

A Pulp Fiber Composition

Technical Field

The present invention generally relates to a pulp
5 fiber composition. The present invention also relates to a
method of producing a paper sheet as well as a tissue
sheet formed from the above pulp fiber composition.

Background

10 Pulp is a common raw material used in the production
of tissues such as toilet tissue, paper towels, napkins,
and other absorption/hygiene product. Typically, tissue
paper is made up of 50 to 90% hardwood pulp and 10 to 50%
softwood pulp, depending on the tissue grade. When tissue
15 paper is made, certain characteristic of pulp material are
linked to desired properties in the resultant tissue such
as softness, smoothness, formation, opacity, color, etc.
In addition, runnability and efficiency during
manufacturing are also important. Hence, the major cost
20 drivers for tissue manufacturing are pulp (hardwood and
softwood), chemicals and utility (electricity, energy,
water, etc).

Acacia pulp, due to its fiber characteristic, gives
better softness for tissue. This can be attributed to
25 higher fiber population (number of fiber at given weight),
higher fiber collapse index compared to eucalyptus and
other hardwood pulp. Acacia also has lower water retention
value (WRV), which contributes to less water holding
capacity leading to lesser heat or energy demand to
30 evaporate water in the Yankee dryer to reach a targeted
dryness.

In addition, the initial strength of acacia pulp is
also higher compared to that of eucalyptus and other
hardwood pulp. By having higher initial strength, fiber

refining can be minimized at acceptable strength properties in order to result in good bulkiness and softness. By lowering fiber refining, the electricity requirement can be consequently lowered, resulting in lower production costs. If there is a need to, another way of improving the strength is by adding expensive fiber such as softwood. Therefore, higher initial strength of acacia fiber potentially results in reducing softwood usage.

However, despite the above advantages of using acacia pulp, acacia pulp has poor adhesion (floating) on Yankee dryer. This problem results in poor machine runnability and machine efficiency, leading to lower quality tissue due to poor creping from Yankee dryer. Therefore, in high speed tissue machines, the amount of acacia used must be limited and is traditionally set at 35%. Increasing the amount acacia pulp usage to more than 35% would normally lead to runnability and quality issues as mentioned above. To improve the adhesion to the Yankee dryer, special adhesive chemicals have been added on Yankee dryer surface, or treating acacia pulp prior to use at tissue making facilities. However, these additional chemicals/treatment are not desirable from an economical and efficiency point of view.

There is a need to provide a pulp fiber composition that overcomes, or at least ameliorates, one or more of the disadvantages described above.

There is a need to provide a method of producing a paper sheet that overcomes, or at least ameliorates, one or more of the disadvantages described above.

Summary

According to a first aspect, there is provided a pulp fiber composition comprising acacia mangium fibers and acacia crassiparva fibers.

5 Advantageously, the pulp fiber composition may be made up of 100% acacia species while having a low lipophilic content in the pulp fiber composition. The pulp fiber composition may not require pre-treatment or enzymatic treatment to reduce the lipophilic contents in
10 the pulp fiber composition.

The pulp fiber composition may have a good adhesion to a Yankee dryer surface without the need for special adhesive chemicals.

The pulp fiber composition may have a high fiber
15 collapsibility, resulting in reduced free water content in the pulp fiber composition. This may result in reducing the amount of drying energy required in the Yankee dryer.

According to a second aspect, there is provided a method of producing a paper sheet comprising the step of
20 drying a pulp fiber composition comprising acacia mangium fibers and acacia crassiparva fibers to form a dried paper sheet. The method may optionally exclude pre-treating the pulp fiber composition or may exclude the addition of adhesive chemicals in excessive high amounts or enzymes to
25 the pulp fiber composition.

According to a third aspect, there is provided a tissue sheet formed from a pulp fiber composition comprising acacia mangium fibers and acacia crassiparva fibers, having a tissue bulk property of at least 13 cm³/g.

30 Advantageously, the tissue sheet may meet or exceed consumer's expectations of tissue softness, tissue opacity and tissue strength, while being sufficiently disposable in toilet systems.

Definitions

The following words and terms used herein shall have the meaning indicated:

The term 'lipophilic components' is to be interpreted broadly to include waxes, fatty acids, alkanols (such as white wax and/or long-chained OH compounds, such as C_{24} - C_{28} -OH, and/or high melting point alkanols of 90°C or greater), hydroxy extractives, fatty alcohols, triglycerides, diglycerides, sterols, steryl esters, etc.

The fatty acids may be fatty acids with an alkyl group of C_4 - C_{30} , such as C_{16} - C_{18} fatty acids, C_{18} - C_{28} fatty acids, and/or C_{20} - C_{26} fatty acids. The fatty acid may be saturated or unsaturated. A portion or all of the fatty acids may be bound or attached to other molecules, such as triglycerides. Other examples include tetradecanoic (myristic, C_{14}); hexadecanoic (palmitic, C_{16}); 9,12-octadecadienoic (linoleic, C_{18}); 7-octadecadienoic (C_{18}); heptadecanoic (margaric, C_{17}) or octadecanoic (stearic, C_{18}); docosanoic (behinic, C_{22}); tetracosanoic (lignoceric, C_{24}); hexacosanoic (cerotic, C_{26}); and/or pentadecanoic (C_{25}). The lipophilic content can be determined by extracting using a non polar solvent such as dichloromethane and the extracted amount measured. Hence, the term "lipophilic component" can also include lipophilic extractives.

The word "substantially" does not exclude "completely" e.g. a composition which is "substantially free" from Y may be completely free from Y. Where necessary, the word "substantially" may be omitted from the definition of the invention.

Unless specified otherwise, the terms "comprising" and "comprise", and grammatical variants thereof, are intended to represent "open" or "inclusive" language such

that they include recited elements but also permit inclusion of additional, unrecited elements.

As used herein, the term "about", in the context of concentrations of components of the formulations, typically means $\pm 5\%$ of the stated value, more typically $\pm 4\%$ of the stated value, more typically $\pm 3\%$ of the stated value, more typically, $\pm 2\%$ of the stated value, even more typically $\pm 1\%$ of the stated value, and even more typically $\pm 0.5\%$ of the stated value.

Throughout this disclosure, certain embodiments may be disclosed in a range format. It should be understood that the description in range format is merely for convenience and brevity and should not be construed as an inflexible limitation on the scope of the disclosed ranges. Accordingly, the description of a range should be considered to have specifically disclosed all the possible sub-ranges as well as individual numerical values within that range. For example, description of a range such as from 1 to 6 should be considered to have specifically disclosed sub-ranges such as from 1 to 3, from 1 to 4, from 1 to 5, from 2 to 4, from 2 to 6, from 3 to 6 etc., as well as individual numbers within that range, for example, 1, 2, 3, 4, 5, and 6. This applies regardless of the breadth of the range.

Certain embodiments may also be described broadly and generically herein. Each of the narrower species and subgeneric groupings falling within the generic disclosure also form part of the disclosure. This includes the generic description of the embodiments with a proviso or negative limitation removing any subject matter from the genus, regardless of whether or not the excised material is specifically recited herein.

Detailed Disclosure of Embodiments

Exemplary, non-limiting embodiments of a pulp fiber composition will now be disclosed. The pulp fiber composition may comprise acacia mangium fibers and acacia crassiparva fibers. The pulp fiber composition may consist of acacia mangium fibers and acacia crassiparva fibers. The pulp fiber composition may consist essentially of acacia mangium fibers and acacia crassiparva fibers.

The pulp fiber composition may be composed of 100% acacia species fibers. Hence, the pulp fiber composition may not require the addition of special adhesive chemicals (in excessive amounts) or enzymes to reduce the amount of lipophilic contents in the pulp fiber composition. The acacia species fibers may be partly or completely virgin pulp fiber. The acacia species fibers may be typically cellulose fibers and may be acacia fibers from Asia, Indonesia, Africa and other tropical climates.

The pulp fiber composition may have a lower lipophilic content than traditional pulp of the prior art even though the amount of acacia species present in the pulp fiber composition is substantially more than what is acceptable in the prior art. For instance, the amount of acacia species in a traditional pulp cannot be more than 35% as increasing the amount of acacia species beyond this limit would result in adhesion problems to a Yankee dryer surface, leading to poor runnability, decreased machine efficiency and lower tissue quality.

However, the present inventors have found that by having a mixture of two acacia species (the total content of which is more than the prior art's limitation of 35%), the amount of lipophilic content in the resultant pulp fiber composition does not increase, but instead can be controlled to a desired value that results in good runnability, higher adhesion force to a Yankee dryer

surface and better tissue quality. Hence, this is contradictory and is opposite to the general consensus of the art in which a limitation on the amount of acacia species present in a pulp must be set to avoid problems in tissue production.

In the pulp fiber composition, the acacia mangium fibers may be present in the pulp fiber composition at a weight concentration of at most about 35wt%, at most about 30wt%, at most about 25wt%, at most about 20wt%, at most about 15wt%, at most about 10wt%, at most about 5wt%, or at most about 0.1wt%.

The acacia crassicarpa may be present in the pulp fiber composition at a weight composition of at least about 65wt%, at least about 70wt%, at least about 75wt%, at least about 80wt%, at least about 85wt%, at least about 90wt%, at least about 95wt%, or at most 99.9wt%.

The pulp fiber composition may have a collapse index of less than 0.420, less than 0.415, less than 0.410, less than 0.405 or less than 0.400. By increasing the collapse index, the void volume for water entrainment after pressing may be minimized, leading to a decrease in the amount of free water content in the fiber. This may aid in reducing the amount of heat energy required to evaporate the water from the fibers in the Yankee dryer since the amount of water in the pulp fiber composition is lessened. The collapse index (or collapse resistance index, CRI) is calculated based on the following equation (1):

$$CRI_i = \frac{1}{N} \sum_{i=1}^N \frac{\text{fiber wall thickness}_i^2}{\text{fiber width}_i - \text{fiber wall thickness}_i} \quad (1)$$

The pulp fiber composition may have an adhesion force to a Yankee dryer surface of at least about 5.0 N/m, at least about 5.5 N/m, at least about 6.0 N/m, at least about 6.5 N/m, or at least about 7.0 N/m. Adhesion of

acacia pulp to Yankee dryer depends on the hydrophilic (or carbohydrate) contents as well as hydrophobic (or lipophilic) contents. Hydrophilic components are the carbohydrates (α , β , γ -celluloses, Arabinose, Galactose, Xylose, Glucose, and Mannose) while lipophilic components are comprised of fatty acids, fatty alcohols, ferulic acids, glycerides, and sterols. Increased hydrophilic or carbohydrate content in pulp such as increased hemicelluloses (arabinose, galactose, or xylose), glucose, and mannose content will improve the adhesion force of pulp to a Yankee dryer surface and improves the water retention value. The improvement of the adhesion force of the pulp to the Yankee dryer is due to the presence of the hydrophilic components that act as an adhesive. The increased water retention value then increases the water content of the pulp, which then aid in adhering the pulp to a metal surface (the Yankee dryer surface) due to the attraction of water to the metal surface through its surface tension and polar attraction. As acacia contains less hemicellulose contents than eucalyptus, the hydrophilic content in acacia pulp can be retained by milder pulping process. The hydrophobic components then prohibit stickiness to a hot metal surface. Accordingly, the amount of hydrophilic and hydrophobic components need to be appropriately controlled and adjusted in order to obtain a desired adhesion force to the Yankee dryer.

The pulp fiber composition may have a lipophilic content in the range of about 0.05% to about 0.15%, about 0.05%, about 0.06%, about 0.07%, about 0.08%, about 0.09%, about 0.10%, about 0.11%, about 0.12%, about 0.13%, about 0.14%, or about 0.15% (as extracted by dichloromethane). The standard test for determining lipophilic content by solvent extraction may be international standard TAPPI T204 cm07. By controlling the amount of lipophilic

contents in the pulp fiber composition, while still ensuring that long chain carbon fatty acids and fatty alcohols (C24 to C28) are present at a controlled level for increasing the adhesion to the Yankee dryer, the pulp
5 fiber composition may be used for producing tissues with good quality.

The pulp fiber composition may have a hemicellulose content of at least about 14.5%, about 15%, or about 20%.

Hence, due to the presence of acacia crassicarpa
10 (which imparts the high fiber collapsibility and low CRI) and acacia mangium (which provides long chain carbon lipophilics with high melting points), while ensuring that the lipophilic content is at most 0.15%, the pulp fiber composition has good adhesion force to a Yankee dryer
15 surface, reduced energy requirements and leads to a tissue with good softness and opacity.

To form the pulp fiber composition, a fixed ratio of acacia mangium wood chips and acacia crassicarpa wood chips (for example, a ratio of 35% to 65% respectively)
20 were obtained from a chip pile. The wood chips mixture was cooked in a digester with white liquor, Weak Black Liquor (WBL) and Hot Black Liquor (HBL) to reach a desired cooking kappa (for example in the range of 17 to 19). Kappa is an indirect measurement for degree of wood
25 delignification. The cooked pulp will be screened to remove any un-cooked wood chips and washed to improve cleanliness before next stage. The washed pulp then enters an Oxygen Delignification (ODL) stage for further lignin removal by using oxygen, oxidized white liquor, and
30 caustic. The pulp then enters the bleaching stages such as D stage (by using ClO_2), EOP stage (by using oxygen, caustic, and peroxide), and then the last D stage (by using ClO_2). Washing stages are applied between each bleaching stage to improve on the cleanliness of the pulp

before the next stage. After the pulp is bleached to a brightness that is required by an end-user, the pulp is stored in slurry storage before entering pulp dryer. In the pulp dryer, the pulp slurry is then further cleaned to
5 remove dirt particles. Slurry is formed into fiber mat while water is removed, then pressed to continue water removal before being further dried in a hot air dryer. Dried pulp sheets (having the acacia mangium fibers and acacia crassiparva fibers therein) are then cut into its
10 bale size and wrapped for shipment.

The above pulp fiber composition may be used to form a paper sheet, such as a tissue sheet. The method of producing a paper sheet may comprise the step of drying a pulp fiber composition comprising acacia mangium fibers
15 and acacia crassiparva fibers to form a dried paper sheet. The dryness of the tissue paper before Yankee may be in the range of at least about 24.2%, at least about 24.3%, at least about 24.4%, at least about 24.5%, at least about 24.6%, at least about 24.7%, at least about 24.8%, at
20 least about 24.9% or at least about 25.0%.

The drying step may be undertaken in a Yankee dryer. The pulp fiber composition may be dried to an acceptable dryness in the Yankee dryer before scrapping with a doctor blade. The pulp fiber composition is capable of adhering
25 to the Yankee dryer surface due to its low lipophilic content without the use of special adhesive chemicals or pre-treatment.

The dried paper sheet, while still on the Yankee dryer, may be scrapped with a doctor blade that is
30 equipped on the Yankee cylinder to crepe the paper. Hence, the method may further comprise the step of creping the dried paper sheet to form creped paper sheet. The creping may be controlled by the adhesion force of the pulp to the Yankee dryer, geometry of the doctor blade, speed

difference between the Yankee and the final section of the paper machine and pulp characteristics.

The method may further comprise the step of processing the creped paper sheet to form a paper product.

5 This may involve rolling, cutting and packaging the creped paper sheet to form the paper product such as packaged tissue papers.

The tissue sheet formed from the pulp fiber composition comprising acacia mangium fibers and acacia
10 crassiparva fibers may have a tissue bulk property of at least about 13.0 cm³/g, at least about 13.1 cm³/g, at least about 13.2 cm³/g, at least about 13.3 cm³/g, at least about 13.4 cm³/g, or at least about 13.5 cm³/g. The tissue sheet may have a tissue tensile index cross direction of at
15 least about 7.5 Nm/g, at least about 7.6 Nm/g, at least about 7.7 Nm/g, at least about 7.8 Nm/g, at least about 7.9 Nm/g, or at least about 8.0 Nm/g. The tissue sheet may have a tissue tensile index machine direction of at least about 9 Nm/g, at least about 9.5 Nm/g, at least about 10
20 Nm/g, at least about 10.5 Nm/g, at least about 11 Nm/g. The tissue sheet may have a tissue softness of at least about 13, or at least about 14. The tissue sheet may have a tissue opacity of at least about 56%, at least about 57%, at least about 58%, at least about 59%, or at least
25 about 60%.

Brief Description Of Drawings

The accompanying drawings illustrate a disclosed embodiment and serves to explain the principles of the
30 disclosed embodiment. It is to be understood, however, that the drawings are designed for purposes of illustration only, and not as a definition of the limits of the invention.

Fig. 1 is a bar chart showing the fiber structures, and collapse indexes of various pulp mixtures after laboratory pulping.

Fig. 2 is a bar chart showing the components of
5 extracted lipophilic material in acacia mangium and acacia crassicarpa wood.

Fig. 3 is a bar graph showing the fatty acid components in acacia mangium and acacia crassicarpa wood.

Fig. 4 is a bar graph showing the fatty alcohol
10 components in acacia mangium and acacia crassicarpa wood.

Fig. 5 is a graph showing the relationship between fatty alcohol melting point and carbon chain length.

Fig. 6 is a graph showing the adhesion force to Yankee dryer as a function of the acacia lipophilic
15 content. This graph also shows the amount of adhesive chemical used in the Yankee dryer to increase the adhesion force of the pulp on the Yankee surface.

Fig. 7 is a bar graph showing the lipophilic content as a function of increasing amounts of acacia crassicarpa
20 in the pulp mixtures by laboratory pulping.

Fig. 8 is a bar graph showing the lipophilic content as a function of increasing amounts of acacia crassicarpa in the pulp mixtures after mill pulping.

Fig. 9 is a bar graph showing the adhesion force to
25 Yankee dryer of Acacia XP compared to other pulps.

Fig. 10 is a bar graph showing the dryness before Yankee of Acacia XP compared to other pulps.

Fig. 11 is a bar graph showing the tensile indexes, refining energy and tensile at 25°SR of Acacia XP compared
30 to the other pulps.

Fig. 12 is a bar graph showing the tissue tensile strength indexes, and tissue bulk values of Acacia XP tissue compared to tissues made from other pulps with similar gsm.

5 Fig. 13 is a bar graph showing the tissue softness and opacity qualities of Acacia XP tissue compared to tissues made from other pulps with similar gsm.

Examples

10 Non-limiting examples of the invention and a comparative example will be further described in greater detail by reference to specific Examples, which should not be construed as in any way limiting the scope of the invention.

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Example 1

Acacia mangium wood chips and acacia crassicarpa wood chips were mixed at various ratios (as mentioned above) prior to pulping and the resultant pulp was characterized
20 to determine the fiber structure, the lipophilic contents and adhesion force to Yankee dryer.

Fiber Structure

The fiber structure was obtained by measurement in a
25 fiber morphology testing instrument (such as Kajaani Fiber lab., Fiber Master, or FQA instrument). Overall, fiber structure or fiber morphology is the result of the average pieces of individual fibers contained in the pulp. For example, 1 milligram of pulp contains 10,000 - 28,000
30 pieces of fibers.

By having a lower collapse resistance index, the void volume for water entrainment after pressing can be decreased or minimized. Lower collapse resistance index

also results in lower free water content. Fig. 1 shows the fiber structure of the various pulp mixtures of acacia mangium and acacia crassiparva. As shown in Fig. 1, 11 pulp mixtures were investigated in which the first sample was 100% acacia mangium with no acacia crassiparva (sample AM100AC00) and subsequent samples were obtained by incrementally decreasing the amount of acacia mangium by 10% and incrementally increasing the amount of acacia crassiparva by 10% (samples AM90AC10, AM80AC20, AM70AC30, AM60AC40, AM50AC50, AM40AC60, AM30AC70, AM20AC80, AM10AC90) until a final sample having 100% acacia crassiparva (sample AM00AC100) was used. It can be seen that by having more than 65% acacia crassiparva in the pulp, the collapse resistance index decreased. By preserving the carbohydrate mainly as hemicellulose content (of at least 14.5%) in the pulp, the pulp can adhere to the surface of the Yankee dryer as well as increase the water content of the pulp after press before the dryer.

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Lipophilic Contents Analysis

The lipophilic content in acacia mangium and acacia crassiparva was identified through extraction with non polar or lipophilic solvent. The extracted lipophilic materials were then identified using a Gas Chromatography (GC) analyser. The testing procedure used here is that of the standard test TAPPI T204 cm07 procedure.

From the laboratory extraction of wood and pulp with dichloromethane solvent, it was found that acacia mangium contains more lipophilic matters than acacia crassiparva. Acacia mangium wood contains 1.21% lipophilic contents while acacia crassiparva wood contains 0.33% lipophilic contents. Acacia mangium pulp contains 0.29% lipophilic

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contents while acacia crassicarpa pulp contains 0.10% lipophilic contents.

Further analysis of lipophilic components between acacia mangium and acacia crassicarpa wood were done using
5 hexane extraction followed by GC identification. Fig. 2 shows the general component of extracted lipophilic materials in the two types of acacia wood. As seen in Fig. 2, acacia mangium wood contains more fatty acids, fatty alcohols, ferulic acids, glycerides and sterols than
10 acacia crassicarpa wood. Due to 80% of the lipophilic contents being linear fats and saponifiables, this contributes to the cleansing effect of acacia wood. In comparison, the lipophilic contents in other hardwoods such as eucalyptus are in the form of polymeric resin and
15 non saponifiable fats, which contribute to dirt or deposition problems in paper or tissue making process, leading to problems associated with the cleanliness of the resultant paper or tissue product.

Further evaluation of the lipophilic component
20 element by GC indicates that reduction of lipophilic content in pulp is difficult as the majority of the elements are in the form of long chain carbon fatty acids and fatty alcohols (C24 to C28), which as shown in Fig. 2 are very high in acacia mangium. Fig. 3 and Fig. 4 show
25 the break-down of the lipophilic components by the number of carbon atoms in both acacia species. These long chain elements in acacia, however, do not affect the dirt or deposition in the paper or tissue making process. The melting points of these long chain carbon fatty alcohols
30 are very high (more than 75°C, see Fig. 5) and were found to be an additional influence to adhesion problem on hot Yankee surface. Hence, it is important that the amount of long chain carbon components in the lipophilic part of the acacia pulp is controlled. The inventors have found that

by having a lipophilic content of less than or equal to 0.16% as DCM extractable gave the best adhesion force to the Yankee dryer surface, see Fig. 6. Hence, a target figure of a lipophilic level of less than or equal to 0.16% as DCM extractable was used to achieve the best acacia pulp grade for tissue production.

As shown above, the amount of long chain lipophilic carbon components in acacia mangium were about 17 times higher compared to those in acacia crassiparva. By knowing the amount of lipophilic contents in acacia mangium and acacia crassiparva, the resultant pulp mixture having less than or equal to 0.15% lipophilic contents can be obtained. Laboratory pulping results indicate that at <30% acacia mangium (and more than 70% acacia crassiparva), the pulp mixture had less than 0.18% lipophilic content as DCM extractable, see Fig. 7. The laboratory pulping was conducted with conventional cooking and washing (with room temperature tap water) done manually by hand at room temperature for every stage of the pulping process. When compared to the pulp mill pulp, with $\leq 35\%$ acacia mangium (and $\geq 65\%$ acacia crassiparva), the pulp mixture had less than or equal to 0.16% total lipophilic content, see Fig. 8. Due to the process used to obtain the pulp (laboratory pulping compared to pulp mill pulping in which laboratory washing was conducted with room temperature tap water while pulp mill process was carried out at an average temperature of 75°C with high pH at some points, leading to enhanced lipophilic removal in the pulp mill process), a higher lipophilic content was obtained in laboratory processed pulp.

Based on the above, a pulp mixture having less than or equal to 35% acacia mangium was selected for further evaluation (hereafter termed as Acacia XP pulp). This pulp mixture advantageously has good adhesion on Yankee dryer

even though the pulp was 100% acacia. Hence, this pulp overcomes a technical prejudice of the art in which the amount of acacia species present in the pulp was traditionally limited to a maximum of 35% due to the problems of poor adhesion and runnability when using a pulp having more than 35% acacia species. In order to reduce the amount of acacia species in the pulp so as to improve the adhesion to the Yankee dryer, traditional methods included the use of special adhesive chemicals or pre-treatment of the acacia pulp, which in turn, led to problems in the quality of the tissue and increased production costs. This example thus demonstrates that in comparison to traditional methods, a pulp having more than 35% acacia species can be easily obtained by using a mixture of two types of acacia species without any additional chemicals or pre-treatment processes. As the disclosed pulp contains 100% acacia species, the resultant tissue is softer with good tissue appearance.

Example 2

The Acacia XP pulp (having $\leq 35\%$ acacia mangium and $\geq 65\%$ acacia crassiparva) was compared to other types of pulp and were characterized by the adhesion force to Yankee dryer, pulp dryness, tissue tensile strength and tissue quality.

The Acacia XP pulp was found to have the best runnability in tissue making process with higher adhesion force to Yankee dryer, see Fig. 9, when compared to other types of pulps based on normal acacia (made from uncontrolled chip mixture with minimum acacia mangium content of 40% and some eucalyptus), mill A eucalyptus, mill F eucalyptus and mill S eucalyptus. Mill A eucalyptus, mill F eucalyptus and mill S eucalyptus were

obtained commercially from Arauco (of Chile), Fibria (of Brazil) and Suzano (of Brazil) respectively.

The pulp dryness of the various pulp samples was then investigated. By having $\leq 35\%$ acacia mangium in the Acacia XP pulp, the high fiber collapsibility of the acacia mangium in the Acacia XP pulp improved the pulp dryness before the Yankee dryer to 24.9% which is higher than the other pulp samples, see Fig. 10. This results in heat energy savings during tissue making while maintaining the improved adhesion force to the Yankee dryer surface.

By having $\leq 35\%$ acacia mangium and $\geq 65\%$ acacia crassiparva with milder pulping process, the best fiber characteristics are obtained which then yield high initial tensile and excellent strength.

Example 3

The Acacia XP pulp was then formed into tissue. The Acacia XP pulp may pass through an optional refiner before blending in a blending chest. The blended pulp then enters a pressure screen stage for further removal of impurities and dirt. After screening, the pulp enters a Headbox stage at a controlled furnish consistency before being injected to a forming board (or in a modern tissue machine, this forming board is replaced by a twin wire forming system) for water removal. After water is removed, the pulp web is pressed for further water removal. The web is then dried in Yankee Dryer. Pulp floating, sticking, and creeping behavior will determine the final tissue quality. The amount of lipophilic content in pulp plays a big role in this process. Adhesion and release agent chemical may be added in Yankee drier process to optimize tissue quality and also drying productivity. It is to be noted that tissue machine technology may be different and hence, the above description merely provides one way of forming the

tissue. Other methods as is known to a skilled person in the art may be utilized instead.

Acacia XP pulp required less than half or refining energy requirement as compared to that required for eucalyptus, see Fig. 11. This showed the high energy saving of electricity required for pulp refining process and indicated the potential reduction in softwood fiber consumption in tissue making process.

After Yankee dryer process, Acacia XP gave better tissue tensile index machine direction (MD) and cross direction (CD) values than normal acacia and eucalyptus (average) samples, see Fig. 12. This indicates that Acacia XP will give better runnability during tissue converting process (rolling, cutting and packaging). The tissue bulk property slightly increased for Acacia XP than normal acacia and eucalyptus, resulting in higher tissue bulk. This bulk mainly affected the packaging and transporting since higher bulk will give lesser number of tissue sheets in a certain volume of tissue packaging or rolls.

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Example 4

The final tissue formed from Acacia XP pulp was characterized in terms of tissue softness and opacity quality. From a consumer's point of view, tissue texture or softness and visual appearance are part of a consumer's expectations. Acacia XP gave the best tissue softness compared to other pulp; this was achieved through its distinct characteristics of fiber collapsibility and improved creeping quality after Yankee drying. The tissue opacity was also the highest among the tested pulp samples by its higher fiber population (fiber per grams) of Acacia XP, see Fig. 13. This will give better tissue visual appearance that is similar to cloth handkerchief, even at very thin or low gsm tissue. If necessary, some wet

strength agent may be added to the tissue for strength preservation at wet conditions while ensuring that the tissue can be disposed after usage without plugging the toilet system.

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Applications

The disclosed pulp fiber composition may be used to form paper products such as tissue. The formed tissue may have good tissue softness, opacity and strength. The disclosed pulp fiber composition may not require any enzymatic treatment to reduce the lipophilic content or increase the adhesion force to a Yankee dryer. While in general, special adhesive chemicals may not be required, a certain amount of these chemicals may still be required to form a film layer between the Yankee and tissue sheets.

It will be apparent that various other modifications and adaptations of the invention will be apparent to the person skilled in the art after reading the foregoing disclosure without departing from the spirit and scope of the invention and it is intended that all such modifications and adaptations come within the scope of the appended claims.

Claims

1. A pulp fiber composition comprising acacia mangium fibers and acacia crassiparva fibers.

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2. The pulp fiber composition as claimed in claim 1, wherein said acacia mangium fibers are present in said pulp fiber composition at a weight concentration of at most 35wt%.

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3. The pulp fiber composition as claimed in claim 1 or 2, wherein said acacia crassiparva fibers are present in said pulp fiber composition at a weight composition of at least 65 wt%.

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4. The pulp fiber composition as claimed in any one of the preceding claims, wherein said pulp fiber composition has a collapse index of less than 0.420.

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5. The pulp fiber composition as claimed in any one of the preceding claims, wherein said pulp fiber composition has a lipophilic content in the range of 0.05% to 0.15% (as extracted by dichloromethane).

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6. The pulp fiber composition as claimed in any one of the preceding claims, wherein said pulp fiber composition has a dryness of at least 24.2% or at least 24.5%.

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7. A method of producing a paper sheet comprising the step of drying a pulp fiber composition comprising acacia mangium fibers and acacia crassiparva fibers to form a dried paper sheet.

8. The method as claimed in claim 6, further comprising the step of creping said dried paper sheet to form creped paper sheet.

5 9. The method as claimed in claim 6 or 7, further comprising the step of processing said creped paper sheet to form a paper product.

10 10. A tissue sheet formed from a pulp fiber composition comprising acacia mangium fibers and acacia crassiparva fibers, having a tissue bulk property of at least 13 cm³/g.

15 11. The tissue sheet of claim 10, having a tissue tensile index cross direction of at least 7.5 Nm/g.

12. The tissue sheet of claim 10 or 11, having a tissue tensile index machine direction of at least 9 Nm/g.

20 13. The tissue sheet of any one of claims 10 to 12, having a tissue softness of at least 13.

25 14. The tissue sheet of any one of claims 10 to 13, having a tissue opacity of at least 56%, or at least 58%.