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(54) Title: A RECYCLABLE SHEET MATERIAL AND A CONTAINER THEREOF

(57) Abstract: The present invention relates to a recyclable sheet material and a container, preferably cup, formed of such recyclable sheet material comprising 1a) a paper board coated with a water barrier coating on at least one of its uncoated surfaces having a smoothness of equal or less than 500 ml/min according to Bendtsen ISO 8791-2 or 1b) a paper board which is coated on at least one of its uncoated surfaces with a first surface coating comprising at least one mineral pigment and at least one polymeric binder, preferably with polar groups, said coated surface having a smoothness of 100 ml/min or less according to Bendtsen ISO 8791-2 and on top of said first surface coating a water barrier coating, wherein said water barrier coatings being based on at least one polymer having a melting point of at least 120 °C is applied in an amount of providing a COBB value of the water barrier coated paper board of equal or less 8 g/m2 per 600 sec and a surface energy equal or greater 38 mJ/m2 at 20 °C (test liquid:water) and 2) optionally a sealable coating based on at least on polymer with polar groups.

A recyclable sheet material and a container thereof

The present invention relates to a recyclable, preferably repulpable sheet material as defined below and a container, preferably a cup, based essentially on cellulosic material for water containing foodstuff formed of such recyclable sheet material comprising

1a) a paper board which is coated with a water barrier coating on at least one of its uncoated surfaces having a smoothness of equal or less than 500 ml/min according to Bendtsen ISO 8791-2
or

1b) a paper board which is coated on at least one of its uncoated surfaces with a first surface coating based on at least one mineral pigment and on at least one polymeric binder, preferably with polar groups, and which on top of the first surface coating having a smoothness of 100 ml/min or less according to Bendtsen ISO 8791-2 is coated with a water barrier coating,

wherein each of said water barrier coatings being based on at least one polymer having a melting point of at least 120 °C is applied in an amount of providing a COBB value of the water barrier coated paper board of equal or less 8 g/m^2 per 600 sec and a surface energy equal or greater 38 mJ/m^2 at 20 °C (test liquid:water) and

2) optionally a sealable coating covering at least partially in designated areas the water barrier coating, which sealable coating is based on at least one polymer, preferably with polar groups, having a melting point of at least 10 °C below the melting point of the polymer component of the water barrier coating.

So called fast food restaurants are a major and growing supplier of nutrition. Predominantly, the logical concept of fast food restaurants is based on the single use package. Single use means that after the consumption of the food, the package of the food is discarded.

Since such packages may consist of both cellulosic material, predominantly in form of fibres, like paper, paper board or other molded fibre items, or plastic materials like polyethylene, polypropylene or polyethylenterephtalate or of a mixture of cellulosic material and plastic material, a waste management based on recycling the material could be difficult, even impossible.

Although it is known that the big advantage of single use package is that the used package need not be taken back for cleaning and thus a lot of energy consumption, like for heating dishwater and/or drying of the cleaned single use packages, is avoided, besides maintaining high and reliable hygienic standards for public use, the main stream of single use packages is worldwide a big problem.

The problem is related to the nature of the waste stream of single use packages. As already mentioned, this waste consists of a mixture of plastic material and cellulosic material typically. In order to recycle this waste, it is necessary to separate the

different materials which could be recycled after separation from each other. However, the waste stream containing a mixture of these materials makes it often impossible to separate and recycle the different materials economically.

Traditionally, in the manufacture of paper and paper board, paraffin waxes and synthetic polymers as plastic material are used as moisture retardants, water repellents, oil repellents, stiffness strengtheners and release agents. Consequently, the waste of such paper and paper board of which single use packages traditionally are made, is not only difficult, but often impossible to be repulped and recycled in standard paper mill processes, because the polymers, in particular the waxes derived from petroleum, are not biodegradable in mill white waters (circulated process waters) and discharge effluents. Additionally, the residue of the waxes that can't be removed from the pulp fibers during the repulping and recycling process can cause severe problems due to buildups that occur on the screens and felts used during the process of forming and making the paper or paperboard sheet.

It is also known that such waxes resist biodegradation and composting when disposed off in landfills and other waste disposal systems. Consequently, paper and paper board coated or impregnated with traditional synthetic polymers and waxes are also difficult and often impossible to repulp and recycle owing to their resistance to separate from the fibres in the standard repulping processes resulting in significant fibre losses in efforts to repulp and thus recycle them. Moreover, such synthetic polymers are also not biodegradable and therefore resist composting.

It is known that such impregnated paper and/or paper board can only be repulped by using specialized repulping machinery that separates the pulp fibres from the

laminated films and/or impregnation which is far more expensive in terms of operating costs and/or recycled pulp fibre yields. The action of separating the fibres from any impregnating synthetic and/or plastic material damages some fibres causing them to be selected out of the recycled pulp and to be lost for reuse. Additionally a separated plastic material waste carries some of the fibres out of the repulpate when its adherence to the fibres is not hindered by the repulping process. Likewise, not only synthetic material used as sheets for the manufacture of paper and paper board, but also coatings and impregnating products made from synthetic materials like waxes, can be repulped for recycling only in specially configured repulping equipment that removes and separates the waxes. However, these more intense physical and chemical requirements of these repulping processes coupled with a loss of fibres that become trapped in the wax cause the recyclable, repulpable fibre levels to fall far below those of the standard repulping processes. In addition, packages made from such products are not biodegradable and must be separated and deposited in separate landfill areas.

It is therefore an object of the present invention to provide a recyclable sheet material especially for a container formed thereof, preferably for single use, based on cellulosic material, preferably on a paper board, which can be repulped and recycled according to standard paper mill processes although having a sufficient high water barrier which allows the production of containers of various kinds especially useful for foodstuff containing water. In addition the residue of the repulped sheet material, if any, is also preferably biodegradable and can be composted when disposed off in a landfill or otherwise dispose systems.

This object is solved by providing a recyclable and preferably repulpable sheet material comprising

1a) a paper board which is coated with a water barrier coating on at least one of its uncoated surfaces having a smoothness of equal or less than 500 ml/min according to Bendtsen ISO 8791-2

or

1b) a paper board which is coated on at least one of its uncoated surfaces with a first surface coating based on 70 – 90 dried wt% of at least one mineral pigment and on 10 – 30 dried wt% of at least one polymeric binder, preferably with polar groups, and optionally 1 – 5 dried wt% of auxiliary agents, with the provision that all components are adding up to 100 dried wt%, and which on top of that first surface coating having a smoothness of 100ml/min or less according to Bendtsen, ISO 8791-2, is coated with a water barrier coating,

wherein each of said water barrier coatings being based on at least one polymer having a melting point of at least 120 °C is applied in an amount of providing a COBB value of the water barrier coated paper board 1a), respectively 1b), of equal or less 8 g/m^2 per 600 sec and a surface energy equal or greater 38 mJ/m^2 at 20 °C (test liquid: water)

and

2) optionally, a sealable coating covering at least partially in designated areas the water barrier coating, which sealable coating is based on at least one polymer, preferably with polar groups, having a melting point of at least 10 °C below the melting point of the polymer component of the water barrier coating.

In order to achieve the recyclability of the inventive sheet material respectively any container formed thereof according to standard paper mill processes the barrier coating of the sheet material must not interfere with these processes however must guarantee a sufficient high water and optionally grease barrier especially for any water containing foodstuff being provided in any container, especially any cup, produced from the inventive sheet material. Accordingly, none of the coatings of the paper board, respectively the containers, especially the cups produced thereof, contain or comprise any wax or wax component.

Additionally, this is also only achieved by using as barrier material in an amount as low as possible but sufficient high to provide the necessary water barrier expressed in a COBB value of equal or less 8 g/m^2 per 600 sec and having a surface energy equal or greater 38 mJ/m^2 at 20 °C for guaranteeing the repulpability respectively recyclability according to standard paper mill processes by allowing an easy separation between the polymer component of the water barrier coating and any fiber material of the paper board.

Moreover, this repulpability of the inventive sheet material is further improved by the fact that the necessary water barrier is already achieved with a barrier coating amounting only to 10 g/m^2 at maximum thereby preventing any fiber clouding during

the repulping process. This amount decreases with increasing smoothness of the paper board surface to be coated with the water barrier coating at a given COBB value.

Thus, a smooth surface of the paper board being coated with the water barrier coating is a requirement for achieving the necessary water barrier with such a low amount of coating.

Accordingly the inventive recyclable sheet material comprises a paper board as substrate sheet of which at least one of its uncoated surfaces has a smoothness of equal or less than 500 ml/min according to Bendtsen ISO 8791-2. This smoothness allows achieving the necessary water barrier expressed as a COBB value of the water barrier coated paper board of equal or less 8 g/m^2 per 600 sec, preferably 1-5 g/m^2 per 600 sec.

Alternatively the paper board 1b)already coated on at least one of its uncoated surfaces with a first surface coating based on at least one mineral pigment and at least one polymeric binder which coated surface has a smoothness of 100ml/min or less according to Bendtsen ISO8791-2, can be coated with an even less amount of a water barrier coating, namely with an amount of as low as 3-9 g/m^2, more preferably 4-6 g/m^2, for achieving a COBB value of the water barrier coated paper board of equal or less 8 g/m^2 per 600 sec, preferably 1-5 g/m^2 per 600 sec.

The inventive recyclable sheet material comprises as substrate preferably a paper board having a grammage of 170-300 g/m^2.

The paper board having a grammage of 170-300 g/m^2 can already have on at least one of its uncoated surfaces a first surface coating being based preferably on a dried water based dispersion consisting of at least one mineral pigment and at least one polymeric binder which polymeric binder has preferably polar groups, and optionally auxiliary agents for achieving a smoothness of 100 ml/min or less according to Bendtsen ISO 8791-2 of the coated surface.

Preferably, this first surface coating of the paper board 1b) comprises at least one mineral pigment and at least one polymeric binder preferably with polar groups. The mineral pigment component is at least one mineral pigment selected from the group comprising clay, talc, calcium carbonate, titanium dioxide, kaolin or mixtures thereof, preferably clay or kaolin, most preferably clay.

Preferably, the polymeric binder is at least one polymeric binder selected from the group comprising polyacrylates, acrylate copolymers, preferably acrylate/styrene copolymers, polyvinyl acetates, ethylene/vinyl acetate copolymers, styrene copolymers, preferably styrene/butadiene copolymers or styrene/butylacrylate copolymers, and mixtures thereof, most preferably acrylate copolymers.

Preferably these polymers are polymers having polar groups, preferably carboxylic groups, carboxylic ester groups, carboxylic amide groups and/or OH groups.

The first surface coating provides a surface energy equal or greater 38 mJ/ m^2 at 20°C (test liquid:water). In order to achieve this surface energy and to provide a smooth surface of the paper board 1b) the first surface coating is applied preferably as water based dispersion on at least one uncoated surface of the paper board 1b).

Thereby, after drying a first coating based on 70-90, preferably 75 – 85, dried wt% of at least one mineral pigment and 10-30, preferably 15 – 25, dried wt% of at least one polymeric binder is achieved.

For a person skilled in the art it is obvious that a water based dispersion used for this application may also contain the usual auxiliary agents like thickening agents, defoaming agents, dispersants, anti-block agents, anti-static agents and/or slipping agents. The amounts of all components of such first the dried surface coating are adding up to 100 dried wt%.

According to the present invention, the same kind of water barrier coating can be applied to at least one uncoated surface of a paper board 1a), respectively on top of the first coating of the paper board 1b).

Such water barrier coating is also applied preferably as a water based dispersion based on at least one polymer preferably with polar groups like carboxylic-, carboxylic ester-, carboxylic amide- and/or OH-groups and optionally usual auxiliaries. Preferably the polymer component of the water based dispersion is at least one polymer selected from the group comprising acrylate polymers, acrylate copolymers, methacrylate polymers, methacrylate copolymers, styrene copolymers, preferably styrene/acrylate copolymers, ethylene/vinyl acetate copolymers and mixtures thereof.

Preferably, the polymer component of the water based dispersion is at least one acrylate polymer, acrylate copolymer, methacrylate copolymer or a mixture of an

acrylate polymer with a methacrylate polymer, most preferably an acrylate/styrene copolymer.

Preferably, the water barrier coating is providing a surface energy of equal or greater 38 mJ/m^2, more preferably from 38 to 55 mJ/m^2 at 20 °C (test liquid:water).

Preferably, the water barrier coating is applied as a water based dispersion of the polymer component and optionally at least one auxiliary agent in an amount of 1-5 dried wt%. As auxiliary agents dispersants, thickening agents, defoaming agents, cross linking agents, anti-block agents, anti-static agents and/or slipping agents can be used. Most preferably the barrier coating is based on 95-99 dried wt% of the polymer component and 1-5 dried wt% of at least one auxiliary agent with the provision that all components are adding up to 100 dried wt%.

The polymer component of the water barrier coating should have a melting point of at least 120 °C unless the barrier coating also serves as sealable coating. In such case, if no sealable coating 2) is present and the barrier coating also functions as sealable material, the polymer component should have a melting point of equal or less 150 °C preferably from 120 to 148 °C.

In case the water barrier coating does not function as a sealable material the barrier coating is covered by a sealable coating at least in designated areas. Preferably, the heat sealable coating is applied at least partially in the areas which have to be joined for the formation of a container formed of the inventive recyclable sheet material.

The sealable coating is based on at least one polymer, preferably with polar groups having a melting point of at least 10 °C below the melting point of the polymer component of the water barrier coating. Preferably, the sealable coating is based on a polymer component having a melting point of 120 °C or less.

Preferably, the sealable coating is based on at least one polymer selected from the group comprising acrylate polymers, acrylate copolymers, methacrylate polymers, methacrylate copolymers, ethylene vinyl acetate copolymers, styrene copolymers, preferably styrene/acrylate copolymers and mixtures thereof, most preferable acrylate/styrene copolymers.

Preferably, the polymer used for the sealable coating has polar groups like carboxylic-, carboxylic ester-, carboxylic amide- and/or OH-groups providing a surface energy of equal or greater 38 mJ/m^2, more preferably from 38 to 55 mJ/m^2 at 20 °C (test liquid:water).

Besides the polymer component the sealable coating can optionally contain auxiliary agents like thickening agents, defoaming agents, dispersants, cross-linking agents, anti-block agents, anti-static agents and/or slipping agents in an amount of 1-5 dried wt%, more preferably the sealable coating is based on 95-99 dried wt% of the polymer component and 1- 5 dried wt% of at least one auxiliary agent, with the provision that all components are adding up to 100 dried wt%.

Preferably the sealable coating is applied on a barrier coating in an amount 12 g/m^2 at maximum, more preferably in an amount of 6-10 g/m^2. If appropriate for the formation of a container by using the inventive recyclable sheet material this amount

can be split, preferably equally between the two preferably overlapping areas that have to be combined for the formation of a container, preferably a cup.

The polymer component of the barrier coating as well as of the sealable coating has preferably a glass transition temperature T_g of 10 – 30 °C (measured according to DSC).

The sealable coating can also be applied as a water based dispersion which is dried after the coating like the first coating of paper board 1b), respectively each of the water barrier coatings of paper board 1a), respectively 1b).

Each of the coatings, namely the first surface coating, the water barrier coating and the sealable coating, can be applied according to known processes, whereby each of the coatings is dried and preferably cooled before the next coating is applied. The application of the coatings can be carried out continuously by using equipment already known in the art, in-line or off-line the paper board production. Off-line coating is preferred in order to have the possibility for necessary variations of the coating compositions.

Moreover the recyclable sheet material can also be coated on both of the uncoated surfaces of the paper board with the same sequence of coatings as is applied to the first uncoated or coated surface of the paper board. This sequence of coatings can also be manufactured by known processes, preferably by laminating and/or coating and/or extrusion of the respective coating. Each coating can be applied on the paper board web, uncoated or already coated by means of blade coating, roll coating, rod coating, curtain coating or spraying.

A further object of the present invention is a container, preferably a cup, most preferably a cup for single use, which is formed of the inventive recyclable sheet material.

In order to form the inventive container, the heat sealable material of the recyclable sheet material, is preferably activated by heat, preferably by hot air, and combined by pressing. The surface of the recyclable sheet material which is at least partially coated with the heat sealing material is preferably the inner surface of the container wall.

According to the present invention the term "recyclable" means that the whole content of cellulosic material (paper board) of the inventive sheet material, respectively inventive container, preferably cup, is recyclable which means repulpable and the contents of the non-cellulosic material like any coatings are at least repulpable according to standard paper mill processes with standard process conditions without relying on any specially configured repulping equipment.

The amount of non-cellulosic material of the inventive sheet material, respectively of an inventive container, preferably cup, formed of the inventive sheet material is at most 15 wt% of the whole sheet material or container, preferably cup.

The non-cellulosic material of the inventive sheet material, respectively inventive container, preferably cup, built thereof which is at least repulpable according to the before described definition is water-dispersible or water-soluble, therefore preferably it can not only be repulped but also at least partially be recycled according to the

standard paper manufacturing processes or be degraded biologically according to DIN EN 13432.

The COBB value is determined according to DIN EN 20535:1994.

The inventive containers, preferably cups, can be produced according to known manufacturing processes.

The inventive containers, preferably cups, are especially useful for providing hot or cold beverages, ice cream or other hot or cold liquids respectively food. The provision of hot or cold liquids, especially aqueous liquids or ice cream, is preferred.

Additionally, it is evident that the inventive sheet material can also be used to produce other containers, especially for single use, than cups and optionally corresponding lids. These products can be trays, packages for milk and juices, plates or folded cartons for frozen foodstuff. All these kinds of containers are especially suitable for single use.

Claims:

1. A recyclable sheet material comprising

1a) a paper board which is coated with a water barrier coating on at least one of its uncoated surfaces having a smoothness of equal or less than 500ml/min according to Bendtsen, ISO 8791-2

or

1b) a paper board which is coated on at least one of its uncoated surfaces with a first surface coating based on 70 – 90 dried wt% of at least one mineral pigment and on 10 – 30 dried wt% of at least one polymeric binder, preferably with polar groups, and optionally 1 – 5 dried wt% of auxiliary agents, with the provision that all components are adding up to 100 dried wt%, and which on top of that first surface coating having a smoothness of 100ml/min or less according to Bendtsen, ISO 8791-2, is coated with a water barrier coating,

wherein each of said water barrier coatings being based on at least one polymer having a melting point of at least 120°C is applied in an amount of providing a COBB value of the water barrier coated paper board 1a) respectively 1b) of equal or less 8g/m^2 per 600 sec and a surface energy equal or greater 38 mJ/ m^2 at 20°C (test liquid:water), and

2) optionally a sealable coating covering at least partially in designated areas of each of said water barrier coatings, which

sealable coating is based on at least one polymer, preferably with polar groups, having a melting point of at least 10°C below the melting point of the polymer component of the water barrier coating.

2. A recyclable sheet material according to claim 1, wherein the water barrier coating amounts to 10 g/m^2 at maximum, which amount decreases with increasing smoothness of the paper board surface coated with the water barrier coating at a given COBB value.

3. A recyclable sheet material according to claim 1 or 2, wherein the first surface coating of the paper board 1b) is based on at least a mineral pigment selected from the group comprising clay, talc, calcium carbonate, titanium dioxide, kaolin and mixtures thereof, and a polymeric binder.

4. A recyclable sheet material as claimed in any one of claims 1 – 3, wherein the polymeric binder of the first surface coating of the paper board 1b) is based on at least one polymer selected from the group comprising polyacrylates, acrylate copolymers, acrylate/styrene copolymers, polyvinyl acetates, ethylene/vinyl acetate copolymers, styrene copolymers, preferably styrene/butadiene copolymers or styrene/butylacrylate copolymers, and mixtures thereof.

5. A recyclable sheet material as claimed in any one of claims 1 – 4, wherein the first surface coating of the paper board 1b) is based on a dried water-based dispersion comprising 75 – 85 dried wt% of at least one mineral pigment and

15 – 25 dried wt% of at least one polymeric binder and optionally 1 – 5 dried wt% of usual auxiliary agents, with the provision that all components are adding up to 100 dried wt%.

6. A recyclable sheet material as claimed in any one of claims 1 – 5, wherein the water barrier coating is based on at least one polymer selected from the group comprising acrylate polymers, acrylate copolymers, methacrylate polymers, methacrylate copolymers, styrene copolymers, preferably styrene/butylacrylate copolymers, ethylene/vinyl acetate copolymers and mixtures thereof, said water barrier coating having a surface energy equal or greater 38 mJ/m^2 at 20°C (test liquid:water).

7. A recyclable sheet material as claimed in any one of claims 1 – 6, wherein the water barrier coating is based on 95 – 99 dried wt% of the polymer component and 1– 5 dried wt% of auxiliary agents, based on the total weight of the dried coating.

8. A recyclable sheet material as claimed in any one of claims 1 – 7, wherein the water barrier coating provides a COBB value of 1 – 5 g/m^2 per 600 seconds of the coated paper board 1a), respectively 1b).

9. A recyclable sheet material as claimed in any one of claims 1 – 8, wherein the sealable coating is based on at least one polymer selected from the group comprising acrylate polymers, acrylate copolymers, methacrylate polymers, methacrylate copolymers, styrene copolymers, preferably styrene/acrylate copolymers, ethylene/vinyl acetate copolymers and mixtures thereof.

10. A recyclable sheet material as claimed in any one of claims 1 – 9, wherein said sealable coating is coated on the water barrier coating in an amount of 12 g/m^2 at maximum at the designated areas of the water barrier coating.

11. A recyclable sheet material as claimed in any one of claims 1 – 10, wherein the sealable coating is based on 95 – 99 dried wt% of the polymer component and 1 – 5 dried wt% of auxiliary agents.

12. A recyclable sheet material as claimed in any one of claims 1 – 11, wherein the polymer component of the water barrier coating and preferably of the sealable coating has a glass transition temperature T_g of 10° – 30°C (measured according to DSC).

13. A recyclable sheet material as claimed in any one of claims 1 – 11, wherein the water barrier coating also functions as sealable coating having a melting point equal or less than 150 °C.

14. A recyclable sheet as claimed in anyone of claims 1 – 13, wherein the second surface of the paper board is provided with the same sequence of coatings as the first surface of the paper board 1a), respectively 1b).

15. A recyclable sheet as claimed in any one of claims 1 – 14, wherein the amount of non-cellulosic material is at most 15 wt% of the whole sheet material.

16. A container, preferably a cup, formed of a recyclable sheet material as claimed in any one of claim 1 – 15, wherein the water barrier coated surface is arranged as inwardly directed surface of the container, preferably cup.

17. A container, preferably a cup, as claimed in claim 16, for hot or cold beverages, ice cream or other hot or cold liquids respectively food.

18. A container, preferably a cup, as claimed in claim 16 or 17 for single use.