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(54) **TRANSLUCENT PAPER PRODUCTS**

(57) A translucent paper comprising a base paper layer, and optionally a coating layer adjacent to the base paper layer, wherein the base paper layer comprises a mixture of wood pulp fiber and microfibrillated cellulose, characterized in that the pulp fiber has a degree of Schopper-Riegler (SR) of more than or equal to 50 SR and that the microfibrillated cellulose is comprised in the mixture of pulp fiber and microfibrillated cellulose in an amount of 10 weight percent to about 50 weight percent, based on the weight of the mixture of pulp fiber and microfibrillated cellulose and wherein the mixture of pulp fiber and microfibrillated cellulose has a degree of Schopper-Riegler (SR) of between 65 SR and 95 SR, preferably of between 70 SR and 90 SR, as measured under ISO 5267-1.

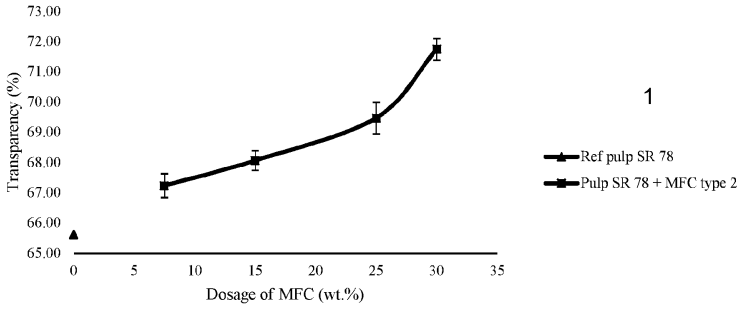

FIG. 1

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Description

TECHNICAL FIELD

[0001] The present invention relates to translucent paper, and a process for making a translucent paper.

PRIOR ART

[0002] In the field of packaging, especially in the field of food packaging, polymer films are used frequently because of their transparency and because of their barrier properties such as grease and oil barrier properties. The transparency of the polymer films is advantageous in that it enables the package to be partially transparent, so that the packaged food can be seen prior to purchase and unpacking. On the other hand, barrier properties prevent the contents of a packaging to exude or leak across the polymer film.

[0003] However, petrochemical products, such as polymers are not considered sustainable as they are not sourced from renewable base materials and there exists a trend to replace petrochemical polymers with renewable materials.

[0004] Glassine is a smooth and glossy paper that is air, water, and grease resistant to some extent. It is also translucent and manufactured by supercalendering: after pressing and drying, the paper web is passed through a stack of alternating steel- and fiber-covered rolls of the supercalender at the end of the paper machine so that the paper fibers flatten facing in the same direction. It is mostly used as release liner or as a wrapping paper for non-food applications, and generally has properties that are deemed insufficient for food packaging.

[0005] On the other hand, it is known that films of pure microfibrillated cellulose (MFC) can be produced and that they can be transparent and have good barrier properties. However, pure microfibrillated cellulose film cannot be reasonably manufactured on a paper machine without extensive hardware adjustments and additional machinery, because if the furnish comprising essentially only microfibrillated cellulose is deposited on the moving woven mesh of the paper machine to create a continuous web of microfibrillated cellulose, it is challenging to drain the furnish of its water because of the water retention associated with microfibrillated cellulose.

[0006] Further, it is known that refining a paper pulp into finer fibers can increase the transparency of paper products obtained from such paper pulp, but the technical reality in the paper mill is that the refiners, if any, used to refine wood pulp for use in the paper machine have a limited range when it comes to the degree of refining that they can produce. Thus, the paper mill is limited to process paper pulps within that range.

[0007] There exist therefore a need to provide a solution to the problem of manufacturing a paper product having sufficient transparency and/or translucency, while also having the required barrier properties for food packaging, on existing paper machines without the need of extensively refining paper pulp.

[0008] WO2011/068457A1 relates to a process for producing a paper or paperboard product, the process of which comprises the steps of providing a furnish comprising fibers, adding starch to the furnish, adding microfibrillated cellulose to the furnish, provide the furnish to a wire in order to form a web, wherein the starch and microfibrillated cellulose (MFC) is added separately to the furnish in an amount 2 to 15% by weight, and 1 to 15% by weigh, respectively. The MFC having more than 80 SR can be obtained before addition to the furnish by refining, enzymatically treating with endoglucanases, refining and microfluidizing bleached chemical hardwood pulp. Transparency was not addressed in WO2011/068457A1.

[0009] EP 2 861 800 B1 relates to a method for producing a release base paper, the method comprising the steps of manufacturing a release base paper with a paper-making furnish having a fiber freeness (Canadian Standard Freeness, CSF) of 180 ml or higher; pressing the furnish into a web of paper; drying the pressed web; and calendering the web to form a release base paper, wherein the release base paper is manufactured with nano-fibrillated cellulose added to the release base paper by means of at least one of: (i) incorporation into the furnish at a loading concentration of from about 10 to about 400 lbs/ton; and (ii) coating on the web of paper at a coating rate of about 0.2 to about 12 g/m.

[0010] WO2017/168353A1 relates to a process for the production of a film comprising the steps of: providing a suspension comprising microfibrillated cellulose, wherein the content of the microfibrillated cellulose of said suspension is at least 60 weight-% based on the weight of solids of the suspension; adding nanoparticles to said suspension to provide a mixture of said microfibrillated cellulose and said nanoparticles, wherein the amount of nanoparticles added is at least 1.0 kg on dry basis per ton of dry solids of the suspension; providing said mixture to a porous wire to form a web; and dewatering said web to form an intermediate thin substrate or film, and where the suspension may comprise a mixture of different types of fibers, such as microfibrillated cellulose, and an amount of other types of fiber, such as kraft fibers, fines, reinforcement fibers, synthetic fibers, dissolving pulp, TMP or CTMP, PGW, etc.

[0011] EP 2 122 053 B1 relates to a method for manufacturing a sheet of natural tracing paper having an opacity index of less than 40%, measured according to ISO 2469 standard, characterized in that it comprises the following successive steps of a. an enzyme preparation containing cellulases is reacted with an aqueous suspension of paper pulp, the fibrous composition of which comprises at least 50% by dry weight of virgin cellulosic fibers, b. after an enzymatic action time

on said pulp of at most 60 minutes, the enzymatic action of cellulases on said paper pulp is inhibited using a chemical inhibitor,c. the paper pulp obtained in step b) is mechanically refined to a Schopper-Riegler degree above 80, d. said refined pulp is drained on the wire cloth of a paper machine, e. the sheet thus formed is dried so as to obtain said sheet of tracing paper. EP 2 122 053 B1 is silent on microcellulose addition to the furnish.

SUMMARY OF THE INVENTION

[0012] It is a first object of the present invention to provide a translucent paper comprising a base paper layer, wherein the base paper layer comprises a mixture of pulp fiber and microfibrillated cellulose, characterized in that the pulp fiber has a degree of Schopper-Riegler (SR) of more than or equal to 50SR and that the microfibrillated cellulose is comprised in the mixture of pulp fiber and microfibrillated cellulose in an amount of 10 weight percent to about 50 weight percent, based on the weight of the mixture of pulp fiber and microfibrillated cellulose and wherein the mixture of pulp fiber and microfibrillated cellulose has a degree of Schopper-Riegler (SR) of between 50 SR and 95 SR, preferably of between 70 SR and 90 SR, as measured under ISO 5267-1.

[0013] It is a further object of the present invention to provide a packaging item comprising a translucent paper according to the first object of the present invention, and preferably comprising a window element made of such a translucent paper.

[0014] It is yet a further object of the present invention to provide a process for making a translucent paper, preferably a translucent paper according to the first object of the present invention, comprising a base paper layer on a paper machine, comprising a step of, in the wet end of the paper machine, forming a wet base paper layer from a furnish comprising a mixture of wood pulp fiber and microfibrillated cellulose, characterised in that the pulp fiber of the furnish has a degree of Schopper-Riegler (SR) of more than 50 SR and that the microfibrillated cellulose of the furnish is comprised in an amount of about 10 weight percent to about 50 weight percent, based on the weight of wood pulp fiber and microfibrillated cellulose in the mixture of wood pulp fiber and microfibrillated cellulose, and wherein the mixture of pulp fiber and microfibrillated cellulose of the furnish has a degree of Schopper-Riegler (SR) of between 65 SR and 95 SR, preferably of between 70 SR and 90 SR, as measured under ISO 5267-1, and a step of drying the wet base paper layer to form a dry base paper layer.

[0015] Further embodiments of the invention are laid down in the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Preferred embodiments of the invention are described in the following with reference to the drawings, which are for the purpose of illustrating the present preferred embodiments of the invention and not for the purpose of limiting the same. In the drawings,

Fig. 1 shows the effect of MFC dosage in paper transparency, and further shows that the addition of MFC enhances transparency and that with increasing amounts of MFC, the enhancement in transparency increases.

Fig. 2 shows images of paper manufactured from refined pulp furnish without MFC added (sample C) and from paper manufactured from refined pulp furnish with 10 wt. % MFC loading (sample D). Homogeneity of formation is enhanced for sample D.

Fig. 3 shows the effect of MFC dosage in grease barrier according to SCAN P-37:77, and further shows that the addition of MFC enhances grease barrier and that with increasing amounts of MFC, the enhancement in grease barrier increases, especially when the amount of MFC exceeds 10 wt%.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0017] The term "translucent paper" in the context of the present invention relates to paper having a transmittance of at least 50%, when measured on three samples according to DIN 53147 measured on a Technidyne ColourTouch PC using light source C.

[0018] For the purposes of the present invention, the term "Schopper-Riegler" or "SR" refers to the degree determined according ISO 5267-1.

[0019] It is a first object of the present invention to provide a translucent paper comprising a base paper layer, wherein the base paper layer comprises a mixture of pulp fiber and microfibrillated cellulose, characterized in that the pulp fiber has a degree of Schopper-Riegler (SR) of more than or equal to 50SR and that the microfibrillated cellulose is comprised in the mixture of pulp fiber and microfibrillated cellulose in an amount of 10 weight percent to about 50 weight percent, based on the weight of the mixture of pulp fiber and microfibrillated cellulose and wherein the mixture of pulp fiber and microfibrillated cellulose has a degree of Schopper-Riegler (SR) of between 65 SR and 95 SR, preferably of between 70 SR and 90 SR, as measured under ISO 5267-1.

[0020] It should be noted, that in conventional papermaking, pulp fibers having high Schopper-Riegler values of are

not habitually used, because of the large energy consumption to refine the pulp fibers to such SR values. In this invention, the pulp refined to high Schopper-Riegler values is preferable as this leads to the manufacturing of paper with a lower opacity.

[0021] Conventionally, in most of the prior art, the microfibrillated cellulose is often added into the furnish to increase the strength and mechanical properties of paper. It should also be noted that adding higher amounts of microfibrillated cellulose into the furnish makes the process of dewatering more challenging.

[0022] In the present invention, the paper with high translucency can be obtained by mixing medium to highly refined pulp fibers with SR values equal or higher than 50, with the microfibrillated cellulose. To obtain highly translucent paper, the mixture of the pulp fiber and the microfibrillated cellulose has a Schopper-Riegler (SR) between 65 and 95 SR.

[0023] The translucent paper according to the invention is characterized with the transmittance of 60% of more, preferably of 65% or more, more preferably of 70% or more, according to DIN 53147 when measured on a Technidyne ColourTouch PC using light source C.

[0024] The pulp fiber comprised in the base paper layer of the translucent paper according to the present invention may be from any commercially available wood pulp, such as for example mechanical wood pulp, thermomechanical wood pulp, or chemithermomechanical wood pulp, chemical wood pulp, recycled wood pulp, or organosolv wood pulp. Examples of such pulps are sulfite pulp, kraft pulp or soda pulp. The wood pulp fiber may be partly or fully replaced by other plant pulps sourced from non-woody plants such as from bamboo, bagasse, kenaf, coconut, straw, grass, and others, having the same degree of Schopper-Riegler (SR).

[0025] In one of the preferred embodiments, the wood pulp fiber is chemical wood pulp fiber, such as kraft or sulphite wood pulp fiber, and preferably is bleached chemical wood pulp fiber.

[0026] The pulp fiber comprised in the base paper layer of the translucent paper according to the present invention may be hardwood pulp such as from acacia, aspen, birch, eucalyptus, maple, pacific albus or rubber tree, and may be softwood pulp such as from pine or spruce.

[0027] In a preferred embodiment of the translucent paper according to the present invention, the wood pulp fiber of the base paper layer may be a mixture of hardwood pulp fiber and softwood pulp fiber. The addition of softwood contributes positively to the strength of the paper.

[0028] In a preferred embodiment of the translucent paper according to the present invention, the wood pulp fiber of the base paper layer may be a mixture of hardwood pulp fiber and softwood pulp fiber, wherein the hardwood pulp fiber is comprised in the mixture of hardwood pulp fiber and softwood pulp fiber in an amount of 50 weight percent, or more, preferably of 75 weight percent or more.

[0029] In a preferred embodiment of the translucent paper according to the present invention, the wood pulp fiber of the base paper layer may be a mixture of hardwood pulp fiber and softwood pulp fiber, wherein the softwood pulp fiber in an amount of 50 weight percent, or less, preferably of 25 weight percent or less.

[0030] In a preferred embodiment, the average fiber length of pulp fibers is between 900 to 1400 micrometers, according to ISO 16065, preferably between 900 and 1100 micrometers. In one of the preferred embodiments, the average fiber length before refining for the mixture of 80% of hardwood and 20% of softwood is between 1000 and 1400 micrometers. After the refining of that pulp to SR>50 the fiber length is between 900 and 1100 micrometers. In a preferred embodiment of the translucent paper according to the present invention, the wood pulp fiber of the base paper layer may be a bleached wood pulp, such as for example beached chemithermomechanical pulp (BCTMP), southern or northern bleached soft-wood kraft pulp (SBSK/NBSK).

[0031] The base paper layer of the translucent paper according to the present invention may further comprise, beyond wood pulp fiber and microfibrillated cellulose, other materials that are commonly used in papermaking, such as for example fillers, such as calcium carbonate, clay or kaolin, sizing agents such as starch, in particular cationic starch, or rosin. Further wet end additives include defoaming agents, biocidal agents, and dewatering aids.

[0032] In a preferred embodiment of the translucent paper according to the present invention, the base paper layer does not comprise fillers such as calcium carbonate, clay or kaolin, since such filler increase opacity, and reduce transparency.

[0033] In a preferred embodiment of the translucent paper according to the present invention, the translucent paper further comprises carboxymethyl cellulose.

[0034] The microfibrillated cellulose comprised in the base paper layer of the translucent paper according to the present invention may be obtained from any commercially available pulp fiber source, such as for example from wood pulp, and in particular from hardwood pulp. However, microfibrillated cellulose may also be sourced from bacteria. The term "microfibrillated cellulose" is a term well-known in the field of paper engineering. Preferably, the microfibrillated cellulose comprised in the base paper layer of the translucent paper according to the present invention has a degree of Schopper-Riegler of at least 95SR, and more preferably of more than 100SR.

[0035] The wood pulp fiber comprised in the base paper layer of the translucent paper according to the present invention has a degree of Schopper-Riegler (SR) of more than 50SR, preferably of more than 65 SR, more preferably of more than 70 SR.

[0036] It is understood that the wood pulp fiber in the base paper of the translucent paper according to the present invention has a degree of Schopper-Riegler (SR) of more than 50SR, preferably of more than 65 SR, more preferably of more than 70 SR, with the proviso that the degree of Schopper-Riegler (SR) of the wood pulp fiber of the mixture of wood pulp fiber and microfibrillated cellulose is smaller than the degree of Schopper-Riegler (SR) of the mixture of wood pulp fiber and microfibrillated cellulose.

[0037] In a preferred embodiment of the translucent paper according to the present invention, the wood pulp fiber of the base paper layer may have a degree of Schopper-Riegler (SR) of between 50 to about 95, preferably of 50 to about 90, more preferably of 65 to 90 and even more preferably of 70 to about 90.

[0038] In a much preferred embodiment of the translucent paper according to the present invention, the wood pulp fiber of the base paper layer may have a degree of Schopper-Riegler (SR) of between 73 to 83.

[0039] The translucent paper has a preferably density of more than 1.1 g cm^{-3}, preferably of more than 1.2 g cm^{-3}, as measured according to ISO 534.

[0040] In the translucent paper according to the present invention, the wood pulp fiber and microfibrillated cellulose are combined in the form of a mixture of wood pulp fiber and microfibrillated cellulose, and in said mixture of pulp fiber and microfibrillated cellulose, the microfibrillated cellulose is comprised in an amount of 10 weight percent to about 50 weight percent, based on the combined weight of the mixture of pulp fiber and microfibrillated cellulose of the mixture.

[0041] In the translucent paper according to the present invention, the mixture of wood pulp fiber and microfibrillated cellulose comprises at least 40% fines. Fines are pulp fibers having have a fibre length of less than 200 micrometers, as measured according to ISO 16065.

[0042] In a preferred embodiment of the translucent paper according to the present invention, the wood pulp fiber and microfibrillated cellulose are combined in the form of a mixture of wood pulp fiber and microfibrillated cellulose, and in said mixture of pulp fiber and microfibrillated cellulose, the microfibrillated cellulose is comprised in an amount of 10 weight percent to about 30 weight percent, more preferably in an amount of 10 weight percent to about 15 weight percent, based on the combined weight of the mixture of pulp fiber and microfibrillated cellulose of the mixture.

[0043] In the translucent paper according to the present invention, the wood pulp fiber and microfibrillated cellulose are combined in the form of a mixture of wood pulp fiber and microfibrillated cellulose, mixture of pulp fiber and microfibrillated cellulose has a degree of Schopper-Riegler (SR) of between 65 SR and 95 SR, preferably of between 70 SR and 90 SR, as measured under ISO 5267-1.

[0044] It is understood that upon mixing the wood pulp fiber and microfibrillated cellulose, the overall degree of Schopper-Riegler (SR) of the mixture of wood pulp fiber and the microfibrillated cellulose will be increased by the addition of microfibrillated cellulose, when compared to the degree of Schopper-Riegler (SR) of the wood pulp fiber alone, which has generally a degree of Schopper-Riegler (SR) of more than 50SR, but of less than the overall degree of Schopper-Riegler (SR) of the mixture of wood pulp fiber and the microfibrillated cellulose. In a preferred embodiment of the translucent paper according to the present invention, the mixture of wood pulp fiber and the microfibrillated cellulose is free of enzymes.

[0045] The grammage of the base paper layer is preferably between 25 and 100 gsm, preferably between 30 and 60 gsm.

[0046] The translucent paper according to the present invention may comprise a coating layer to add a desired functionality to the base paper layer. For example, the translucent paper according to the present invention may comprise a coating layer comprising a polymer or copolymer of vinyl alcohol, preferably in combination with a carboxymethyl cellulose. In a yet more preferred embodiment of the translucent paper according to the present invention, said coating layer may have a areal weight of about from 0.5 gsm to 20 gsm, or 0.5 gsm to about 1.5 gsm.

[0047] It is a further object of the present invention to provide a packaging item comprising a translucent paper according to the first object of the present invention.

[0048] The packaging item may be any suitable type of packaging such as for example a box, envelope, or bag. In particular, the packaging item may be a food packaging such as a food wrapping, food tray, food box, food bag, separating sheet for cheese or cured meat slices, liquid cup or food container.

[0049] In a preferred embodiment of the packaging item or food packaging item according to the present invention, the packaging item comprises a window element made of such a translucent paper or the packaging item or food packaging item according to the present invention may be formed entirely from such a translucent paper.

[0050] It is yet a further object of the present invention to provide a process for making a translucent paper, preferably a translucent paper according to the first object of the present invention, comprising a base paper layer on a paper machine, comprising a step of, in the wet end of the paper machine, forming a wet base paper layer from a furnish comprising a mixture of wood pulp fiber and microfibrillated cellulose, characterised in that the pulp fiber of the furnish has a degree of Schopper-Riegler (SR) of more than 50 SR and that the microfibrillated cellulose of the furnish is comprised in an amount of about 10 weight percent to about 50 weight percent, based on the weight of wood pulp fiber and microfibrillated cellulose in the mixture of wood pulp fiber and microfibrillated cellulose, and wherein the mixture of pulp fiber and microfibrillated cellulose of the furnish has a degree of Schopper-Riegler (SR) of between 65 SR and 95

SR, preferably of between 70 SR and 90 SR, as measured under ISO 5267-1, and a step of drying the wet base paper layer to form a dry base paper layer.

[0051] In a preferred embodiment of the process for making a translucent paper, the process further comprises the step of rewetting the dry base paper layer to form a rewetted base paper layer, the step of keeping the rewetted base paper wet, and the step of (super) calendaring.

[0052] In a preferred embodiment of the process for making a translucent paper, in the step of rewetting, the rewetted base paper layer has a water content of about from 10 weight percent to about 30 weight percent, and more preferably of from 15 to 25 weight percent, and even more preferred of from 18 to 22 weight percent, based on weight of the rewetted base paper layer.

[0053] In a preferred embodiment of the process for making a translucent paper, in the step of keeping the rewetted base paper wet, the base paper layer is kept wet for at least 2 hours, preferably for at least 4 hours, or for 4 to 8 hours, more preferably for at least 6 hours, or for 6 to 8 hours, i.e. for the time between rewetting and (super)calendaring steps.

[0054] In a preferred embodiment of the process for making a translucent paper, the rewetted and (super)calendared base paper layer is dried again to yield the final translucent paper.

[0055] In a preferred embodiment of the process for making a translucent paper, in the step of (super)calendaring, the nip pressure of the (super)calendar is of from 0.00028 kN/mm^2 to 0.0012 kN/mm^2 and the temperature of the (super)calendar of at least 90 °C, and preferably of at least 100°C. (Super)calendaring allows to densify the rewetted base paper layer and leads to a translucent paper having a higher transmittance according to DIN 53147. It was found that when a rewetted base paper layer is supercalendared, an increase in transmittance of 25 to 35% was achieved as compared to (super)calendaring the base paper layer without rewetting, thus significantly increasing the transparency.

EXAMPLES

Example 1. Different pulp recipes affecting paper transparency. Effect of calendering in increasing paper density and paper transparency

[0056] Example 1 shows different pulp mixture recipes (Table 1) that were used for the manufacture of translucent paper and illustrates how the degree of pulp refining, % fines and %fibril area, and the amount of MFC can influence paper properties such as density and transparency and also shows the effect of calendaring on one hand increasing the density and on the other hand transparency of paper (Table 2).

Table 1. List of pulp mixtures used to make paper. Each pulp mixture has a distinct Schopper-Riegler (SR) value and distinct fiber morphology.

Sample ID	Sample description	SR[1]	% fibril area	% fines[2]
A	Furnish refined to 180 kWh/t	50	4.5	35
B	Furnish refined to 180 kWh/t + 30 wt. % MFC	74	6	40
C	Furnish refined to 320 kWh/t	78	7	40
D	Furnish refined to 320 kWh/t +	83	9	41
	10 wt.% MFC			
[1]Schopper-Riegler (SR) according to ISO 5267-1 [2]% fines according to ISO 16065				

Table 2. Apparent sheet density, Bendtsen air permeability and transparency before and after calendaring of papers produced from different pulp furnishes

Sample ID	Properties before calendering			Properties after calendering	
	Density[3] (gcm^{-3})	Bendtsen air permeability[4] (mL/min)	Transparency[5] (%)	Density[3] (gcm^{-3})	Transparency[5] (%)
A	0.68	4.860	48	1.07	62
B	0.70	0.276	52	1.10	68
C	0.71	-	54	1.14	70

(continued)

Sample ID	Properties before calendering			Properties after calendering	
	Density[3] (gcm^{-3})	Bendtsen air permeability[4] (mL/min)	Transparency[5] (%)	Density[3] (gcm^{-3})	Transparency[5] (%)
D	0.71	0.265*	60	1.20	75

*Device detection limit
[3]Apparent sheet density is determined according to ISO 534
[4]Bendtsen air permeability is determined according to ISO 5636-3
[5]Paper transmittance is determined according to DIN 53147

[0057] Sample A is a pulp mixture consisting of a mix of softwood and hardwood pulp that was refined to a specific refining energy of 180 kWh/t to achieve a SR of about 50. The hardwood constituted the larger part by weight of the mixture. Paper produced from this furnish had a density of 0.68 g/cm^3 and a transmittance of 48%. After post-processing of this paper by rewetting, aging and supercalendering, the density of this paper increased to 1.09 g/cm^3 and transmittance to 62%.

[0058] It was found that paper with a higher amount of fine fibrillated material leads to a denser paper with increased transparency. Further refining a pulp, as in the case of Sample C, when compared to sample A, increases the amount of fines and fibrillated material (higher fibril area values), which increases the percentage of fine material that can be retained in the paper and therefore leading to higher paper density and transparency. On the other hand, the addition of microfibrillated cellulose to a refined pulp increases the amount of fibrillated material, amount of fines as well as the percentage of fines retained in the base paper without the need to further refine the pulp mixture. This again has an effect in increasing paper density, which in turn decreases air permeability and increases paper transparency. That is observed for sample D, which corresponds to a a fibrous mixture of 90 wt.% furnish C refined to a SR of 78 + 10 wt.% MFC. The mixture of both components has a SR of 83. The addition of MFC also leads to an increase in density and therefore in transparency.

Example 2. Addition of MFC leading to improved paper formation

[0059] Example 2 shows the effect of MFC in improving paper formation. 50 gsm papers made from fibre sample C (100 wt.% of pulp refined to 320 kWh/t) and from fiber sample D (90 wt.% of pulp refined to 320 kWh/t + 10 wt.% MFC) were compared in terms of their formation index. Table 3 shows that the addition of MFC leads to an improvement in formation as well as a paper with less quantity and smaller size of the fiber flocs. This is thought to be due to the negative surface charge of MFC, which makes it act as a dispersing agent and thus contributes to a better dispersion of the larger and less refined pulp fibers. A better formation seems to lead to increased paper density and therefore increased paper transparency.

[0060] Figure 2 shows images of paper manufactured from refined pulp furnish without MFC added (sample C) and from paper manufactured from refined pulp furnish with 10 wt.% MFC loading (sample D).

Example 3. Effect of MFC in increasing paper transparency

[0061] Example 3 shows the effect of adding different amounts of MFC to less refined pulp fibers in paper transparency.

[0062] A pulp mixture consisting of HW and SW was refined using a lab scale refiner to achieve a SR 78. Different amounts (7.5, 15, 25, 30 wt%) of MFC were added to the refined pulp and paper with a grammage of 50 gsm was manufactured from these mixtures using a pilot scale paper machine. Figure 1 shows that paper transparency increases with higher amounts of MFC.

Example 4. Addition of MFC leading to increased grease resistance

[0063] Example 4 shows the effect of adding MFC to less refined pulp fibers in increasing paper grease resistance. The same pulp mixture consisting of HW and SW refined using a lab scale refiner to achieve a SR 78 as in Example 3 was used. Different amounts of MFC (7.5, 15, 25, 30 wt%) were added to the refined pulp and uncoated paper with a grammage of 50 gsm was manufactured from these mixtures using a pilot scale paper machine. Figure 3 shows that the addition of MFC leads to an increase in grease resistance.

[0064] As can be seen from Fig.1 and 3, the addition of MFC to less refined pulp mixtures can lead to the same transparency in paper as can be achieved with more refined pulp mixtures, while at the same increasing the grease

resistance of such papers.

LIST OF REFERENCE SIGNS

[0065] none

Claims

1. A translucent paper comprising a base paper layer, wherein the base paper layer comprises a mixture of pulp fiber and microfibrillated cellulose,
characterized in that

the pulp fiber has a degree of Schopper-Riegler (SR) of more than or equal to 50 SR,
and that the microfibrillated cellulose is comprised in the mixture of pulp fiber and microfibrillated cellulose in an amount of 10 weight percent to about 50 weight percent, based on the weight of the mixture of pulp fiber and microfibrillated cellulose,
and wherein the mixture of pulp fiber and microfibrillated cellulose has a degree of Schopper-Riegler (SR) of between 65 SR and 95 SR, preferably of between 70 SR and 90 SR, measured according ISO 5267-1.

2. The translucent paper according to claim 1, wherein the translucent paper has a transmittance of 60% or more, preferably of 65% or more, more preferably of 70% or more, according to DIN 53147.

3. The translucent paper according to any one of the preceding claims, wherein the microfibrillated cellulose is comprised in the mixture of pulp fiber and microfibrillated cellulose in an amount of 10 weight percent to about 30 weight percent, preferably in an amount of 10 weight percent to about 15 weight percent, based on the weight of the mixture of pulp fiber and microfibrillated cellulose.

4. The translucent paper according to any one of the preceding claims, wherein the wood pulp fiber comprises, or consists of, a mixture of hardwood pulp fiber and softwood pulp fiber, wherein preferably the hardwood pulp fiber is comprised in the mixture of hardwood pulp fiber and softwood pulp fiber in an amount of 50 weight percent, or more, preferably of 75 weight percent or more, and/or the softwood pulp fiber is comprised in the mixture of hardwood pulp fiber and softwood pulp fiber in an amount of 50 weight percent, or less, preferably of 25 weight percent or less.

5. The translucent paper according to any one of the preceding claims, wherein the average fiber length of pulp fibers is between 900 to 1400 micrometers, according to ISO 16065, preferably between 900 and 1100 micrometers.

6. The translucent paper according to any one of the preceding claims, wherein the mixture of wood pulp and microfibrillated cellulose comprises at least 40 weight percent of fines.

7. The translucent paper according to any one of the preceding claims, wherein the base paper layer comprises a coating layer adjacent to the base paper layer, the coating layer preferably comprising a polymeric coating, preferably comprising a polymer or copolymer of vinyl alcohol, preferably in combination with a carboxymethyl cellulose.

8. The translucent paper according to any one of the preceding claims, wherein the grammage of the base paper layer is between 25 and 100 gsm, preferably between 30 and 60 gsm, and/or wherein the grammage of the coating layer is between 0.5 and 20 gsm.

9. The translucent paper according to any one of the preceding claims, wherein the pulp fiber has a degree of Schopper-Riegler (SR) of between 50 to 90 SR, more preferably of 73 to 83 SR.

10. The translucent paper according to any one of the preceding claims, wherein the translucent paper has a density of more than 1.1 g cm^{-3}, preferably of more than 1.2 g cm^{-3}, as measured according to ISO 534.

11. The translucent paper according to any one of the preceding claims, wherein the pulp fiber is chemical wood pulp fiber, such as kraft or sulphite wood pulp fiber, and preferably is bleached chemical wood pulp fiber.

12. A packaging item comprising a translucent paper according to any one of the preceding claims, and preferably

comprising a window element made of a translucent paper according to any one of the preceding claims.

13. A process for making a translucent paper on a paper machine, comprising a step of, in the wet end of the paper machine, forming a wet base paper layer from a furnish comprising a mixture of pulp fiber and microfibrillated cellulose, **characterised in that** the pulp fiber of the furnish has a degree of Schopper-Riegler (SR) of more than 50 SR

and that the microfibrillated cellulose of the furnish is comprised in an amount of about 10 weight percent to about 50 weight percent, based on the weight of pulp fiber and microfibrillated cellulose in the mixture of pulp fiber and microfibrillated cellulose,
and wherein the mixture of pulp fiber and microfibrillated cellulose of the furnish has a degree of Schopper-Riegler (SR) of between 65 SR and 95 SR, preferably of between 70 SR and 90 SR, as measured under ISO 5267-1,
and a step of drying the wet base paper layer to form a dry base paper layer.

14. The process for making a translucent paper on a paper machine according to claim 13, wherein it further comprises the step of rewetting the dry base paper layer to form a rewetted base paper layer, the step of keeping the rewetted base paper layer wet, and the step of (super)calendaring the rewetted base paper layer, and optionally redrying the rewetted base paper layer.

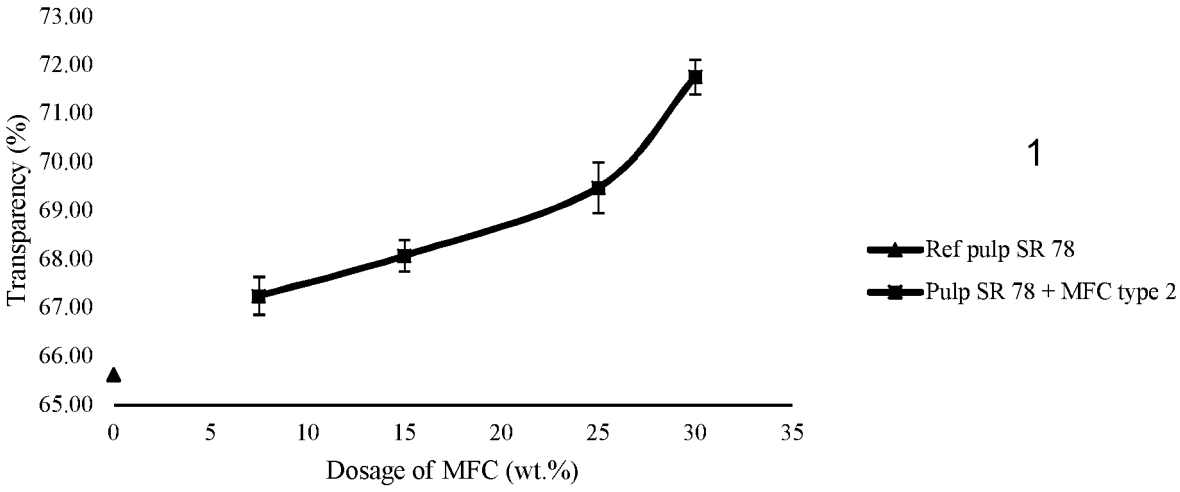
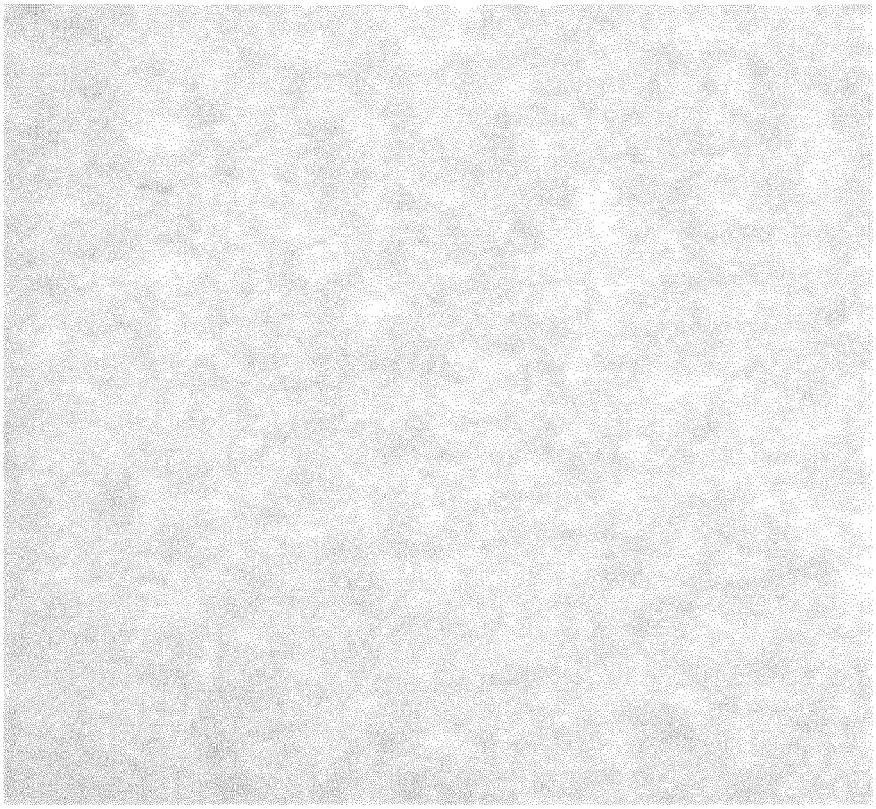

73.00
72.00
71.00
70.00
69.00
68.00
67.00
66.00
65.00
Transparency (%)
0
5
10
15
20
25
30
35
Dosage of MFC (wt.%)
1
Ref pulp SR 78
Pulp SR 78 + MFC type 2

FIG. 1

C



D

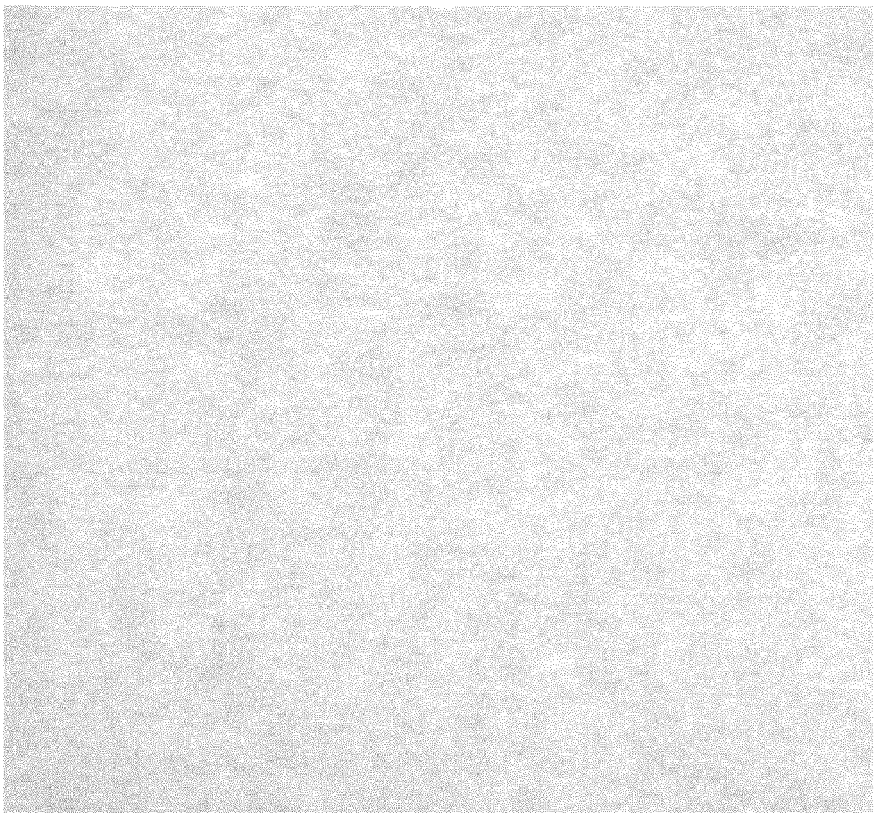


FIG. 2

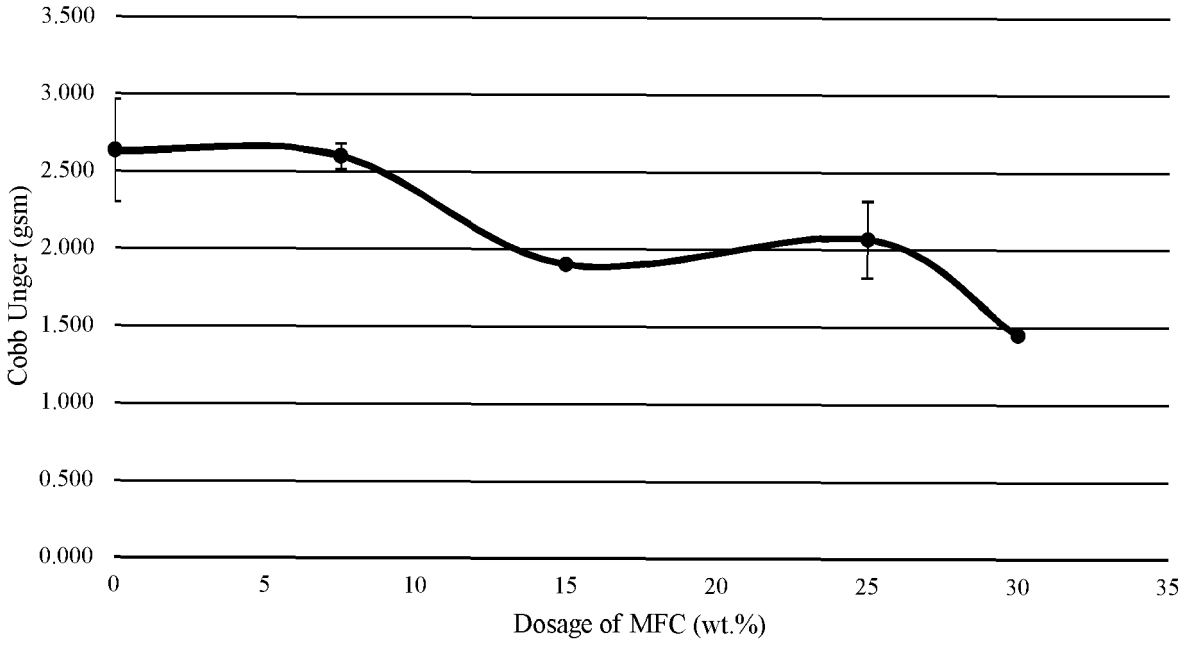

3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
Cobb Unger (gsm)
0
5
10
15
20
25
30
35
Dosage of MFC (wt.%)

FIG. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 22 18 5880

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2014/147295 A1 (AHLSTROEM OY [FI]) 25 September 2014 (2014-09-25) * claims 1-16 * * table 6 * * paragraph [0031] - paragraph [0038] * * paragraph [0092] *	1-14	INV. D21H11/18 D21H19/60 D21H21/16 D21H25/00 D21H27/06 D21H27/10
X,D	EP 2 861 800 B1 (UNIV MAINE SYSTEM [US]; STIRLING CONSULTING INC [US]) 15 February 2017 (2017-02-15) * claims 1-14 * * paragraph [0052]; figure 6 * * paragraphs [0012], [0013], [0043], [0050] *	1,6,13	
X	WO 2021/224839 A1 (STORA ENSO OYJ [FI]) 11 November 2021 (2021-11-11) * page 4, line 16 - line 29 * * page 13, line 5 - line 7 * * example 1 *	1,12,13	
			TECHNICAL FIELDS SEARCHED (IPC)
A	JP 2011 074535 A (JUJO PAPER CO LTD) 14 April 2011 (2011-04-14) * claims 1-4 *	1-14	D21H
A	US 2003/226656 A1 (HARADA JUNJI [JP] ET AL) 11 December 2003 (2003-12-11) * paragraph [0060]; examples 1-3 *	1-14	
A	US 2022/153477 A1 (GIUSTI STEFANO [IT] ET AL) 19 May 2022 (2022-05-19) * claims 1-18 *	1-14	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	21 December 2022	Billet, Aina

CATEGORY OF CITED DOCUMENTS

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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21-12-2022

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2014147295 A1	25-09-2014	CA 2900723 A1	25-09-2014
		DK 2956582 T3	17-10-2016
		EP 2956582 A1	23-12-2015
		ES 2593680 T3	12-12-2016
		FR 3003581 A1	26-09-2014
		PL 2956582 T3	31-08-2017
		US 2016016717 A1	21-01-2016
		WO 2014147295 A1	25-09-2014
EP 2861800 B1	15-02-2017	CA 2876083 A1	19-12-2013
		EP 2861800 A1	22-04-2015
		ES 2625421 T3	19-07-2017
		HU E032595 T2	30-10-2017
		PL 2861800 T3	29-09-2017
		US 2015125658 A1	07-05-2015
		WO 2013188739 A1	19-12-2013
WO 2021224839 A1	11-11-2021	CA 3180353 A1	11-11-2021
		SE 2050524 A1	08-11-2021
		WO 2021224839 A1	11-11-2021
JP 2011074535 A	14-04-2011	NONE	
US 2003226656 A1	11-12-2003	AU 2002304108 B2	22-04-2004
		CN 1463315 A	24-12-2003
		CN 1661160 A	31-08-2005
		EP 1403430 A1	31-03-2004
		EP 2312051 A2	20-04-2011
		JP 4252892 B2	08-04-2009
		JP WO2002099193 A1	16-09-2004
		KR 20030042442 A	28-05-2003
		US 2003226656 A1	11-12-2003
		US 2013233529 A1	12-09-2013
		WO 02099193 A1	12-12-2002
US 2022153477 A1	19-05-2022	AU 2020224404 A1	02-09-2021
		CN 114127363 A	01-03-2022
		EP 3927887 A1	29-12-2021
		US 2022153477 A1	19-05-2022

EPO FORM P0459

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2011068457 A1 **[0008]**
- EP 2861800 B1 **[0009]**
- WO 2017168353 A1 **[0010]**
- EP 2122053 B1 **[0011]**