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(54) **PRODUCTION OF PAPER- OR LINERBOARD**

(57) There is provided a method of producing a paper- or linerboard having a grammage measured according to ISO 536:2019 of 170-310 g/m$^2$ and comprising a print layer, a middle layer and a back layer, wherein the middle layer is formed from a middle layer furnish comprising at least 25% by dry weight CTMP and the back layer is formed from a back layer furnish comprising an unbleached pulp, such as an unbleached kraft pulp, said method comprising the step of subjecting a multi-layered web at a speed of at least 600 m/min to pressing in a press section comprising a first and a second double-felted shoe press nip arranged in series, wherein the total press impulse of the double-felted shoe press nips is at least 95 kPa*s, preferably at least 100 kPa*s.

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## Description

### TECHNICAL FIELD

**[0001]** The present disclosure relates to the field of production of paper- and linerboard.

### BACKGROUND

**[0002]** A machine for producing multi-layered paper- or linerboard has different sections. In the wet end of the paper machine, furnishes are prepared from pulps and additives (added to improve properties such as retention, dewatering and strength). In the forming/wire section, a multi-layered web is then formed from the furnishes. The multi-layered web is dewatered in the press section and dried in the drying section. Downstream the drying section, the multilayered web may be coated and/or calendered. When the multilayered web is both coated and calendered, calendering can be carried upstream or downstream the coating step(s) or even between coating steps.

**[0003]** The pulps that can be used in the paperboard machine include virgin pulps, recycled pulps (i.e. pulps prepared from recycled paper and/or paperboard) and broke pulps (pulps of fibres recycled from downstream portions of the same process). Further, virgin pulps are typically divided into chemical pulps and mechanical pulps. Sulfate (kraft) pulp and sulfite pulp are examples of chemical pulp. Groundwood pulp, thermomechanical pulp (TMP) and chemi-thermomechanical pulp (CTMP) are examples of mechanical pulp. All these pulps can be made from hardwood, softwood or mixtures thereof. Further, the pulps can be bleached or unbleached.

**[0004]** A furnish for a particular layer typically comprise a mixture of different pulps. The properties of the final board product are not only a result of the pulp mixture of each furnish; they also depend on the degree of refining of the pulps, the types and amounts of additives and other operating conditions. However, the process for making paperboard cannot be designed with only the final properties in mind; runnability in the paper machine and energy consumption must also be taken into consideration.

### SUMMARY

**[0005]** The present disclosure aims to provide an efficient method of producing a paper- or linerboard of satisfactory properties.

**[0006]** Accordingly, the present disclosure provides a method of producing a paper- or linerboard having a grammage measured according to ISO 536:2019 of 170-310 g/m$^2$ and comprising a print layer, a middle layer and a back layer, wherein the middle layer is formed from a middle layer furnish comprising at least 25% by dry weight CTMP and the back layer is formed from a back layer furnish comprising an unbleached pulp, such as an unbleached kraft pulp, said method comprising the step of subjecting a multi-layered web at a speed of at least 600 m/min to pressing in a press section comprising a first and a second double-felted shoe press nip arranged in series, wherein the total press impulse of the double-felted shoe press nips is at least 95 kPa*s, preferably at least 100 kPa*s.

**[0007]** Compared to the prior art, this press impulse is high, which increases the press dryness (i.e. the dryness of the multilayered web exiting the press section). As a result, less steam is consumed in the drying section. The skilled person making paperboard is often reluctant to use high press impulses as they can densify the web to such an extent that inferior bending stiffness is obtained. However, the selection of an unbleached pulp for the back layer furnish and the inclusion of CTMP in the middle layer furnish make the web of the method of the present disclosure relatively insensitive to high press impulses. The press dryness is further increased by both shoe press nips being double-felted.

### DETAILED DESCRIPTION

**[0008]** The present disclosure provides a method of producing a paper- or linerboard having a grammage measured according to ISO 536:2019 of 170-310 g/m$^2$.

**[0009]** The paper- or linerboard comprises a print layer, a middle layer and a back layer. In one embodiment, the paper- or linerboard comprises more than one middle layer.

**[0010]** The middle layer is formed from a middle layer furnish comprising at least 25% by dry weight CTMP. In case of more than one middle layer, each middle layer furnish preferably comprise at least 25% by dry weight CTMP. The CTMP of the middle layer(s) preferably has a Canadian Standard Freeness (CSF) measured according to ISO 5267-2:2001 of 525-625 ml, such as 550-600 ml. To reach such a CSF, the CTMP may be subjected to refining. If the CSF is too low, dewatering is impaired and density increases. If the CSF is too high, strength properties may be insufficient.

**[0011]** In one embodiment, the middle layer furnish comprises at least 30% by dry weight CTMP, preferably at least 35% by dry weight CTMP, such as at least 40% by dry weight CTMP.

**[0012]** In addition to CTMP, the middle layer furnish may comprise at least 20% by dry weight broke pulp, such as at least 30% by dry weight broke pulp. The broke pulp of the middle layer furnish preferably has a Schopper-Riegler number (°SR) of less than 35 (such as 26-34), more preferably less than 33 (such as 27-32). To reach such a °SR, the broke pulp may be subjected to refining. In the present disclosure, °SR is measured according to ISO 5267-1:1999.

**[0013]** In one embodiment, the CTMP and the broke pulp together constitute at least 65% by dry weight of the middle layer furnish, such as at least 75% by dry weight of the middle furnish.

**[0014]** The middle layer furnish may further comprises

kraft pulp, such as softwood kraft pulp. This kraft pulp may have a relatively low °SR, such as 18-25, preferably 18-23.

**[0015]** The head box consistency of the middle layer furnish may be 0.15% - 0.42%, such as 0.25% - 0.40%.

**[0016]** The back layer is formed from a back layer furnish comprising an unbleached pulp, such as an unbleached chemical pulp, preferably an unbleached kraft pulp. The unbleached pulp of the back layer preferably has a °SR of 19-26, such as 20-25. To reach such a °SR, the unbleached pulp maybe subjected to refining. If the °SR is too high, dewatering is impaired. If the °SR is too low, strength properties may be insufficient.

**[0017]** The unbleached pulp of the back layer is typically a softwood pulp.

**[0018]** In one embodiment, the back layer furnish comprises at least 50% by dry weight of the unbleached pulp, such as at least 60% by dry weight of the unbleached pulp.

**[0019]** In addition to the unbleached pulp, the back layer furnish may comprise broke pulp. The broke pulp of the back layer furnish preferably has a °SR of less than 35 (such as 26-34), more preferably less than 33 (such as 27-32). To reach such a °SR, the broke pulp may be subjected to refining.

**[0020]** In one embodiment, the unbleached pulp and broke pulp together constitute at least 80 % by dry weight of the back layer furnish, such as at least 90 % by dry weight of the back layer furnish.

**[0021]** The head box consistency of the back layer furnish may be 0.12% - 0.25%.

**[0022]** The print layer furnish preferably comprises a mixture of hardwood kraft pulp and softwood kraft pulp, such as a mixture of bleached hardwood kraft pulp and bleached softwood kraft pulp. However, the print layer may also be unbleached.

**[0023]** Each of the kraft pulps of print layer furnish preferably has a °SR of 21-29. To reach such a °SR, the kraft pulps are typically subjected to refining.

**[0024]** In one embodiment, hardwood kraft pulp and softwood kraft pulp together constitute at least 80% by dry weight of the print layer furnish, such as at least 90% by dry weight of the print layer furnish.

**[0025]** The head box consistency of the print layer furnish may be 0.12% - 0.25%.

**[0026]** As understood by the skilled person, the above-mentioned furnishes form a multi-layered web in a forming section. A top former may be arranged to aid the dewatering of the middle layer in the forming section. Further, the formation of the middle layer preferably comprises the use of a breast roll shaker.

**[0027]** The method of the present disclosure comprises the step of subjecting the multi-layered web to pressing in a press section at a speed of at least 600 m/min, such as at least 650 m/min, such as at least 700 m/min, such as at least 750 m/min.

**[0028]** The press section comprises a first and a second double-felted shoe press nip arranged in series. As understood by the skilled person, the second double-felted shoe press nip is arranged downstream the first double-felted shoe press nip. Preferably the line load of the second double-felted shoe press nip is higher than the line load of the first double-felted shoe press nip.

**[0029]** The total press impulse of the double-felted shoe press nips is at least 95 kPa*s, preferably at least 100 kPa*s. An upper limit maybe 150 kPa*s or 200 kPa*s

**[0030]** If the grammage is relatively high, such as 250-310 g/m$^2$, the speed of the multi-layered web is typically lower, which means that the press impulse can be higher, e.g. at least 105 kPa*s, such as at least 110 kPa*s.

**[0031]** In a preferred embodiment, the press section comprises a further nip arranged downstream the double-felted shoe press nips. The further nip is preferably a non-felted nip or a single-felted nip, such as a non-felted hard nip or a single-felted shoe press nip. When the further nip is a non-felted hard nip, its line load may be in the range of 25-100 kN/m, such as 30-75 kN/m, such as 30-60 kN/m. The main purpose of such a hard nip is to smoothen the print side, which was in contact with a felt in the first and the second double-felted shoe press nip. When the further nip is a single-felted shoe press nip, the felt is preferably contacting the back side. Thereby, the single-felted shoe press nip not only further dewaters the web, it also smoothens the print side, which - as mentioned above - was in contact with a felt in the first and the second double-felted shoe press nip.

**[0032]** The print layer of the paper- or linerboard may be coated with a composition comprising at least one pigment and at least one binder. Accordingly, the method of the present disclosure may further comprise a coating step. The coating step may comprise a plurality of substeps, each applying a sublayer.

**[0033]** When pigment-coated, the print side of the paper- or linerboard of the present disclosure may have a PPS 1.0 roughness of below 2.0 μm, such as below 1.8 μm. A lower limit for this PPS 1.0 roughness may be 0.8 μm. In the present disclosure, PPS 1.0 roughness is measured according to ISO 8791-4:2013 (soft backing & 1000 kPa clamping pressure).

**[0034]** In an embodiment, the method of the present disclosure comprises no calendering step, which typically saves bulk.

**[0035]** The density of the paper- or linerboard of the present disclosure may be below 810 kg/m$^3$. If not coated with a pigment coating, the density may be below 800 kg/m$^3$. In the present disclosure, density is measured according to ISO 534:2011.

## EXAMPLE

### Production of a ~200 g/m$^2$ WTL

**[0036]** A three-layer white-top linerboard (WTL) was produced in a full-scale paperboard machine. The layer design of the WTL was as follows: a print layer (58 g/m$^2$), a back layer (45 g/m$^2$), a middle layer (77 g/m$^2$) and a

pigment coating (20 g/m$^2$, applied onto the print layer).

**[0037]** To prepare a print layer furnish, bleached hardwood kraft pulp (NBHK) and bleached softwood kraft pulp (NBSK) were mixed in a 70:30 dry weight ratio. Before the mixing, the NBHK and the NBSK were subjected to LC refining (50 and 120 kWh/tonne, respectively) such that both pulps obtained a °SR value of 25. Before the print layer headbox, rosin size (0.5 kg/tonne), alum (2 kg/tonne), strength agent (cationic starch, 5 kg/tonne), retention starch (3 kg/tonne), retention polymer (75 g/tonne), silica (300 g/tonne) and clay (55 kg/tonne) were added. In the print layer headbox, the consistency was 0.21% and the pH was 6.8.

**[0038]** To prepare a back layer furnish, unbleached softwood kraft pulp (UBK) and broke pulp were mixed in a 75:25 dry weight ratio. Before the mixing, the UBK and the broke pulp were subjected to LC refining to obtain °SR values of 23 and 30, respectively. Before the back layer headbox, AKD (0.5 kg/tonne), alum (0.4 kg/tonne), strength agent (cationic starch, 5 kg/tonne), retention starch (3 kg/tonne), retention polymer (75 g/tonne) and silica (300 g/tonne) were added. In the bottom layer headbox, the consistency was 0.18% and the pH was 7.5.

**[0039]** To prepare a middle layer furnish, broke pulp, NBSK and CTMP were mixed in a 45:10:45 dry weight ratio. Before the mixing, the pulps were subjected to LC refining to obtain the following values: °SR 30 for the broke pulp; °SR 20 for the NBSK and CSF 580 ml for the CTMP. Before the middle layer headbox, AKD (0.5 g/tonne), alum (0.3 g/tonne), strength agent (cationic starch, 4 kg/tonne), retention starch (3 kg/tonne), retention polymer (150 g/tonne) and silica (350 g/tonne) were added. In the middle layer headbox, the consistency was 0.32% and the pH was 7.5. The wire used for forming the middle layer included e.g. a top former and a breast roll shaker.

**[0040]** In the wire section, 0.7 g/m$^2$ starch was sprayed to each of the print layer web and the back layer web for ply-bond strength. At the end of the wire section, the three individual webs were couched together to form a three-layered web. In the press section arranged downstream the wire section, the three-layered web was pressed in three nips; a first double-felted shoe press nip followed by a second double-felted shoe press nip and a hard nip. The line load of the first double-felted shoe press nip was 656 kN/m. The line load of the second double-felted shoe press nip was 828 kN/m. The line load of the hard nip was 50 kN/m. The web speed in the press section was 854 m/min, which means that the press impulse of the whole press section was 108 kPa*s and that the total press impulse of the double-felted shoe press nips was 104 kP*s.

**[0041]** Downstream the press section, the three-layered web was dried in a drying section (the steam consumption in this section was relatively low) and then coated in a coating section according to the following: in a first blade coater, 8.5 g/m$^2$ of a pigment coating composition was applied to the surface of the print layer to form a first coating layer; and in a second blade coater, 11.5 g/m$^2$ of a pigment coating composition was applied to the first coating layer to form a second coating layer. Hence the total (dry) coat weight on the print layer surface was 20 g/m$^2$. Further, a very small amount (~0.3 g/m$^2$) of starch was applied to the surface of the back layer in the coating section.

**[0042]** The properties of the resulting WTL product are presented in table 1 below. The properties are satisfactory.

Table 1. "MD" means machine direction. "CD" means cross direction". "GM" means geometrical. "PS" means print side. "BS" means back side.

| Property | Unit | Value |
|---|---|---|
| Grammage | g/m$^2$ | 202 |
| Caliper | μm | 252 |
| Density | kN/m | 800 |
| Tensile Strength MD | kN/m | 17.6 |
| Tensile Strength CD | kN/m | 12.6 |
| Stretch, MD | % | 2.0 |
| Stretch, CD | % | 6.2 |
| Bending Resistance Index GM | mNm$^6$/g$^3$ | 9.5 |
| SCT MD | kN/m | 6.1 |
| SCT CD | kN/m | 4.6 |
| Burst Strength | kPa | 734 |
| Scott Bond | J/m$^2$ | 336 |
| Z-strength | kPa | 593 |
| Brightness | $D6_5$ % | 79.9 |
| Roughness Bendtsen, PS | ml/min | 50 |
| Roughness, PS | PPS 1.0 | 1.5 |
| Cobb 60, PS | g/m$^2$ | 26 |
| Cobb 60, BS | g/m$^2$ | 33 |

**[0043]** Had the grammage been higher, the middle layer would have been a greater part of the whole board structure and the density would therefore have been lower. Further, the grammage would have been higher if the board was not pigment-coated.

## Claims

1. A method of producing a paper- or linerboard having a grammage measured according to ISO 536:2019 of 170-310 g/m$^2$ and comprising a print layer, a middle layer and a back layer, wherein the middle layer is formed from a middle layer furnish comprising at least 25% by dry weight CTMP and the back layer is formed from a back layer furnish comprising an unbleached pulp, such as an unbleached kraft pulp, said method comprising the step of subjecting a multi-layered web at a speed of at least 600 m/min to pressing in a press section comprising a first and a second double-felted shoe press nip arranged in series, wherein the total press impulse of the double-felted shoe press nips is at least 95 kPa*s, preferably at least 100 kPa*s.

2. The method of claim 1, wherein the speed is at least 650 m/min, such as at least 700 m/min, such as at least 750 m/min.

3. The method of claim 1 or 2, wherein the line load of the second double-felted shoe press nip is higher than the line load of the first double-felted shoe press nip.

4. The method of any one of the preceding claims, wherein the head box consistency of the middle layer furnish is 0.15% - 0.42%, such as 0.25% - 0.40%.

5. The method of any one of the preceding claims, wherein the head box consistency of the print layer furnish is 0.12% - 0.25%.

6. The method of any one of the preceding claims, wherein the head box consistency of the back layer furnish is 0.12% - 0.25%.

7. The method of any one of the preceding claims, wherein the middle layer furnish comprises at least 30% by dry weight CTMP, such as at least 35% by dry weight CTMP, such as at least 40% by dry weight CTMP.

8. The method of any one of the preceding claims, wherein the middle layer furnish further comprises at least 20% by dry weight broke pulp, such as at least 30% by dry weight broke pulp.

9. The method of claim 8, wherein CTMP and broke pulp together constitute at least 65% by dry weight of the middle layer furnish, such as at least 75% by dry weight of the middle furnish.

10. The method of any one of the preceding claims, wherein the middle layer furnish further comprises kraft pulp.

11. The method of any one of the preceding claims, wherein the print layer furnish comprises a mixture of hardwood kraft pulp and softwood kraft pulp.

12. The method of claim 11, wherein hardwood kraft pulp and softwood kraft pulp together constitute at least 80% by dry weight of the print layer furnish, such as at least 90% by dry weight of the print layer furnish.

13. The method of any one of the preceding claims, wherein the back layer furnish further comprises broke pulp.

14. The method of claim 13, wherein unbleached kraft pulp and broke pulp together constitute at least 80% by dry weight of the back layer furnish, such as at least 90% by dry weight of the back layer furnish.

15. The method of any one of the preceding claims, wherein the forming the middle layer comprises use of a breast roll shaker.

16. The method of any one of the preceding claims, wherein the press section comprises a further nip arranged downstream the double-felted shoe press nips.

17. The method of claim 16, wherein the further nip is a hard nip or a single-felted shoe press nip.

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# EUROPEAN SEARCH REPORT

Application Number
EP 22 16 8616

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The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
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X : particularly relevant if taken alone
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# EUROPEAN SEARCH REPORT

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CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
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# ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 22 16 8616

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