for a relatively low proportion of bleached pulp in the pulp mixture, i.e. a ratio between 7:1 and 1.5:1.

[0041] The Kappa number may be measured according to SCAN-C 1:00 or ISO 302:2004.

[0042] It is also preferred that the bleached pulp is chemical pulp, such as Kraft pulp or sulfite pulp. As for the unbleached pulp, the benefits of selecting a chemical pulp are a relatively strong paper and relatively low Kappa numbers after the cooking process.

[0043] The Kappa number of the bleached pulp is preferably less than 10, such as less than 7, such as less than 4, such as less than 2. The inventors believe that, at least to some extent, lower Kappa numbers in the bleached pulp are associated with an increased disintegratability of the final sack paper.

[0044] The brightness of a pulp is a measure of the degree of bleaching. As for the Kappa number, the inventors believe that, at least to some extent, higher brightness of the bleached pulp is associated with an increased disintegratability of the final sack paper. The ISO brightness (ISO 2470-1) of the bleached pulp may thus be at least 60, for example. It may be preferred if the ISO brightness of the bleached pulp is at least 70. In some embodiments, it may be at least 80 or 85. From an economical and environmental perspective it may however be preferred not to bleach as far as to an ISO brightness of 80 or 85. Accordingly, in some embodiments, the ISO brightness is less than 85, such as 50-80.

[0045] As understood by the skilled person, a sheet is formed from the bleached pulp to facilitate the measurement of its ISO brightness.

[0046] Softwood pulps are generally associated with long fibers that result in strong paper. Therefore, the unbleached pulp and/or the bleached pulp of the present disclosure may comprise at least 50 % (based on dry weight) softwood pulp. The proportion of softwood pulp may for example be at least 75 % or 90 % (based on dry weight) of the unbleached pulp and/or the bleached pulp.

[0047] As understood from the discussion above, the method of the first aspect may further comprise a bleaching process to prepare the bleached pulp. Such a bleaching process may for example comprise oxygen delignification.

[0048] The oxygen delignification may for example be the first step of the bleaching process. Accordingly, pulp from a cooking process may be subjected to the oxygen delignification. Such pulp, which leaves the cooking process and is subjected to the oxygen delignification, may for example have a Kappa number below 45, such as 20-40 before the oxygen delignification.

[0049] Accordingly, the cooking process used in the preparation of the bleached pulp may for example result in a lower Kappa number than the cooking process used in the preparation of the unbleached pulp.

[0050] Alternatively, the same cooking process is used in the preparation of both pulps.

[0051] As a complement or alternative to the oxygen delignification ("O"), the bleaching process may comprise one of more of the following steps (which are all well known to the skilled person):

chlorine dioxide bleaching ("D")
ozone bleaching ("Z");
extraction with sodium hydroxide ("E");
alkaline hydrogen peroxide bleaching ("P");
peracetic acid bleaching ("PAA"); and
bleaching with sodium dithionite (a.k.a. sodium hydrosulfite) ("Y").

[0052] In one embodiment, the bleaching process comprises O and at least two or three of D, Z, E, P, PAA and Y.

[0053] In step a) of the method of the first aspect, the pulps (i.e. the unbleached pulp and the bleached pulp) are mixed in such proportions that the dry weight ratio of unbleached pulp to bleached pulp in the pulp mixture is between 7:1 and 1:1, preferably between 6:1 and 1:1, such as between 5:1 and 1:1, such as between 4:1 and 1:1, such as between 3.5:1 and 1.1:1, such as between 3:1 and 1.2:1, such as between 2.8:1 and 1.3:1.

[0054] If the proportion of bleached pulp is too low, the disintegratability of the resulting paper will be too low. If however the proportion of bleached pulp is too high, the production costs may be too high.

[0055] The method of the first aspect further comprises the step of:
b) forming the sack paper from said pulp mixture.

[0056] Step b) usually comprise the normal operations for forming a paper from a pulp, such as forming a web on a wire in a wire section, pressing the web in a press section and drying the web in a drying section.

[0057] The sack paper obtained in step b) is still considered to be brown sack paper. Accordingly, the ISO brightness of the sack paper is preferably less than 30, such as less than 25, such as less than 22.

[0058] Paper properties of sack paper are often measured in the machine direction (MD) and in the cross direction (CD), since there may be significant differences in the properties, depending on the orientated fibre flow out of the headbox on the paper machine.

[0059] To obtain the index of a certain property, it is calculated by dividing the actual value by the grammage for the paper in question.

[0060] The grammage (sometimes referred to as basis weight) is measured by weight and surface area, e.g. according to ISO 536.

[0061] The tensile strength is the maximum force that a paper will withstand before breaking. In the standard test ISO 1924-3, a stripe of 15 mm width and 100 mm length is used with a constant rate of elongation. The tensile strength is one parameter in the measurement of the tensile energy absorption (TEA). In the same test, the tensile strength, the stretch and the TEA value are obtained.

[0062] TEA is sometimes considered to be the paper property that best represents the relevant strength of the paper sack wall. This is supported by the correlation between TEA and drop tests. By dropping a sack the filling goods will move when reaching the floor. This movement strains the sack wall. To withstand the strain, the TEA should be high, which means that a combination of high tensile strength and good stretch in the paper absorbs the energy.

[0063] The grammage (ISO 536) of the sack paper of the present disclosure is normally in the range of 50 to 140 g/m^2. Generally, it is preferred to add another paper ply in a sack instead of increasing the grammage of a ply above 140 g/m^2. Preferably, the grammage (ISO 536) of the sack paper of the present disclosure is 50-130 g/m^2, such as 60-120 g/m^2, such as 60-110 g/m^2, such as 70-110 g/m^2, such as 75-100 g/m^2.

[0064] To take the TEA in both MD and CD into account, a geometric TEA may be calculated as the square root of the product TEA in MD and TEA in CD (TEA (geometric) = √(TEA (MD) * TEA (CD))).

[0065] The geometric TEA index (ISO 1924-3) of the sack paper of the present disclosure is preferably at least 2 J/g. For example, it may be at least 2.4 J/g, such as at least 2.8 J/g, such as at least 3.2 J/g.

[0066] Crêping of paper improves stretchability and thereby the TEA index. Accordingly, in one embodiment of the method of the first aspect, step b) comprises crêping.

[0067] The inventors have also realized that the disintegratability may be improved by decreasing the amount of hydrophobic size, such as alkylketene dimer (AKD), alkyl succinic anhydride (ASA) and/or rosin size, added in the method. In one embodiment, the amount of hydrophobic size added in the process is less than 2 kg/ton paper. For example, the amount may be less than 1.5 kg/ton paper, such as less than 1 kg/ton paper, such as less than 0.5 kg/ton paper, such as less than 0.3 kg/ton paper. In one embodiment, no hydrophobic size is added in the method.

[0068] Further, the inventors have realized that the disintegratability may be improved by minimizing the amount of starch. In one embodiment, the amount of starch added in the process is less than 7 kg/ton paper, such as less than 5 kg/ton paper, such as less than 4 kg/ton paper. To still obtain sufficient strength, the minimum amount of starch added may for example be at least 1 kg/ton paper, such as at least 2 kg/ton paper, such as at least 3 kg/ton paper. Here, "starch" comprises starch of any charge.

[0069] The starch is preferably added before step b).

[0070] In the context of the present disclosure, "kg/ton paper" refers to kg per ton of dried paper from the paper making process. Such dried paper normally has a dry matter content (w/w) of 90-95 %.

[0071] As a second, non-claimed, aspect of the present disclosure, there is provided a sack paper having a Gurley porosity (ISO 5636-5) of less than 25 s composed of a mixture of unbleached fibers and an bleached fibers, wherein the dry weight ratio of unbleached fibers to bleached fibers in the mixture is between 7:1 and 1:1.

[0072] The sack paper of the second aspect may be manufactured using the method of the first aspect. Accordingly, the embodiments and examples of the first aspect apply *mutatis mutandis* to the second aspect.

[0073] Further, there is provided a sack for a hydraulic binder, such as cement, comprising a ply composed of the sack paper of the second aspect.

[0074] The sack of the present disclosure is normally a valve sack.

[0075] The sack may for example be a multiple-ply sack comprising an inner ply composed of the sack paper according to the second aspect.

[0076] In a multiple-ply valve sack, each paper ply may for example have a grammage of 50-100 g/m^2, such as 60-90 g/m^2.

[0077] The multiple-ply sack may further comprise an outer ply composed of a white sack paper. An example of a suitable white sack paper for the purpose is described in the patent application EP14175729.4. In some embodiments, such a white sack paper comprises a moisture barrier coating. Various moisture barriers are known to the skilled person. The coat weight of the moisture barrier coating may for example be 5-30 g/m^2. The moisture barrier properties may be considered to be sufficient when the water vapor transmission rate (WVTR, ISO 2528, measured at 38 °C and 90 % relative humidity (tropic climate)) is less than 1400 g/m^2*24h, preferably less than 1200 g/m^2*24h. For example, the WVTR of sack paper comprising a moisture barrier may be 700-1200 g/m^2*24h. Preferably, the white sack paper forming the outer ply is disintegratable, also when it is provided with a moisture barrier coating. An example of such a coated paper is described in the patent application EP14175736.9.

[0078] When an outer ply is provided with a moisture barrier coating, it is often practically impermeable to air. To then achieve deaeration during filling, the sack may comprise a top end formed by folding and gluing the ply material such that a portion of the top end is not sealed by the gluing. In such an embodiment, the folding and gluing is such that air may escape through the non-sealed portion during filling of the sack with the hydraulic binder. Preferably, such a sack is designed such that air penetrates the innermost ply and then escapes through the non-sealed portion during filling at high throughput rates.

[0079] Alternatively, the multiple-ply sack may comprise an outer ply composed of the sack paper according to the second aspect. For example, all plies of the multiple-ply sack may be composed of sack paper according to the second aspect. From an economical perspective, it is beneficial if all the paper needed for a sack can be produced with a single paper making process.

[0080] The volume of the sack of the present disclosure may for example be 8-45 liters, such as 15-45 liters.

[0081] The sack of the present disclosure may for example contain a hydraulic binder, such as cement. The amount of the hydraulic binder may for example be 20-60 kg. For example, 25 kg, 35 kg and 50 kg sacks are demanded on the market and may be prepared according to the present disclosure. The dimensions of a filled 25 kg sack may for example be 400x450x110 mm. A "25 kg sack" typically can be filled with about 17.4 liters of material, while a "50 kg sack" is typically can be filled with about 35 liters of material.

[0082] To achieve protection against atmospheric water vapor penetration, many prior art sacks comprise a plastic film arranged between two paper plies of the sacks. Such a film, which normally is composed of polyethylene, is often referred to as a "free film". A plastic free film disintegrates poorly in a cement mixer. Hence it is preferred that the sack of the present disclosure does not comprise a plastic free film.

[0083] As a third aspect of the present disclosure, there is provided a method of producing a hydraulic composition, comprising adding water and a sack according to the present disclosure to a mixer and allowing the ply material of the sack to disintegrate during mixing in the mixer.

[0084] The hydraulic composition is thus a mix comprising the hydraulic binder and water (often referred to as mixing water). The composition may for example further comprise one or more aggregates, one or more additives and/or one or more mineral additions. An example of an aggregate is sand, which may have different particle sizes. The hydraulic composition of the present disclosure is preferably a cement slurry, a mortar, a concrete, a plaster paste or a slurry of hydraulic lime. In one embodiment, the hydraulic composition is selected from a cement slurry, a mortar and a concrete.

[0085] In another aspect of the invention, bleached fibers are not necessarily mixed with unbleached fibers. Instead, the production of a disintegratable sack paper is based on a pulp having a Kappa number that is relatively low compared to many unbleached pulps. Furthermore, the addition of starch, the addition of hydrophobic size and LC refining are kept at relatively low levels. The "low Kappa pulp" may be obtained by mixing unbleached pulp with bleached pulp as in the first aspect or by a cooking process that is designed to produce the "low Kappa pulp". For example, the duration or residence time of a cooking process may be adapted to obtain an unbleached pulp having the desired Kappa number (as mentioned above, longer cooking times generally results in lower Kappa numbers). Also, oxygen delignification may be used to reduce the Kappa number below 25 or 30.

[0086] As a fourth aspect of the present disclosure, there is thus provided a method of manufacturing a sack paper having a Gurley porosity (ISO 5636-5) of less than 25 s, comprising the steps of:

a) providing a pulp having a Kappa number (SCAN-C 1:00) of 15-40;
b) subjecting the pulp to high consistency (HC) refining and optionally low consistency (LC) refining to obtain refined pulp, wherein the energy supply of the LC refining is less than 120 kWh per ton paper; and
c) forming the sack paper from said pulp mixture,

wherein the amount of starch added in the method is 1-7 kg/ton paper and the amount of hydrophobic size added in the method is less than 2 kg/ton.

[0087] HC refining is typically carried out at a fibre suspension consistency of 15% by weight or higher, such as 15%-45% by weight. LC refining is typically carried out at a fibre suspension consistency of 10% by weight or lower, such as 2%-10%.

[0088] For example, the energy supply in the HC refining may be between 100 and 320 kWh/ ton paper, preferably between 150 and 300 kWh/ ton paper, such as between 170 and 300 kWh/ton paper.

[0089] As stated above, the energy supply is less than 120 kWh per ton paper (such as 10-120 kWh per ton paper) if LC refining is carried out. Preferably, the energy supply of the LC refining is less than 110 kWh per ton paper, such as 10-110 kWh per ton paper, and more preferably less than 100 kWh per ton paper, such as 10-100 kWh per top paper.

[0090] The Gurley porosity (ISO 5636-5) of the sack paper of the fourth aspect is preferably less than 20 s, such as less than 15 s, such as 10 s or less. In some embodiments, it is even less than 8 s, such as less than 7 s, such as less than 6 s.

[0091] Step a) preferably comprises Kraft pulping, which means the Kraft pulping is used for converting wood into the pulp having a Kappa number (SCAN-C 1:00) of 25-40. Preferably, at least 50 % by dry weight of the wood used in such Kraft pulping is softwood. More preferably, at least 60 %, 70 %, 80 % or 90 %, of the dry weight of the wood is softwood. If a Kappa number below 25 or 30 is desired, the pulping may be combined with subsequent oxygen delignification.

[0092] Preferably, the Kappa number (SCAN-C 1:00) of the pulp provided in step a) is 20-35. The skilled person knows how to adjust a cooking process to obtain such a Kappa number.

[0093] The amount of hydrophobic size added in the method of the fourth aspect is preferably less than 1.5 kg/ton paper, such as less than 1.0 kg/ton paper, such as less than 0.5 kg/ton paper, such as less than 0.3 kg/ton paper. In one embodiment, addition of hydrophobic size is completely omitted in the method.

[0094] The amount of starch is preferably kept relatively low to improve the disintegratability. At the same time, the strength of the resulting paper may be too low if starch is completely omitted. Therefore, the amount of starch added in the method of the fourth aspect is preferably 1-5 kg/ton paper, such as 2-5 kg/ton paper.

[0095] Otherwise, the embodiments and examples of the first aspect apply *mutatis mutandis* to the fourth aspect when compatible.

BRIEF DESCRIPTION OF THE FIGURE

[0096] Fig 1 is a plot showing the disintegratability of various papers.

EXAMPLES

[0097] For the trials presented below, "kg/ton" refers to "kg/ton paper"

Full scale trial

[0098] A full scale trial was carried out on paper machine 9 (PM9) at BillerudKorsnäs AB's mill in Skärblacka, Sweden. In the trial, the disintegratability of a paper obtained from a mixture of an unbleached pulp (57 wt.%) and a bleached pulp (43 wt.%) was compared to the disintegratability of a reference paper obtained from the unbleached pulp only. The grammage of the papers was 90 g/m^2.

[0099] Both pulps were softwood kraft pulps subjected to HC refining (about 120 kWh/ton) and LC refining (20 kWh/ton), to which starch (8 kg/ton), Fennosil 517 (0.25 kg/ton) and ASA size (1 kg/ton) had been added . The Kappa number (SCAN-C 1:00) of the unbleached pulp was 50. The ISO brightness (ISO 2470-1) of the bleached pulp was 90.

[0100] The disintegratability of the papers was tested according to the following protocol:

1. Cut paper (dry weight 30.0 g) into pieces of about 1.5 cm x 1.5 cm and add them to 2 l of water having a temperature of 20 °C;
2. After 2 minutes, add the paper-water mixture to a laboratory defibrator (L&W);
3. Run 5000 revolutions;
4. Add the contents from the defibrator to a laboratory sieve equipment having sieve openings of 0.15 mm and run the sieve for 15 minutes;
5. After completed filtration, collect the retentate;
6. Dry the retentate at 105 °C;
7. Weigh the dried retentate; and
8. Calculate the disintegratability (%) using the formula ((30-w)/30)*100, wherein w is the weight (g) of the dried retentate.

[0101] The Gurley porosity was also measured. The results are shown in table 1 below.

Table 1.

	Unbleached pulp	Bleached pulp	Gurley (ISO 5636-5)	Disintegratability
Reference paper	100 wt.%	0 wt.%	5s	30 %
Inventive paper	57 wt.%	43 wt. %	5.3 s	93 %

Laboratory trials

[0102] The laboratory trial set-up was first evaluated and found to have a sufficient correlation with the full scale trial.
[0103] In the laboratory trials, bleached and unbleached pulps were obtained from paper mills.

Trial 1

[0104] The unbleached pulp was unbleached softwood kraft pulp subjected to HC refining (250 kWh/ton) and LC refining (18 kWh/ton). The Kappa number (SCAN-C 1:00) of the unbleached pulp was 50. The bleached pulp was bleached softwood kraft pulp subjected to HC refining (150 kWh/ton) and LC refining (16 kWh/ton). The ISO brightness (ISO 2470-1) of the bleached pulp was 90.
[0105] Different pulps for sheet forming were prepared according to table 2 below. Laboratory sheets having a grammage of 80 g/m^2 were prepared in a dynamic sheet former according to BillerudKorsnäs' internal method. The disintegratability of the sheets, which is also shown in table 2 below, was tested as in the full scale trial described above.

Table 2.

	Reference	Test 1	Test 2	Test 3	Test 4
Unbleached pulp (wt. %)	100	100	90	68	57
Bleached pulp (wt.%)	0	0	10	32	43
Starch (kg/ton)	8	8	8	8	8
Fennosil 517 (kg/ton)	0.25	0.25	0.25	0.25	0.25
ASA (kg/ton)	1	0	0	0	0
Disintegratability	41 %	60 %	62 %	88 %	96 %

[0106] From tables 1 and 2, it can be concluded that an addition of bleached pulp to unbleached pulp significantly improves the disintegratability of the resulting paper, in particular if the pulp mixture from which the paper is formed comprises more than 10 % bleached pulp, such as at least 20 % bleached pulp. Further, table 2 shows that the disintegratability is significantly improved by reducing the amount of ASA size (an hydrophobic size) added to the pulp.
[0107] The results from tables 1 and 2 are also presented in Fig 1.

Trial 2

[0108] The unbleached pulp and the bleached pulp were the same as in trial 1 with the exception that for the unbleached pulp, the degree of HC refining was 258 kWh/ton and the degree of LC refining was 41 kWh/ton.

[0109] Different pulps for sheet forming were prepared according to table 3 below. As in Trial 1, Fennosil 517 (kg/ton) was added in an amount of 0.25 kg/ton. No ASA was added in trial 2. Laboratory sheets having a grammage of 80 g/m^2 were prepared in a dynamic sheet former according to BillerudKorsnäs' internal method. The disintegratability of the sheets, which is also shown in table 3 below, was tested as in the full scale trial described above.

Table 3. "UBP" refers to the unbleached pulp (wt.%). "BP" refers to the bleached pulp (wt.%). "S" refers to starch (kg/ton). "D" refers to disintegratability (%).

Test	1	2	3	4	5	6	7	8	9	10	11	12
UBP	100	90	68	57	100	90	68	57	100	90	68	57
BP	0	10	32	43	0	10	32	43	0	10	32	43
S	8	8	8	8	5	5	5	5	2	2	2	2
D	19	59	74	84	58	62	85	92	76	85	95	98

[0110] In table 3, it is verified that an addition of bleached pulp (BP) to unbleached pulp (UBP) significantly improves the disintegratability (D) of the resulting paper. Further, table 3 shows that the disintegratability (D) is significantly improved by reducing the amount of starch (S) added to the pulp. Finally, a comparison of the values for 8 kg/ton starch in table 3 to those of table 2 shows that the disintegratability (D) was lower when the degree of LC refining of the unbleached pulp was higher.

Trials 3 and 4

[0111] In trial 3, the unbleached pulp was unbleached softwood kraft pulp subjected to 177 kWh/ton HC refining and 131 kWh/ton LC refining. In trial 4, the unbleached pulp was the same type of unbleached softwood kraft pulp subjected to 210 kWh/ton HC refining and 95 kWh/ton LC refining. The Kappa number (SCAN-C 1:00) of the unbleached pulp was 30 in both trial 3 and trial 4. The bleached pulp was the same as in trial 1.

[0112] Trial 3 and trial 4 were carried at different occasions.

[0113] Different pulps for sheet forming were prepared according to table 4 and 5 below. As in Trial 1, Fennosil 517 (kg/ton) was added in an amount of 0.25 kg/ton. No ASA was added in trials 3 and 4. Laboratory sheets having a grammage of 80 g/m^2 were prepared in a dynamic sheet former according to BillerudKorsnäs' internal method. The disintegratability of the sheets, which is also shown in tables 4 and 5 below, was tested as in the full scale trial described above.

Table 4. Trial 3. "UBP" refers to the unbleached pulp (wt.%). "BP" refers to the bleached pulp (wt.%). "S" refers to starch (kg/ton). "D" refers to disintegratability (%).

Test	1	2	3	4	5	6	7	8	9	10
UBP	100	90	80	68	57	100	80	68	100	80
BP	0	10	20	32	43	0	20	32	0	20
S	8	8	8	8	8	5	5	5	2	2
D	49	66	79	89	97	82	95	95	86	97

[0114] In table 4, it is verified that an addition of bleached pulp (BP) to unbleached pulp (UBP) significantly improves the disintegratability (D) of the resulting paper and that the disintegratability (D) is significantly improved by reducing the amount of starch (S) added to the pulp. It is also notable that the disintegratability (D) of table 4, which were obtained with an unbleached pulp having a Kappa number of 30, are generally higher than those of table 3, which were obtained with an unbleached pulp having a Kappa number of 50. As an example, the disintegratability for 32 % bleached pulp and 5 kg/ton starch is 95 % in table 4 compared to 85 % in table 3.

Table 5. Trial 4. "UBP" refers to the unbleached pulp (wt.%). "BP" refers to the bleached pulp (wt.%). "S" refers to starch (kg/ton). "D" refers to disintegratability (%).

Test	1	2	3	4	5
UBP	100	100	80	68	57
BP	0	0	20	32	43
S	2	2	2	2	2

(continued)

Test	1	2	3	4	5
D	96	99	100	100	100

[0115] A comparison of the values in table 5 to those of table 4 shows that the disintegratability (D) was higher when the degree of LC refining of the unbleached pulp was lower. Further, it is shown in table 5 that when the kappa number, degree of LC refining and the amount of starch are all kept relatively low, it is not necessary to add bleached pulp to reach high (>95 %) disintegratability values. However, a positive effect of additions of bleached pulp is still observed in table 5.

Claims

1. A method of manufacturing a sack paper having a Gurley porosity (ISO 5636-5) of less than 15 s, comprising the steps of:

a) providing a pulp having a Kappa number (SCAN-C 1:00) of 15-40;
b) subjecting the pulp to high consistency (HC) refining and optionally low consistency (LC) refining to obtain refined pulp, wherein the energy supply of the LC refining is less than 120 kWh/ton paper ; and
c) forming the sack paper from said pulp mixture,

wherein the amount of starch added in the method is 1-5 kg/ton paper and the amount of hydrophobic size added in the method is less than 2 kg/ton.

2. The method of claim 1, wherein the Gurley porosity (ISO 5636-5) of the sack paper is less than 10 s, such as less than 8 s, such as less than 7 s, such as less than 6 s.

3. The method of claim 1 or 2, wherein the Kappa number (SCAN-C 1:00) of the pulp provided in step a) is 20-35.

4. The method of any one of claims 1-3, wherein the geometric tensile energy absorption index (ISO 1924-3) of the sack paper is at least 2 J/g, such as at least 2.4 J/g, such as at least 2.8 J/g, such as at least 3.2 J/g.

5. The method of any one of claims 1-4, wherein the grammage (ISO 536) of the sack paper is 50-140 g/m^2, such as 60-120 g/m^2, such as 60-110 g/m^2, such as 70-110 g/m^2, such as 75-100 g/m^2.

6. The method of any one of claims 1-5, wherein the pulp provided in step a) is a chemical pulp, such as a Kraft pulp.

7. The method of any one of claims 1-6, wherein at least 50 %, such as at least 60 %, 70 %, 80 % or 90 %, of the dry weight of the pulp provided in step a) is softwood pulp.

8. The method of any one of claims 1-7, wherein step c) comprises crêping.

9. The method of any one of claims 1-8, wherein the amount of hydrophobic size is less than 1.5 kg/ton paper, such as less than 1.0 kg/ton paper, such as less than 0.5 kg/ton paper, such as less than 0.3 kg/ton paper, such as 0 kg/ton paper.

10. The method of any one of claims 1-9, wherein the amount of starch is 2-5 kg/ton paper.

11. The method of any one of claims 1-10, wherein step a) comprises conversion of wood into a pulp having a Kappa number (SCAN-C 1:00) of 25-40 using Kraft pulping.

12. The method of any one of claims 1-11, wherein the energy supply of the LC refining is less than 110 kWh/ton paper, such as less than 100 kWh/ton paper.

Patentansprüche

1. Verfahren zur Herstellung eines Sackpapiers mit einer Gurley-Porosität (ISO 5636-5) von weniger als 15 s, umfassend die Schritte:

   a) Bereitstellen eines Zellstoffs mit einer Kappazahl (SCAN-C 1:00) von 15-40;
   b) Unterziehen des Zellstoffs einer hochkonsistenten (HC) Refinermahlung und wahlweise einer niederkonsistenten (LC) Refinermahlung zum Erhalt eines gemahlenen Zellstoffs, wobei die Energiezufuhr der LC-Mahlung kleiner als 120 kWh/Tonne Papier ist; und
   c) Formieren des Sackpapiers aus dem Zellstoffgemisch, wobei die im Verfahren zugegebene Menge von Stärke 1-5 kg/Tonne Papier beträgt und die im Verfahren zugegebene Menge von hydrophobem Leim weniger als 2 kg/Tonne beträgt.

2. Verfahren nach Anspruch 1, wobei die Gurley-Porosität (ISO 5636-5) des Sackpapiers kleiner als 10 s, wie kleiner als 8 s, wie kleiner als 7 s, wie kleiner als 6 s ist.

3. Verfahren nach Anspruch 1 oder 2, wobei die Kappazahl (SCAN-C 1:00) des in Schritt a) bereitgestellten Zellstoffs 20-35 beträgt.

4. Verfahren nach einem der Ansprüche 1-3, wobei der geometrische Zugenergieaufnahmeindex (ISO 1924-3) des Sackpapiers 2 J/g, wie mindestens 2,4 J/g, wie mindestens 2,8 J/g, wie mindestens 3,2 J/g beträgt.

5. Verfahren nach einem der Ansprüche 1-4, wobei die flächenbezogene Masse (ISO 536) des Sackpapiers 50-140 g/m^2, wie 60-120 g/m^2, wie 60-110 g/m^2, wie 70-110 g/m^2, wie 75-100 g/m^2 beträgt.

6. Verfahren nach einem der Ansprüche 1-5, wobei der in Schritt a) bereitgestellte Zellstoff ein chemisch aufgeschlossener Faserstoff, wie ein Kraftzellstoff, ist.

7. Verfahren nach einem der Ansprüche 1-6, wobei es sich bei mindestens 50 %, wie mindestens 60 %, 70 %, 80 % oder 90 %, der Trockenmasse des in Schritt a) bereitgestellten Zellstoffs um Nadelholzzellstoff handelt.

8. Verfahren nach einem der Ansprüche 1-7, wobei Schritt c) ein Kreppen umfasst.

9. Verfahren nach einem der Ansprüche 1-8, wobei die Menge von hydrophobem Leim weniger als 1,5 kg/Tonne Papier, wie weniger als 1,0 kg/Tonne Papier, wie weniger als 0,5 kg/Tonne Papier, wie weniger als 0,3 kg/Tonne Papier, wie 0 kg/Tonne Papier beträgt.

10. Verfahren nach einem der Ansprüche 1-9, wobei die Menge von Stärke 2-5 kg/Tonne Papier beträgt.

11. Verfahren nach einem der Ansprüche 1-10, wobei Schritt a) umfasst: Umwandlung von Holz in einen Zellstoff mit einer Kappazahl (SCAN-C 1:00) von 25-40 im Kraftaufschlussverfahren.

12. Verfahren nach einem der Ansprüche 1-11, wobei die Energiezufuhr der LC-Mahlung kleiner als 110 kWh/Tonne Papier, wie kleiner als 100 kWh/Tonne Papier ist.

Revendications

1. Procédé de fabrication d'un papier pour sacs ayant une porosité de Gurley (ISO 5636-5) inférieure à 15 s, comprenant les étapes suivantes :

   a) fourniture d'une pâte ayant un indice Kappa (SCAN-C 1:00) de 15 à 40 ;
   b) soumission de la pâte à un raffinage à haute consistance (HC) et éventuellement à un raffinage à basse consistance (LC) pour obtenir une pâte raffinée, l'alimentation en énergie du raffinage LC étant inférieure à 120 kWh/tonne de papier ; et
   c) formation du papier pour sacs à partir dudit mélange de pâte,

   la quantité d'amidon ajoutée dans le procédé étant de 1 à 5 kg/tonne de papier et la quantité d'apprêt hydrophobe ajoutée dans le procédé étant inférieure à 2 kg/tonne.

2. Procédé selon la revendication 1, la porosité Gurley (ISO 5636-5) du papier pour sacs étant inférieure à 10 s, telle qu'inférieure à 8 s, telle qu'inférieure à 7 s, telle qu'inférieure à 6 s.

3. Procédé selon la revendication 1 ou 2, l'indice Kappa (SCAN-C 1:00) de la pâte à papier fournie à l'étape a) étant compris entre 20 et 35.

4. Procédé selon l'une quelconque des revendications 1 à 3, l'indice géométrique d'absorption d'énergie en traction (ISO 1924-3) du papier pour sacs étant d'au moins 2 J/g, tel qu'au moins 2,4 J/g, tel qu'au moins 2,8 J/g, tel qu'au moins 3,2 J/g.

5. Procédé selon l'une quelconque des revendications 1 à 4, le grammage (ISO 536) du papier pour sacs étant de 50 à 140 g/m^2, tel que 60 à 120 g/m^2, tel que 60 à 110 g/m^2, tel que 70 à 110 g/m^2, tel que 75 à 100 g/m^2.

6. Procédé selon l'une quelconque des revendications 1 à 5, la pâte fournie à l'étape a) étant une pâte chimique, telle qu'une pâte Kraft.

7. Procédé selon l'une quelconque des revendications 1 à 6, au moins 50 %, tel qu'au moins 60 %, 70 %, 80 % ou 90 %, du poids sec de la pâte fournie à l'étape a) étant une pâte de résineux.

8. Procédé selon l'une quelconque des revendications 1 à 7, l'étape c) comprenant le crêpage.

9. Procédé selon l'une quelconque des revendications 1 à 8, la quantité d'apprêt hydrophobe étant inférieure à 1,5 kg/tonne de papier, telle qu'inférieure à 1,0 kg/tonne de papier, telle qu'inférieure à 0,5 kg/tonne de papier, telle qu'inférieure à 0,3 kg/tonne de papier, par exemple 0 kg/tonne de papier.

10. Procédé selon l'une quelconque des revendications 1 à 9, la quantité d'amidon étant de 2 à 5 kg/tonne de papier.

11. Procédé selon l'une quelconque des revendications 1 à 10, l'étape a) comprenant la conversion du bois en une pâte ayant un indice Kappa (SCAN-C 1:00) de 25 à 40 à l'aide de la mise en pâte Kraft.

12. Procédé selon l'une quelconque des revendications 1 à 11, l'alimentation en énergie du raffinage LC étant inférieure à 110 kWh/tonne de papier, telle qu'inférieure à 100 kWh/tonne de papier.

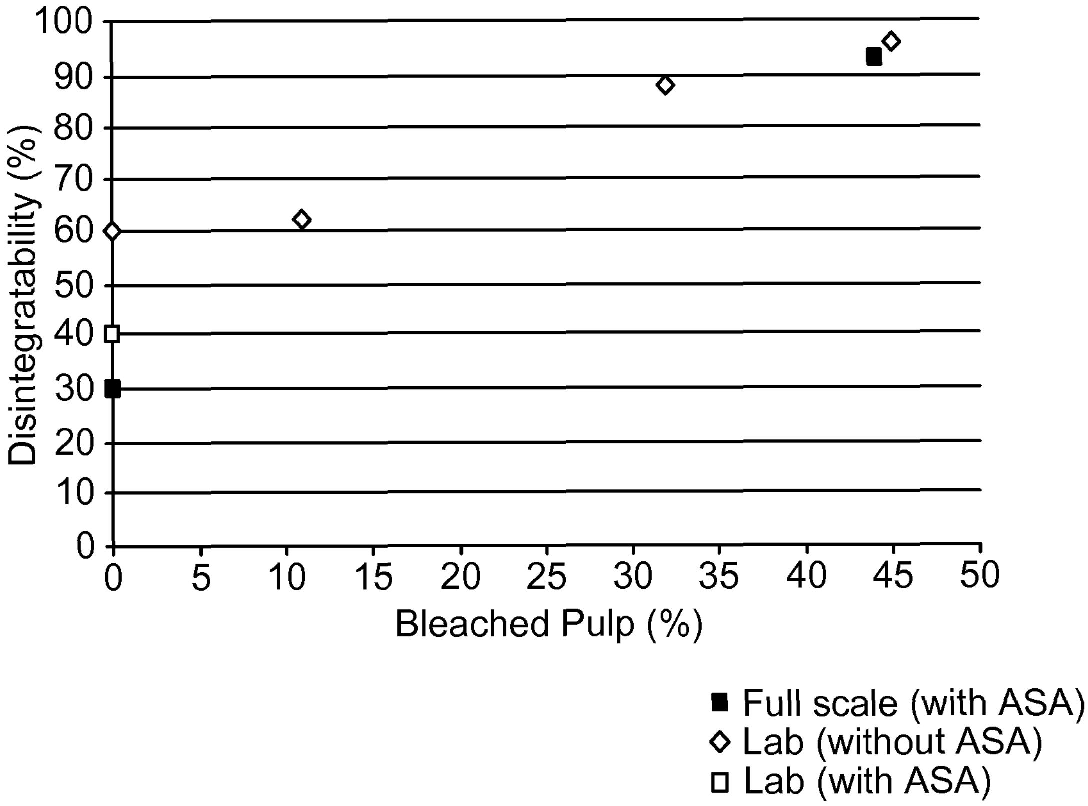
100
90
80
70
60
50
40
30
20
10
0
Disintegratability (%)
0
5
10
15
20
25
30
35
40
45
50
Bleached Pulp (%)
Full scale (with ASA)
Lab (without ASA)
Lab (with ASA)

Fig. 1

REFERENCES CITED IN THE DESCRIPTION

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