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(54) **PAPERBOARD COMPRISING RECYCLED FIBRES**

KARTON MIT RECYCELTEN FASERN

CARTON COMPRENANT DES FIBRES RECYCLÉES

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Description

TECHNICAL FIELD

5 **[0001]** The present disclosure relates to the field of paperboard and production thereof.

BACKGROUND

10 **[0002]** Traditionally, only virgin pulps have been used to form high-quality paperboard. In case of a multi-layered paperboard of at least three layers, which is a common type of paperboard in Europe, chemical pulps, predominantly kraft pulps, are typically used for the outer layers, while a mechanical pulp in combination with a chemical pulp is often used for the middle layer(s). Further, broke pulp, which is inevitably generated in paperboard production, is typically included in the formation of paperboard.

15 **SUMMARY**

[0003] The objective of the present disclosure is to include recycled fibres in paperboard while maintaining or even improving properties characteristic of high-quality paperboard.

20 **[0004]** Accordingly, there is provided a method of producing a paperboard comprising a top layer, a back layer and a middle layer, said method comprising the steps of:

- forming a middle layer furnish comprising an old corrugated container (OCC) pulp, a chemithermomechanical pulp (CTMP) and broke pulp; and
- forming said middle layer from said middle layer furnish,

25 wherein, in the middle layer furnish, the amount of OCC pulp is higher than the amount of CTMP, which is higher than the amount of broke pulp as per dry weight and wherein the combined amount of OCC pulp, CTMP and broke pulp constitutes at least 88% as per dry weight of the middle layer furnish
30 and wherein the OCC pulp constitutes more than 35% by dry weight of the middle layer furnish, the CTMP constitutes at least 25% by dry weight of the middle layer furnish and the broke pulp constitutes at least 13% by dry weight of the middle layer furnish.

[0005] Further, there is provided a paperboard comprising a top layer, a back layer and a middle layer,

35 wherein the middle layer comprises a OCC pulp, a chemithermomechanical pulp (CTMP) and broke pulp and wherein, in the middle layer, the amount of OCC pulp is higher than the amount of CTMP, which is higher than the amount of broke pulp as per dry weight and wherein the combined amounts of OCC pulp, CTMP and broke pulp constitutes at least 88% as per dry weight of the middle layer and
40 wherein the OCC pulp constitutes more than 35% by dry weight of the middle layer, the CTMP constitutes at least 25% by dry weight of the middle layer and the broke pulp constitutes at least 13% by dry weight of the middle layer.

[0006] As shown in the Examples section below, the method and paperboard recipe defined above enables the formation of a paperboard of equal bending resistance as that of a prior art paperboard (formed from virgin pulp only) at a lower total fibre consumption. In other words, the present disclosure not only enables the introduction of a significant
45 portion of recycled fibres in high-quality paperboard without sacrificing the bending resistance of the board, but it also enables a reduction of the amount of fibres needed to reach the desired bending resistance.

DETAILED DESCRIPTION

50 **[0007]** As a first aspect of the present disclosure, there is provided a method of producing a paperboard comprising a top layer, a back layer and a middle layer. As understood by the skilled person, the middle layer is arranged between the top layer and the back layer. The top layer may be intended for printing. Hence, the top layer may be provided with a pigment-based coating, which may consist of several sublayers applied in consecutive coating steps. The top layer may be bleached.

55 **[0008]** The method comprises the steps of:

- forming a middle layer furnish comprising an old corrugated container (OCC) pulp, a chemithermomechanical pulp (CTMP) and broke pulp; and

- forming said middle layer from said middle layer furnish.

[0009] An OCC pulp is formed by pulping and cleaning OCC, which is a well-known type of recycled material in the field of paper and paperboard.

[0010] In the middle layer furnish, the amount of OCC pulp is higher than the amount of CTMP (as per dry weight). In turn, the amount of CTMP is higher than the amount of broke pulp (as per dry weight). Further, the combined amount of OCC pulp, CTMP and broke pulp constitutes at least 88% as per dry weight of the middle layer furnish. In one embodiment, said combined amount constitutes at least 90%, such as at least 92%, as per dry weight of the middle layer furnish.

[0011] The OCC pulp constitutes more than 35% by dry weight of the middle layer furnish, such as at least 40% by dry weight of the middle layer furnish. An upper limit may be 55%.

[0012] The CTMP constitutes at least 25% by dry weight of the middle layer furnish, such as at least 30% by dry weight of the middle layer furnish.

[0013] Broke pulp constitutes at least 13% by dry weight of the middle layer furnish, such as at least 15% by dry weight of the middle layer furnish.

[0014] The middle layer furnish may further comprise one or more strength agents, such as starch (preferably cationic starch), carboxymethyl cellulose (CMC) and/or microfibrillated cellulose (MFC).

[0015] In one embodiment, the paperboard is a liquid packaging board (LPB). In such an embodiment, each of the (fibre-based) layers of the paperboard comprise hydrophobic size. The hydrophobic size is preferably selected from the group consisting of ASA, AKD, rosin size and combinations thereof.

[0016] The amount of hydrophobic size in the middle layer furnish may for example be at least 2.5 kg/tonne dry fibre, such as at least 3.0 kg/tonne dry fibre. The amount of hydrophobic size in the outer layers is preferably lower than the amount of hydrophobic size in the middle layer.

[0017] In a preferred embodiment, the hydrophobic size in each of the furnishes of the method of the first aspect is a combination of AKD and rosin size. When such a combination is used, the headbox pH of the furnishes is preferably in the range of 6.6-7.2, such as 6.9-7.1.

[0018] In an embodiment, the density according to ISO 534:2011 of the OCC pulp is below 620 kg/m³ after sheet forming according to ISO 5269-2:2004. As an example, this density may be 500-616 kg/m³, such as 526-616 kg/m³.

[0019] In one embodiment, the tensile stiffness index according to ISO 1924-3:2011 of the OCC pulp is at least 4.3 MNm/kg after sheet forming according to ISO 5269-2:2004. As an example, this tensile stiffness index may be 4.5-5.7 MNm/kg.

[0020] In one embodiment, the OCC pulp is a fraction obtained by a fractionating operation, such as screening (see Example 2 below) or hydrocyclone fractionation (see Example 2 below).

[0021] The fraction may (on average) have coarser or longer fibres than the OCC pulp subjected to the fractionation operation. Accordingly, a sheet formed from the fraction typically has lower density than a sheet formed from the OCC pulp subjected to the fractionation operation.

[0022] The density according to ISO 534:2011 of the fraction pulp may for example be below 575 kg/m³ after sheet forming according to ISO 5269-2:2004. In one embodiment, this density is 500-570 kg/m³, such as 526-570 kg/m³.

[0023] The tensile stiffness index according to ISO 1924-3:2011 of the fraction may for example be at least 3.9 MNm/kg after sheet forming according to ISO 5269-2:2004. In one embodiment, this tensile stiffness index is 3.9-5.0 MNm/kg.

[0024] The remainder of the fractionated OCC pulp (typically a fraction of finer or shorter fibres) is preferably used in another process of making paper or paperboard, such as a process of making containerboard to be used as fluting or testliner.

[0025] The method of the first aspect may further comprise the steps of:

- forming a top layer furnish comprising at least 80% by dry weight of kraft pulp, such as at least 90% by dry weight of kraft pulp; and
- forming said top layer from said top layer furnish.

[0026] The fibres of the top layer furnish may be bleached.

[0027] Also, the method of the first aspect may further comprise the steps of:

- forming a back layer furnish comprising at least 60% by dry weight of kraft pulp, such as at least 70% by dry weight of kraft pulp; and
- forming said back layer from said back layer furnish.

[0028] In one embodiment, the back layer furnish further comprises broke pulp.

[0029] As understood by the skilled person, the method of the first aspect typically comprises a step of couching to join the paperboard layers to each other.

[0030] The grammage, excluding any coating layers, of the paperboard formed by the method of the first aspect may for example be 120-400 g/m² when measured according to ISO 536:2019. If pigment-coating layers are included, the grammage may be 140-420 g/m², such as 150-350 g/m².

[0031] In one embodiment, the grammage of the middle layer is higher than the grammage of each of the top layer and the back layer. As an example, each of the top layer and the back layer may have a grammage below 80 g/m², while the grammage of the middle layer is above 100 g/m², such as at least 115 g/m², such as 115-150 g/m².

[0032] In a particular embodiment, the grammage of the top layer is below 80 g/m², the grammage of the back layer is below 65 g/m² and the grammage of the middle layer is higher than the grammage of each of the top layer and the back layer, e.g. above 100 g/m².

[0033] In one embodiment, OCC pulp constitutes 18%-32% by dry weight of the total amount of fibres used to form the paperboard according to the first aspect.

[0034] In one embodiment, the top layer furnish and the back layer furnish comprise no OCC pulp or broke pulp.

[0035] In one embodiment, CTMP constitutes 16%-22% by dry weight of the total amount of fibres used to form the paperboard according to the first aspect.

[0036] In one embodiment, broke pulp constitutes 10%-20%, such as 10%-16%, by dry weight of the total amount of fibres used to form the paperboard according to the first aspect.

[0037] As a second aspect of the present disclosure, there is provided a paperboard comprising a top layer, a back layer and a middle layer,

wherein the middle layer comprises an OCC pulp, a chemithermomechanical pulp (CTMP) and broke pulp. As understood by the skilled person, that the middle layer comprises the OCC pulp, the CTMP and the broke pulp means that it is formed from a mixture comprising these three pulps.

[0038] As also understood by the skilled person, the middle layer is arranged between the top layer and the back layer. The top layer may be intended for printing. Hence, the top layer may be provided with a pigment-based coating, which may consist of several sublayers. Further, the top layer may be bleached.

[0039] In the middle layer of the paperboard of the second aspect, the amount of OCC pulp is higher than the amount of CTMP as per dry weight. In turn, the amount of CTMP is higher than the amount of broke pulp as per dry weight. Further, the combined amounts of OCC pulp, CTMP and broke pulp constitutes at least 88% as per dry weight of the middle layer. In one embodiment, said combined amount constitutes at least 90%, such as at least 92%, as per dry weight of the middle layer.

[0040] The OCC pulp constitutes more than 35% by dry weight of the middle layer, the CTMP constitutes at least 25% by dry weight of the middle layer and the broke pulp constitutes at least 13% by dry weight of the middle layer.

[0041] The middle layer may further comprise one or more strength agents, such as starch (preferably cationic starch), carboxymethyl cellulose (CMC) and/or microfibrillated cellulose (MFC).

[0042] In one embodiment, the paperboard of the second aspect is a liquid packaging board (LPB). In such an embodiment, each of the (fibre-based) layers of the paperboard comprise hydrophobic size. The hydrophobic size is preferably selected from the group consisting of ASA, AKD, rosin size and combinations thereof.

[0043] The amount of hydrophobic size in the middle layer may for example be at least 2.5 kg/tonne dry fibre, such as at least 3.0 kg/tonne dry fibre. The amount of hydrophobic size in the outer layers is preferably lower than the amount of hydrophobic size in the middle layer.

[0044] In a preferred embodiment, the hydrophobic size in each of the fibre-based layers of the LPB of the second aspect is a combination of AKD and rosin size.

[0045] In an embodiment of the second aspect the top layer comprises at least 80% by dry weight of kraft pulp, such as at least 90% by dry weight of kraft pulp.

[0046] In an embodiment of the second aspect, the back layer comprises at least 60% by dry weight of kraft pulp, such as at least 75% by dry weight of kraft pulp.

[0047] The grammage, excluding any coating layers, of the paperboard of the second aspect may for example be 120-400 g/m² when measured according to ISO 536:2019. If pigment-coating layers are included, the grammage may be 140-420 g/m², such as 150-350 g/m².

[0048] In one embodiment of the second aspect, the grammage of the middle layer is higher than the grammage of each of the top layer and the back layer. As an example, each of the top layer and the back layer may have a grammage below 80 g/m², while the grammage of the middle layer is above 100 g/m², such as at least 115 g/m², such as 115-150 g/m².

[0049] In a particular embodiment, the grammage of the top layer is below 80 g/m², the grammage of the back layer is below 65 g/m² and the grammage of the middle layer is higher than the grammage of each of the top layer and the back layer, e.g. above 100 g/m².

[0050] OCC pulp preferably constitutes a significant part of the paperboard of the second aspect. In one embodiment, the paperboard comprises 18%-32% by dry weight of OCC pulp, such as 18%-28% by dry weight of OCC pulp.

[0051] In one embodiment, the top layer and the back layer comprise no OCC pulp or broke pulp.

[0052] CTMP preferably constitutes a significant part of the paperboard of the second aspect. In one embodiment, the paperboard comprises 16%-22% by dry weight of CTMP.

EXAMPLES

[0053] An OCC product sourced in the The Netherlands and called "OCC 90/10" was purchased from the company Prezero. The OCC product was slushed in a pulper for 15 minutes to produce a crude OCC pulp that was stored in a tank. The crude OCC pulp was subjected to coarse screening using a screen having 2 mm diameter holes to obtain an OCC pulp and a coarse reject. The main reason for the coarse screening was to remove trash and impurities.

[0054] Some of the OCC pulp was fractionated by screening to obtain a long fibre fraction and a short fibre fraction (see Example 2 below) or by hydrocyclones to obtain a coarse fibre fraction and a fine fibre fraction (see Example 3 below).

[0055] In many board applications, the bending resistance may be considered the most important parameter. Hence, the effect on bending resistance of including recycled pulp in a board structure was calculated based on layer grammage and density and tensile stiffness index (TSI) values in accordance with the method devised by Carlsson and Fellers in a journal article titled FLEXURAL STIFFNESS OF MULTI-PLY PAPERBOARD (Fibre Science and Technology 13 (1980) 213-223). This required the conversion of bending stiffness (S^b) values to bending resistance values (having the unit mN), which was done according to the following formula: $Bending\ resistance\ (mN) = S^b / 0.084$ (see Pappersteknik page 318, Gavelin, FoU medd. 13/1979).

[0056] In more detail, it was calculated which board grammage that was needed after replacing a portion of the pulp in a reference board with recycled fibres to obtain the same bending resistance as that of the reference board. The pulp replacements that were made are shown in Examples 1-3.

[0057] In these calculations, the reference board is a 250 g/m² prior art liquid packaging board (LPB) structure having the composition of table 1. The pulps of this prior art board structure are the following:

- Bleached hardwood kraft pulp (BHKP) having a density of 750 kg/m³ and a TSI of 7.0 MNm/kg;
- More refined bleached softwood kraft pulp (BSKP high) having a density of 692 kg/m³ and a TSI of 5.1 MNm/kg;
- Less refined bleached softwood kraft pulp (BSKP low) having a density of 654 kg/m³ and a TSI of 4.5 MNm/kg;
- Unbleached kraft pulp (UKP) having a density of 681 kg/m³ and a TSI of 5.5 MNm/kg;
- CTMP having a density of 456 kg/m³ and a TSI of 3.1 MNm/kg; and
- Broke pulp (Broke) having a density of 647 kg/m³ and a TSI of 5.0 MNm/kg (the density and TSI values were determined according to ISO 534:2011 and ISO 1924-3:2011, respectively, after sheet forming according to ISO 5269-2:2004).

Table 1. Reference board structure

Layer	Pulp composition	Gsm (g/m ²)	Density (kg/m ³)	TSI (MNm/kg)
Top	BHKP: 30% BSKP high: 70%	70	709 [#]	5.7 [□]
Middle	CTMP: 35% Broke: 25% BSKP low: 40%	130	583	4.1
Back	UKP: 100%	50	681	5.5

[#] 30%*750 + 70%*692 = 709 (corresponding calculations are used for the other layers of this Examples section)

[□] 35%*3.1 + 25%*5.0 + 40%*4.5 = 4.1 (corresponding calculations are used for the other layers this Examples section)

[0058] In the reference board structure and in the modified board structures presented below, the proportion of broke pulp is about 13% to reflect a full-scale process in which a broke pulp stream corresponding to 13% of the total amount of fibres is generated and subsequently accommodated by the full-scale process.

Example 1

[0059] Properties of the OCC pulp were measured. The values obtained are presented in Table 2 below.

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Table 2. "Gsm" means grammage. "Gurley" means Gurley porosity. "TS" means tensile stiffness. "TSI" means tensile stiffness index. "Brightn." means Brightness D65.

Property	SR	Gsm*	Caliper*	Density*	Brightn.*	Gurley*	TS*	TSI*
Unit		g/m ²	μm	kg/m ³	%	s	kN/m	MNm/kg
OCC Pulp**	16	107.6	177	608	39.5	5.6	493	4.6
*Property measured after sheet forming according to ISO 5269-2:2004. **Prepared from OCC 90/10								

[0060] Notably, the OCC pulp has higher TSI and lower density than the less refined bleached softwood kraft pulp (BSKP low).

Example 1.1

[0061] To obtain a recycled fibre content of about 24-25%, the kraft pulp and some of the broke pulp of the middle layer of the reference board was replaced with the OCC pulp. To still accommodate all the broke pulp, some of it was added to the back layer. The resulting board composition is shown in table 3 below.

Table 3. Inventive board structure 1.1.

Layer	Pulp composition	Density (kg/m ³)	TSI (MNm/kg)
Top	BHKP: 30% BSKP high: 70%	709	5.7
Middle	CTMP: 35% Broke: 17% BSKP low: 0% OCC pulp: 48%	555	4.5
Back	UKP: 79% Broke: 21%	674	5.4

[0062] The grammage needed for board structure 1.1 to reach the same bending resistance as the reference board is presented under Results below.

Example 1.2

[0063] The proportion of recycled fibres was reduced compared to Example 1.1. Thereby, all recycled pulp and all broke pulp could be accommodated by the middle layer (without having to reduce the proportion of CTMP in the middle layer) to avoid that any recycled fibres end up in the back layer, which may be desirable in food- or liquid packaging applications. The resulting board composition is shown in table 4 below.

Table 4. Inventive board structure 1.2.

Layer	Pulp composition	Density (kg/m ³)	TSI (MNm/kg)
Top	BHKP: 30% BSKP high: 70%	709	5.7
Middle	CTMP: 35% Broke: 25% BSKP low: 0% OCC pulp: 40%	559	4.4
Back	UKP: 100% Broke: 0%	681	5.5

[0064] The grammage needed for board structure 1.2 to reach the same bending resistance as the reference board is

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presented under Results below.

Example 1.3

5 **[0065]** To obtain a recycled fibre content of 24-25% without having to add any broke pulp to the back layer (and thereby avoid that any recycled fibres end up in the back layer), the grammage of the back ply was reduced by 15 g/m² and the grammage of the middle ply was increased by the same amount. The resulting board composition is shown in table 5 below.

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Table 5. Inventive board structure 1.3.

Layer	Pulp composition	Density (kg/m ³)	TSI (MNm/kg)
Top	BHKP: 30% BSKP high: 70%	709	5.7
Middle	CTMP: 35% Broke: 22% BSKP low: 0% OCC pulp: 43%	557	4.5
Back	UKP: 100% Broke: 0%	681	5.5

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[0066] The grammage needed for board structures 1.3 to reach the same bending resistance as the reference board is presented under Results below.

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Example 2

[0067] The OCC pulp was fractionated by screening using a screen having 1 mm diameter holes to obtain a long fibre fraction and a short fibre fraction in a 42:58 mass flow ratio. Properties of the fractions are presented in Table 6 below.

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Table 6. "Gsm" means grammage. "Gurley" means Gurley porosity. "TS" means tensile stiffness. "TSI" means tensile stiffness index. "Brightn." means Brightness D65.

Property	Gsm*	Caliper*	Density*	Brightn.*	Gurley*	TS*	TSI*
Unit	g/m ²	µm	kg/m ³	%	s	kN/m	MNm/kg
Short fraction	106.2	173	616	34	19.4	459	4.3
Long fraction	91.2	164	557	33	9.1	423	4.6

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*Property measured after sheet forming according to ISO 5269-2:2004.

[0068] Notably, the long fraction has slightly higher TSI and much lower density than the less refined bleached softwood kraft pulp (BSKP low).

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[0069] To obtain a recycled fibre content of 24-25%, the kraft pulp and some of the broke pulp of the middle layer of the reference board was replaced with the long fraction. To still accommodate all the broke pulp, some of it was added to the back layer. The resulting board composition is shown in table 7 below.

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Table 7. Inventive board structure 2.

Layer	Pulp composition	Density (kg/m ³)	TSI (MNm/kg)
Top	BHKP: 30% BSKP high: 70%	709	5.7
Middle	CTMP: 35% Broke: 17% BSKP low: 0% Long fraction: 48%	537	4.2

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(continued)

Layer	Pulp composition	Density (kg/m ³)	TSI (MNm/kg)
Back	UKP: 79% Broke: 21%	674	5.4

[0070] The grammage needed for board structure 2 to reach the same bending resistance as the reference board is presented under Results below.

Example 3

[0071] The OCC pulp was fractionated by hydrocyclones to obtain a coarse fibre fraction and a fine fibre fraction in a 41:59 mass flow ratio. Properties of the fractions are presented in Table 8 below.

Table 8. "Gsm" means grammage. "Gurley" means Gurley porosity. "TS" means tensile stiffness. "TSI" means tensile stiffness index. "Brightn." means Brightness D65.

Property	Gsm*	Caliper*	Density*	Brightn.*	Gurley*	TS*	TSI*
Unit	g/m ²	μm	kg/m ³	%	s	kN/m	MNm/kg
Fine fraction	110.0	179	615	35	34.4	508	4.6
Coarse fraction	89.3	165	541	32	2.7	349	3.9

*Property measured after sheet forming according to ISO 5269-2:2004.

[0072] Notably, the sheet formed from the coarse fraction has much lower density than the sheet formed from the less refined bleached softwood kraft pulp (BSKP low).

[0073] To obtain a recycled fibre content of 24-25%, the kraft pulp and some of the broke pulp of the middle layer of the reference board was replaced with the coarse fraction. To still accommodate all the broke pulp, some of it was added to the back layer. The resulting board composition is shown in table 9 below.

Table 9. Inventive board structure 3.

Layer	Pulp composition	Density (kg/m ³)	TSI (MNm/kg)
Top	BHKP: 30% BSKP high: 70%	709	5.7
Middle	CTMP: 35% Broke: 17% BSKP low: 0% Coarse fraction: 48%	529	3.8
Back	UKP: 79% Broke: 21%	674	5.4

[0074] The grammage needed for board structure 3 to reach the same bending resistance as the reference board is presented under Results below.

Results

[0075]

Table 10. Board structures having about the same bending resistance. "TL", "ML" and "BL" means top layer, middle layer and back layer, respectively. "Recycl." means recycled fibres. Numbers in bold shows change compared to reference.

Board structure	Layer grammage	Total grammage	Bending resistance	Broke (%)	Recycl. (%)	CTMP (%)
Ref.	TL: 70 g/m ²	250 g/m ²	221.1 mN	13.0	0	18.2

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(continued)

Board structure	Layer grammage	Total grammage	Bending resistance	Broke (%)	Recycl. (%)	CTMP (%)
	ML: 130 g/m ² BL: 50 g/m ²					
5 1.1	TL: 70 g/m ² ML: 124 g/m ² BL: 50 g/m ²	244 g/m ² (-6 g/m²)	222.0 mN	12.9	24.4	17.8
10 1.2	TL: 70 g/m ² ML: 123 g/m ² BL: 50 g/m ²	243 g/m ² (-7 g/m²)	220.1 mN	12.7	20.2	17.7
15 1.3	TL: 70 g/m ² ML: 138 g/m ² BL: 35 g/m ²	243 g/m ² (-7 g/m²)	220.2 mN	12.5	24.4	19.9
20 2	TL: 70 g/m ² ML: 121 g/m ² BL: 50 g/m ²	241 g/m ² (-9 g/m²)	222.0 mN	12.9	24.1	17.6
25 3	TL: 70 g/m ² ML: 120 g/m ² BL: 50 g/m ²	240 g/m ² (-10 g/m²)	221.2 mN	12.9	24.0	17.5

25 **[0076]** As shown in Table 10, the inventive concept not only enables a replacement of a significant portion of virgin fibres by recycled fibres, it also allows for a reduction of the total fibre consumption without a loss of bending resistance.

Example 4

30 **[0077]** Properties of pulps from other OCC products were also measured. The values obtained are presented in Table 11 below.

Table 11. "Gsm" means grammage. "Gurley" means Gurley porosity. "TS" means tensile stiffness. "TSI" means tensile stiffness index. "Brightn." means Brightness D65.

Property Unit	SR	Gsm* g/m ²	Caliper* µm	Density* kg/m ³	Brightn.* %	Gurley* s	TS* kN/m	TSI* MNm/kg
OCC Pulp**	16	107.6	177	608	39.5	5.6	493	4.6
40 Pulp from OCC 95/5 [#]	18	105.3	173	607	33.1	6.5	492	4.7
Pulp from Recycled§ OCC	18	107.3	177	607	30.6	6.6	568	5.3
Pulp from Clippings [‡] OCC	15	105.4	171	615	23.9	6.2	580	5.5
*Property measured after sheet forming according to ISO 5269-2:2004. **From table 2 above #Sourced in The Netherlands and supplied by the company Prezero §Sourced in Sweden ‡From corrugated board converters								

50 **[0078]** Notably, all the OCC pulps of table 11 have higher TSI and lower density than the less refined bleached softwood kraft pulp (BSKP low).

55 **[0079]** Given the density and TSI values in table 11, it is concluded that the effects shown in examples in table 10 above are not limited to the use of one particular type of OCC pulp. Instead, the same or even better effects can be obtained with other types of OCC pulp provided that the middle layer is composed according to the present disclosure.

Claims

1. A method of producing a paperboard comprising a top layer, a back layer and a middle layer, said method comprising the steps of:

- forming a middle layer furnish comprising an OCC pulp, a chemithermomechanical pulp (CTMP) and broke pulp; and
 - forming said middle layer from said middle layer furnish,
- wherein, in the middle layer furnish, the amount of OCC pulp is higher than the amount of CTMP, which is higher than the amount of broke pulp as per dry weight and wherein the combined amount of OCC pulp, CTMP and broke pulp constitutes at least 88% as per dry weight of the middle layer furnish and wherein the OCC pulp constitutes more than 35% by dry weight of the middle layer furnish, the CTMP constitutes at least 25% by dry weight of the middle layer furnish and the broke pulp constitutes at least 13% by dry weight of the middle layer furnish.

2. The method of claim 1, wherein the OCC pulp constitutes at least 40% by dry weight of the middle layer furnish.

3. The method of claim 1 or 2, wherein the CTMP constitutes at least 30% by dry weight of the middle layer furnish.

4. The method of any one of the preceding claims, wherein the broke pulp constitutes at least 15% by dry weight of the middle layer furnish.

5. The method of any one of the preceding claims, wherein the density according to ISO 534:2011 of the OCC pulp is below 620 kg/m³ after sheet forming according to ISO 5269-2:2004.

6. The method of any one of the preceding claims, wherein the tensile stiffness index according to ISO 1924-3:2011 of the OCC pulp is at least 4.3 MNm/kg after sheet forming according to ISO 5269-2:2004.

7. The method of any one of the preceding claims, wherein the OCC pulp is a fraction obtained by a fractionating operation, such as screening or hydrocyclone fractionation.

8. The method of claim 7, wherein the density according to ISO 534:2011 of the fraction is below 575 kg/m³ after sheet forming according to ISO 5269-2:2004.

9. The method of claim 7 or 8, wherein the tensile stiffness index according to ISO 1924-3:2011 of the fraction is at least 3.9 MNm/kg after sheet forming according to ISO 5269-2:2004.

10. The method of any one of the preceding claims, further comprising the steps of:

- forming a top layer furnish comprising at least 80% by dry weight of kraft pulp;
- forming a back layer furnish comprising at least 60% by dry weight of kraft pulp;
- forming said top layer from said top layer furnish; and
- forming said back layer from said back layer furnish.

11. A paperboard comprising a top layer, a back layer and a middle layer,

wherein the middle layer comprises an OCC pulp, a chemithermomechanical pulp (CTMP) and broke pulp and wherein, in the middle layer, the amount of OCC pulp is higher than the amount of CTMP, which is higher than the amount of broke pulp as per dry weight and wherein the combined amounts of OCC pulp, CTMP and broke pulp constitutes at least 88% as per dry weight of the middle layer and wherein the OCC pulp constitutes more than 35% by dry weight of the middle layer, the CTMP constitutes at least 25% by dry weight of the middle layer and the broke pulp constitutes at least 13% by dry weight of the middle layer.

12. The paperboard of claim 11, wherein the OCC pulp constitutes at least 40% by dry weight of the middle layer.

13. The paperboard of claim 11 or 12, wherein the CTMP constitutes at least 30% by dry weight of the middle layer.

14. The paperboard of any one of claims 11-13, wherein the broke pulp constitutes at least 15% by dry weight of the middle

layer.

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15. The paperboard of any one of claims 11-14, wherein the top layer comprises at least 80% by dry weight of kraft pulp and the back layer comprises at least 60% by dry weight of kraft pulp.
 16. The paperboard of any one of claims 11-15, which comprises 18%-28% by dry weight of OCC pulp.

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Patentansprüche

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1. Verfahren zur Herstellung von Pappe, bestehend aus einer Deckschicht, einer Rückschicht und einer Mittelschicht, wobei das Verfahren die folgenden Schritte aufweist:
 - Bilden eines Mittelschichtfaserstoffs, der OCC-Zellstoff, chemothermomechanischen Zellstoff (CTMP) und Ausschusszellstoff aufweist; und
 - Bilden der Mittelschicht aus dem Mittelschichtfaserstoff,

wobei in dem Mittelschichtfaserstoff die Menge an OCC-Zellstoff höher ist als die Menge an CTMP, die höher ist als die Menge an Ausschusszellstoff, bezogen auf das Trockengewicht, und wobei die kombinierte Menge an OCC-Zellstoff, CTMP und Ausschusszellstoff mindestens 88 % des Trockengewichts des Mittelschichtfaserstoffs ausmacht, und wobei der OCC-Zellstoff mehr als 35 % des Trockengewichts des Mittelschichtfaserstoffs ausmacht, der CTMP mindestens 25 % des Trockengewichts des Mittelschichtfaserstoffs ausmacht, und der Ausschusszellstoff mindestens 13 % des Trockengewichts des Mittelschichtfaserstoffs ausmacht.
 2. Verfahren nach Anspruch 1, wobei der OCC-Zellstoff mindestens 40 % des Trockengewichts des Mittelschichtfaserstoffs ausmacht.
 3. Verfahren nach Anspruch 1 oder 2, wobei der CTMP mindestens 30 % des Trockengewichts des Mittelschichtfaserstoffs ausmacht.
 4. Verfahren nach einem der vorhergehenden Ansprüche, wobei der Ausschusszellstoff mindestens 15 % des Trockengewichts des Mittelschichtfaserstoffs ausmacht.
 5. Verfahren nach einem der vorhergehenden Ansprüche, wobei die Dichte des OCC-Zellstoffs gemäß ISO 534:2011 nach der Blattbildung gemäß ISO 5269-2:2004 geringer als 620 kg/m³ ist.
 6. Verfahren nach einem der vorhergehenden Ansprüche, wobei der Zugsteifigkeitsindex gemäß ISO 1924-3:2011 des OCC-Zellstoffs nach der Blattbildung gemäß ISO 5269-2:2004 mindestens 4,3 MNm/kg beträgt.
 7. Verfahren nach einem der vorhergehenden Ansprüche, wobei der OCC-Zellstoff eine durch einen Fraktionierungsvorgang, wie etwa Siebung oder Hydrozyklonfraktionierung, gewonnene Fraktion ist.
 8. Verfahren nach Anspruch 7, wobei die Dichte gemäß ISO 534:2011 der Fraktion nach der Blattbildung gemäß ISO 5269-2:2004 geringer als 575 kg/m³ ist.
 9. Verfahren nach Anspruch 7 oder 8, wobei der Zugsteifigkeitsindex gemäß ISO 1924-3:2011 der Fraktion nach der Blattbildung gemäß ISO 5269-2:2004 mindestens 3,9 MNm/kg beträgt.
 10. Verfahren nach einem der vorhergehenden Ansprüche, ferner aufweisend die folgenden Schritte:
 - Bilden eines Deckschichtfaserstoffs, der mindestens 80 % des Trockengewichts an Kraftzellstoff aufweist;
 - Bilden eines Rückschichtfaserstoffs, der mindestens 60 % des Trockengewichts an Kraftzellstoff aufweist;
 - Bilden der Deckschicht aus dem Deckschichtfaserstoff; und
 - Bilden der Rückschicht aus dem Rückschichtfaserstoff.
 11. Pappe, die eine Deckschicht, eine Rückschicht und eine Mittelschicht aufweist, wobei die Mittelschicht OCC-Zellstoff, chemothermomechanischen Zellstoff (CTMP) und Ausschusszellstoff aufweist, und

wobei in der Mittelschicht die Menge an OCC-Zellstoff höher ist als die Menge an CTMP, die höher ist als die Menge an Ausschusszellstoff, bezogen auf das Trockengewicht, und wobei die kombinierten Mengen an OCC-Zellstoff, CTMP und Ausschusszellstoff mindestens 88 % des Trockengewichts der Mittelschicht ausmachen, und

wobei der OCC-Zellstoff mehr als 35 % des Trockengewichts der Mittelschicht ausmacht, der CTMP mindestens 25 % des Trockengewichts der Mittelschicht ausmacht, und der Ausschusszellstoff mindestens 13 % des Trockengewichts der Mittelschicht ausmacht.

12. Pappe nach Anspruch 11, wobei der OCC-Zellstoff mindestens 40 % des Trockengewichts der Mittelschicht ausmacht.

13. Pappe nach Anspruch 11 oder 12, wobei der CTMP mindestens 30 % des Trockengewichts der Mittelschicht ausmacht.

14. Pappe nach einem der Ansprüche 11 bis 13, wobei der Ausschusszellstoff mindestens 15 % des Trockengewichts der Mittelschicht ausmacht.

15. Pappe nach einem der Ansprüche 11 bis 14, wobei die Deckschicht mindestens 80 % des Trockengewichts an Kraftzellstoff aufweist und die Rückschicht mindestens 60 % des Trockengewichts an Kraftzellstoff aufweist.

16. Pappe nach einem der Ansprüche 11 bis 15, die 18-28 % des Trockengewichts an OCC-Zellstoff aufweist.

Revendications

1. Procédé de fabrication d'un carton comprenant une couche supérieure, une couche inférieure et une couche intermédiaire, ledit procédé comprenant les étapes consistant à :

- former une composition de couche intermédiaire comprenant une pâte OCC, une pâte chimico-thermomécanique (CTMP) et de la pâte de rebut ; et
- former ladite couche intermédiaire à partir de ladite composition de couche intermédiaire,

dans lequel, dans la composition de couche intermédiaire, la quantité de pâte OCC est supérieure à la quantité de CTMP, qui est supérieure à la quantité de pâte de rebut en poids sec et dans lequel la quantité combinée de pâte OCC, CTMP et pâte de rebut constitue au moins 88 % en poids sec de la composition de couche intermédiaire et dans lequel la pâte OCC constitue plus de 35 % en poids sec de la composition de couche intermédiaire, la CTMP constitue au moins 25 % en poids sec de la composition de la couche intermédiaire et la pâte de rebut constitue au moins 13 % en poids sec de la composition de la couche intermédiaire.

2. Procédé selon la revendication 1, dans lequel la pâte OCC constitue au moins 40 % en poids sec de la composition de la couche intermédiaire.

3. Procédé selon l'une quelconque des revendications 1 ou 2, dans lequel la pâte CTMP constitue au moins 30 % en poids sec de la composition de la couche intermédiaire.

4. Procédé selon l'une quelconque des revendications précédentes, dans lequel la pâte de rebut constitue au moins 15 % en poids sec de la composition de la couche intermédiaire.

5. Procédé selon l'une quelconque des revendications précédentes, dans lequel la densité selon la norme ISO 534:2011 de la pâte OCC est inférieure à 620 kg/m³ après formage en feuille selon la norme ISO 5269-2:2004.

6. Procédé selon l'une quelconque des revendications précédentes, dans lequel l'indice de rigidité à la traction selon la norme ISO 1924-3:2011 de la pâte OCC est d'au moins 4,3 MNm/kg après formage en feuille selon la norme ISO 5269-2:2004.

7. Procédé selon l'une quelconque des revendications précédentes, dans lequel la pâte OCC est une fraction obtenue par une opération de fractionnement, telle que le tamisage ou le fractionnement par hydrocyclone.

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8. Procédé selon la revendication 7, dans lequel la densité selon la norme ISO 534:2011 de la fraction est inférieure à 575 kg/m³ après formage en feuille selon la norme ISO 5269-2:2004.
9. Procédé selon la revendication 7 ou la revendication 8, dans lequel l'indice de rigidité à la traction selon la norme ISO 1924-3:2011 de la fraction est d'au moins 3,9 MNm/kg après formage de la feuille selon la norme ISO 5269-2:2004.
10. Procédé selon l'une quelconque des revendications précédentes, comprenant en outre les étapes consistant à :
- former une composition de couche supérieure comprenant au moins 80 % en poids sec de pâte kraft ;
 - former une composition de couche inférieure comprenant au moins 60 % en poids sec de pâte kraft ;
 - former ladite couche supérieure à partir de ladite composition de couche supérieure ; et
 - former ladite couche inférieure à partir de ladite composition de couche inférieure.
11. Carton comprenant une couche supérieure, une couche inférieure et une couche intermédiaire,
- dans lequel la couche intermédiaire comprend une pâte OCC, une pâte chimico-thermomécanique (CTMP) et une pâte de rebut et
- dans lequel, dans la couche intermédiaire, la quantité de pâte OCC est supérieure à la quantité de CTMP, qui est supérieure à la quantité de pâte de rebut en poids sec et
- dans lequel les quantités combinées de pâte OCC, CTMP et pâte de rebut constituent au moins 88 % en poids sec de la couche intermédiaire et
- dans lequel la pâte OCC constitue plus de 35 % en poids sec de la couche intermédiaire, la CTMP constitue au moins 25 % en poids sec de la couche intermédiaire et la pâte de cassés constitue au moins 13 % en poids sec de la couche intermédiaire.
12. Carton selon la revendication 11, dans lequel la pâte OCC constitue au moins 40 % en poids sec de la couche intermédiaire.
13. Carton selon la revendication 11 ou la revendication 12, dans lequel la pâte CTMP constitue au moins 30 % en poids sec de la couche intermédiaire.
14. Carton selon l'une quelconque des revendications 11 à 13, dans lequel la pâte de rebut constitue au moins 15 % en poids sec de la couche intermédiaire.
15. Carton selon l'une quelconque des revendications 11 à 14, dans lequel la couche supérieure comprend au moins 80 % en poids sec de pâte kraft et la couche arrière comprend au moins 60 % en poids sec de pâte kraft.
16. Carton selon l'une quelconque des revendications 11 à 15, qui comprend 18 à 28 % en poids sec de pâte OCC.

REFERENCES CITED IN THE DESCRIPTION

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Non-patent literature cited in the description

- **CARLSSON ; FELLERS**. FLEXURAL STIFFNESS OF MULTI-PLY PAPERBOARD. *Fibre Science and Technology*, 1980, vol. 13, 213-223 **[0055]**