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(54) **SCOURING MATERIAL COMPRISING NATURAL FIBRES**

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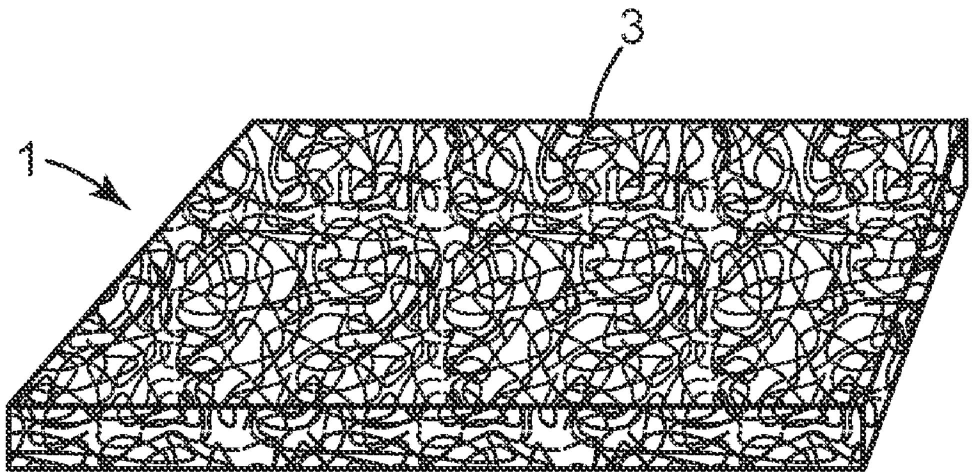
(57) **ABSTRACT**

A scouring material comprises a three-dimensional non-woven web (**3**) of entangled fibres (**5**) bonded to one another at mutual contact points (**7**). The fibres comprise natural vegetable fibres in an amount of at least 50% by weight, and crimped synthetic fibres in an amount of at least 5% by weight. The fibres, throughout the web, have a substantially continuous coating of binder resin; and the web of bonded fibres has a maximum density of 60 kg/m^3. A method of making the scouring material comprises the steps of: forming a three-dimensional non-woven web of entangled fibres; roll-coating the web with a binder resin; and curing the binder resin to form the scouring material.



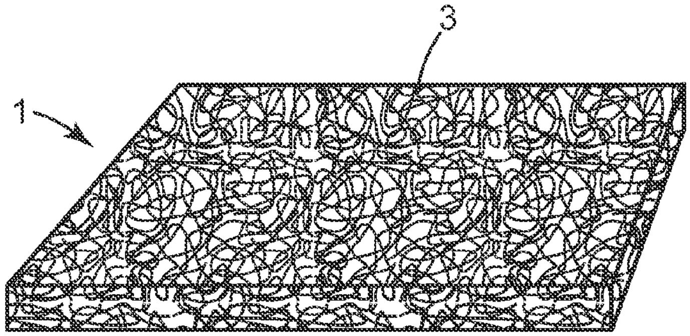


Fig. 1

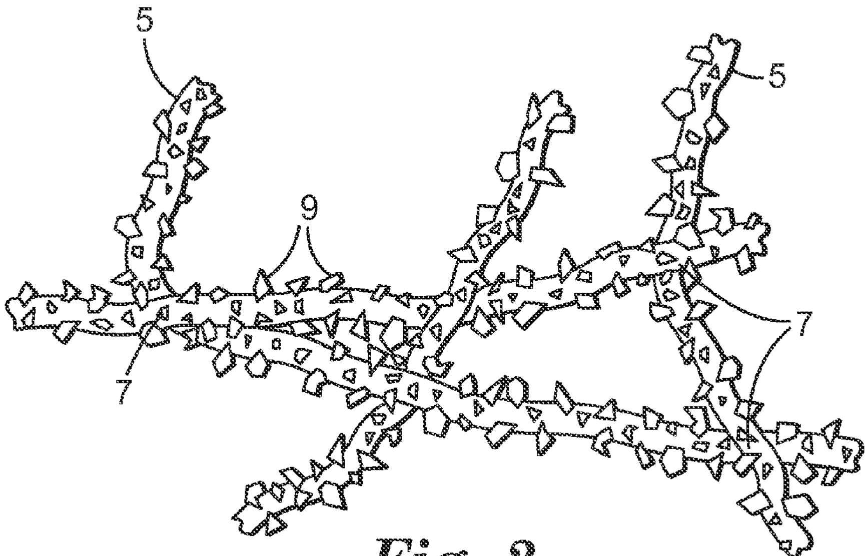


Fig. 2

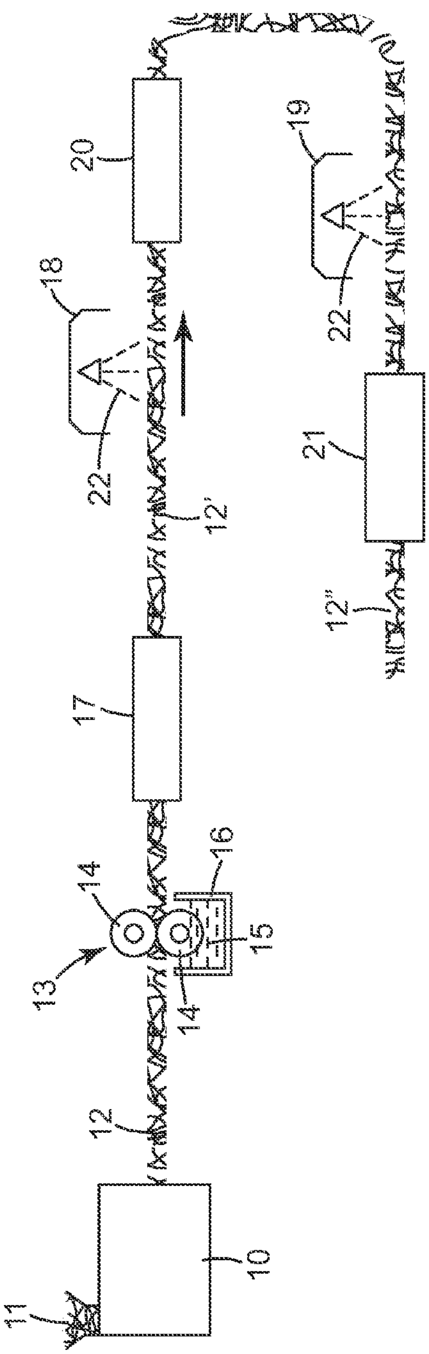

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Fig. 3

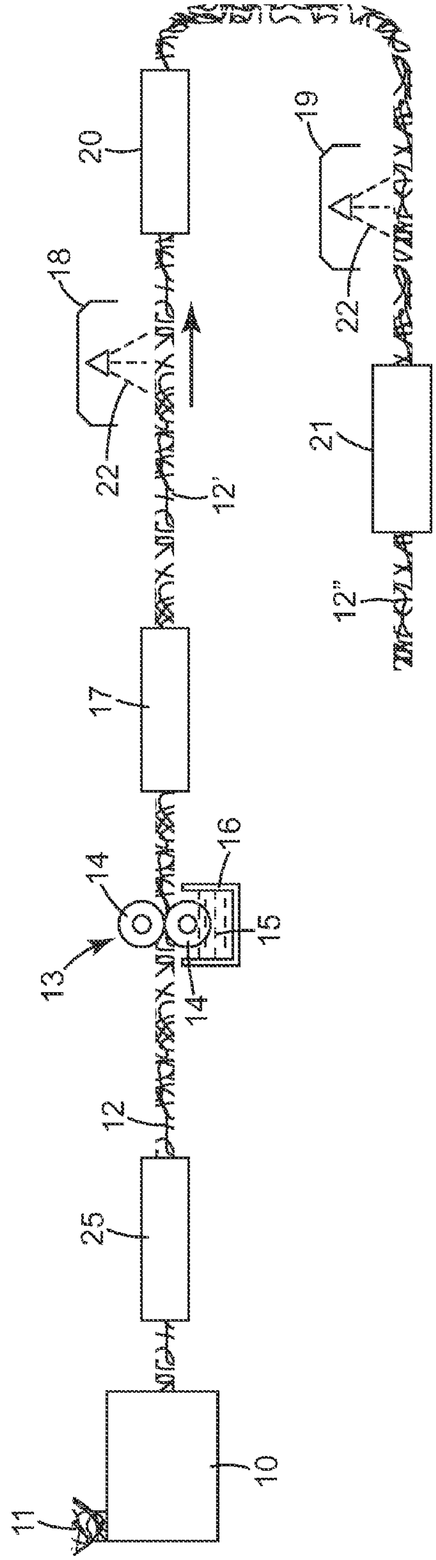
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Fig. 4

SCOURING MATERIAL COMPRISING NATURAL FIBRES

[0001] This application claims priority from United Kingdom Application No. 0818186.9, filed Oct. 6, 2008.

[0002] The present disclosure relates to non-woven fibrous scouring materials suitable for use for cleaning surfaces.

BACKGROUND

[0003] Scouring materials are produced in many forms, one being as a web of non-woven fibrous material (for example material of the type described in U.S. Pat. No. 2,958,593 of Hoover et al). Following manufacture, the web of scouring material may be divided into individual pieces of a size suitable for its intended use.

[0004] Examples of scouring pads comprising non-woven fibrous materials are described in U.S. Pat. No. 2,327,199 (Loeffler), U.S. Pat. No. 2,375,585 (Rimer), and U.S. Pat. No. 3,175,331 (Klein). Non-woven fibrous hand pads for domestic use and for more general abrasive applications are available, under the trademark "Scotch-Brite", from 3M Company of St. Paul, Minn., USA, and non-woven fibrous hand pads that provide a very mild scouring action for skin cleansing are available, under the trademark "Buf-puf", also from 3M Company. Non-woven fibrous scouring materials are also used outside the domestic environment, for example in floor pads such as those available, also under the trademark "Scotch-Brite", from 3M Company.

[0005] A non-woven fibrous scouring material is preferably a comparatively open material (i.e. it has a comparatively high void volume) so that it can retain debris removed from the surface that is being cleaned and thereby provide an effective cleaning action. Such a material can also be cleaned very easily by rinsing in water or another suitable liquid, so that it can be re-used.

[0006] Known processes for manufacturing non-woven fibrous materials having a comparatively high void volume involve forming an open, three-dimensional non-woven web of synthetic fibres, applying a liquid binder resin to the web, and then curing the binder resin to bond the fibres together. A preferred method of applying the binder resin is roll coating, which coats the fibres with the resin substantially continuously throughout the web. For use as a scouring material, this bonded web of fibres typically has a maximum density of 60 kg/m^3. The characteristics of the bonded web may be such that it can be used without further treatment as a scouring material. Alternatively, abrasive particles can be adhered to the bonded web to enhance the abrasive characteristics of the web.

[0007] Scouring products formed from materials produced in this way are popular with consumers and are widely used in the domestic environment and elsewhere. However, in this area as in many others, environmental concerns are leading to an increasing demand from consumers for products that are based on natural materials, especially materials derived from plants (including trees and bushes). In the case of fibres, there is a growing interest in fibres derived directly from plants (i.e. non-regenerated vegetable fibres, hereinafter referred to as natural vegetable fibres).

[0008] Scouring materials formed solely from natural vegetable fibres are known and include, for example, traditional scourers for domestic use formed from the fibrous parts of gourds or palm leaves. Such traditional scourers have the disadvantage that they cannot be mass-produced to a uniform standard.

[0009] The use of a substantial amount of natural vegetable fibres in place of synthetic fibres in a conventional manufacturing process of the type described above has not been seen as an option for mass-producing non-woven fibrous scouring materials having a comparatively high void volume because of the risk that the vegetable fibres will be crushed when the liquid binder resin is applied, resulting in a bonded web that has a reduced void volume and is too compact to function effectively as a scouring material. The risk of the fibres being crushed is considered to be particularly high if the binder resin is applied by roll coating. With that mind, EP-A-1 618 239 (3M Innovative Properties Company) describes a method of making a scouring material comprising the steps of: forming a three-dimensional non-woven web of natural fibres contacted with dry particulate material that includes fusible binder particles; exposing the web to conditions that cause the binder particles to form a flowable liquid binder; and then solidifying the liquid binder to form bonds between the fibres of the web and thereby provide a bonded web. Abrasive particles are then adhered to the pre-bonded web by at least a make-coat resin.

[0010] Although the method described in EP-A-1 618 239 is effective, it requires the use of apparatus that is less widely available than that used to carry out the conventional type of manufacturing process referred to above. It would be advantageous to be able to continue to use the conventional type of process to produce non-woven fibrous scouring materials comprising a substantial amount of natural vegetable fibres, and the present disclosure is based on the surprising discovery that this can be achieved through an appropriate selection of the fibres employed.

SUMMARY

[0011] The present disclosure provides a scouring material comprising a three-dimensional non-woven web of entangled fibres bonded to one another at mutual contact points, wherein:

(i) the fibres comprise natural vegetable fibres in an amount of at least 50% by weight, and crimped synthetic fibres in an amount of at least 5% by weight;

(ii) the fibres, throughout the web, have a substantially continuous coating of binder resin; and

(iii) the web of bonded fibres has a maximum density of 60 kg/m^3.

[0012] In the case of hand pads for domestic use, the scouring material typically has a maximum density of 55 kg/m^3, more especially a density in the range of from 25 to 45 kg/m^3.

[0013] The inclusion of crimped synthetic fibres with the natural vegetable fibres has been found to facilitate the production of a scouring material using the conventional type of manufacturing process described above, especially one in which a binder resin is applied to a web of fibres by roll coating.

[0014] With a view to providing scouring materials in which the amount of natural vegetable fibres in the non-woven web is greater than 50% by weight, it has been found advantageous to select natural fibres that comprise fibres from the hearts of *Agave tequilana*; fibres from the leaves of *Agave sisalana*; or fibres from the tissues surrounding the seeds of

Cocos nucifera; or mixtures thereof. The natural vegetable fibres may also comprise finer fibres, for example hemp fibres.

[0015] A method of making a scouring material in accordance with the disclosure may comprise the steps of:

(a) forming a three-dimensional non-woven web of entangled fibres;

(b) roll-coating the web with a binder resin; and

(c) curing the binder resin to form the scouring material.

[0016] As described above, such a method offers the advantage that it can be carried out using apparatus that is already known and widely available. In some cases, the non-woven web of entangled fibres includes heat-sensitive fibres and the method comprises the further step, between steps (a) and (b), of applying heat to the web to form a pre-bonded web in which some at least of the fibres are bonded to one another at mutual contact points by a pre-bond resin provided by the heat-sensitive fibres. The heat-sensitive fibres, when present, may contribute at least some of the crimped synthetic fibres in the web of bonded fibres. For example, if the heat-sensitive fibres are bi-component fibres having a sheath/core structure, the cores of the heat-sensitive fibres may contribute at least some of the crimped synthetic fibres in the web of bonded fibres.

[0017] As used herein, the term "natural vegetable fibres" means fibres derived directly from plants (including trees and bushes); the term "synthetic fibres" means fibres produced from synthetic polymers, typically by extrusion; and the term "roll-coating" means a process in which a nonwoven fibrous web is passed between rollers that apply resin to the web with sufficient pressure to ensure that the fibres, throughout the web, receive a substantially continuous coating of the resin.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] By way of example only, scouring materials in accordance with the disclosure and methods of making those materials will now be described with reference to the accompanying drawings, in which

[0019] FIG. **1** shows a scouring pad comprising scouring material in accordance with the disclosure;

[0020] FIG. **2** illustrates diagrammatically, and on an enlarged scale, the structure of the scouring pad of FIG. **1**;

[0021] FIG. **3** is a diagrammatic illustration of apparatus for making scouring materials in accordance with the disclosure; and

[0022] FIG. **4** is a diagrammatic illustration of another form of apparatus for making scouring materials in accordance with the disclosure.

DETAILED DESCRIPTION

[0023] FIG. **1** shows a generally-rectangular scouring pad **1** intended for hand use, and FIG. **2** illustrates the structure of the pad material in greater detail. The pad **1** comprises a three-dimensional non-woven web **3** of entangled fibres **5**, bonded to one another at mutual contact points **7**. The fibres **5**, described in greater detail below, comprise at least 5% by weight of crimped synthetic fibres and at least 50% by weight of natural vegetable fibres. Throughout the web **3**, the fibres **5** have a substantially continuous coating of binder resin (not visible in the drawing). FIG. **2** also shows optional abrasive particles **9** adhered to the fibres. The web of fibres **5**, including the binder resin but without the abrasive particles **9** has a maximum density of 60 kg/m^3 (more preferably, in the case of hand pads for domestic use, a density in the range of from 25 to 45 kg/m^3).

[0024] If desired, a scouring pad as shown in FIG. **1** can be laminated to another type of material, for example a sponge material. Advantageously, that other material is a natural material (for example, a cellulosic sponge) or has a comparatively high content of natural material.

[0025] A process for making the web **3** and the scouring pad **1** will now be described with reference to FIG. **3**, which illustrates apparatus for carrying out the process.

[0026] The apparatus illustrated in FIG. **3** comprises web-forming equipment **10** to which a selected mix of fibres **11** is supplied to be formed into a dry-laid, open, lofty three-dimensional web **12**. A preferred type of web is an air-laid web as described in U.S. Pat. No. 2,958,593, in which case the web-forming equipment **10** may be a commercially-available "Rando-Webber" device available, for example, from the Rando Machine Co. of Macedon, N.Y., USA. Alternatively, the web-forming equipment **10** may be of the type described in WO 05/044529 (Form-Fibre Denmark APS), or of the type available from DOA of Linz, Austria.

[0027] The fibre mix **11** comprises at least 50% by weight natural vegetable fibres and at least 5% by weight crimped synthetic fibres. Examples of suitable fibre mixes will be described in greater detail below. For the production of a web of open scouring material, the web-forming equipment **10** is preferably operated to produce a dry-laid web **12** having a minimum thickness of about 5 mm and a maximum basis weight of about 500 g/m^2. If the web is intended for conversion into hand pads, a maximum basis weight of about 300 g/m^2 may be preferred. Other web thicknesses and basis weights may, however, be appropriate depending on the required nature of the scouring material that is being produced.

[0028] Downstream of the web-forming equipment **10** is a conventional roll-coating station **13**, where the web **12** passes through the nip between rollers **14** that apply a binder resin **15** from a tank **16** to the web at a metered rate. The pressure exerted by the rollers **14** on the web is sufficient to ensure that the binder resin penetrates the entire thickness of the web and coats the fibres throughout. The web then passes through an oven **17** which is operated at a temperature sufficient to cure the binder resin **15** whereby, when the web has emerged from the oven and cooled, the fibres **11** are bonded together at their points of contact and, throughout the web (now indicated by the reference **12'**), have a substantially continuous coating of the binder resin.

[0029] Through a suitable choice of the materials and the process conditions employed, the characteristics of the web **12'** (e.g. its tensile strength, flexibility, durability) can be adapted to the intended use of the web.

[0030] Depending on the nature of the fibres **11**, the bonded web **12'** may be suitable without further treatment for use as a scouring material for domestic or cosmetic cleaning. If so, it can be cut into pads of a suitable size for the intended use, typically pads of a suitable shape and size for hand-held use. If required, however, the abrasive properties of the web **1** can be enhanced by applying a make-coat resin with optional abrasive particles **9** to the web as shown in FIG. **2**. That can be achieved by passing the web **12'** through the additional apparatus illustrated in FIG. **3**, which comprises successive spray booths **18**, **19**, each having an associated oven **20**, **21**. As the web passes through the first spray booth **18**, one surface of the web is sprayed with a liquid make-coat resin (or a slurry **22** of abrasive particles mixed with the make-coat resin) that is subsequently cured by passing the web through the oven **20**. The web then passes through the second spray booth **19**, in which other surface of the web is sprayed with the same liquid make-coat resin, or abrasive-resin slurry, which is then cured by passing the web through the oven **21**. The resulting abrasive web **12"** may then be cut into pads of a suitable shape and size as already described above. If the surfaces of the web are required to have different scouring properties, two different make-coat resins or abrasive-resin slurries can be used in the spray booths **18**, **19**. Alternatively, a make-coat resin or abrasive-resin slurry may be applied to one surface only of the web.

[0031] In a modified version of the apparatus, the second spray booth **19** and the associated oven **21** are omitted and the web is turned over after it has left the first oven **20** and is conveyed a second time through the first spray booth **18** so that the other side of the web can be sprayed. The web then passes for a second time through the oven **20**. The web may then be cut into pads of a suitable shape and size as already described above.

[0032] FIG. **4** illustrates a modified form of the apparatus shown in FIG. **3**, suitable for use when it is desired to consolidate the web **12** emerging from the web-forming equipment **10** before it passes to the roll-coating station **13**. The consolidation may be required, for example, if the web **12** cannot be passed directly to the roll-coating station **13** from the web-forming equipment **10** and, consequently, is subjected to additional handling. The apparatus of FIG. **4** differs from that shown in FIG. **3** by the inclusion of an oven **25** between the web-forming equipment **10** and the roll-coating station **13**. Use of the apparatus of FIG. **4** requires that the fibre mix **11** supplied to the web-forming equipment includes heat-sensitive fibres that will melt when the web **12** passes through the oven **25**, forming bonds between other fibres in the web sufficient to enable the web to withstand any handling that it might receive during its passage to the roll-coating station **13**. Thereafter, the process carried out using the apparatus of FIG. **4** is as described above with reference to FIG. **3**.

[0033] When appropriate, other methods could be used in the process of FIG. **4** for consolidating the web **12** emerging from the web-forming equipment **10**.

[0034] Scouring materials can be produced as described above in a variety of thicknesses and basis weights, and can be cut into other shapes, depending on their intended use. Thicker webs, for example, may be cut into discs for use as floor pads.

[0035] The materials employed when using the apparatus of FIG. **3** or FIG. **4** to make scouring materials in accordance with the disclosure will now be described.

The Fibres

[0036] Any suitable fibres can be used in the apparatus of FIGS. **3** and **4**, provided they enable a non-woven fibrous material suitable for use as a scouring material to be produced.

[0037] With regard to the crimped synthetic fibres, and without wishing to be bound by theory, it is believed that they contribute to the resilience of the web **12** that is produced in the web-forming equipment **10** of the apparatus of FIGS. **3** and **4**, and thus influence the ability of the web to be roll-coated in the station **13** without being crushed to such an extent that its open nature is destroyed. The crimped synthetic fibres should comprise at least 5% by weight of the total fibre content of the final scouring material, the actual amount being determined having regard to the nature of the other fibres in the fibre mix **11** (particularly the natural vegetable fibres) and the required characteristics of the final scouring material. Crimped synthetic fibres suitable for use in the fibre mix **11** include crimped nylon fibres and crimped polyester fibres. Mixtures of different crimped synthetic fibres may also be used.

[0038] Generally, it has been observed that the ability of the web **12** to resist being crushed in the roll-coating station **13** tends to increase with the amount of synthetic fibre present in the web; with the linear density of the crimped synthetic fibres; and with the degree of crimp in the crimped synthetic fibres. The synthetic fibres should have a length in the range normally used for non-woven fibrous webs (typically between 40 and 60 cm), it being known that very long fibres may get trapped in the web-forming equipment **10** and that short fibres tend to reduce the cohesion of the web.

[0039] In examples of scouring materials in accordance with the disclosure, at least some of the crimped synthetic fibres have a linear density of at least 15 dtex. However, the use of crimped synthetic fibres having a linear density of less than 15 dtex is possible, depending on the nature of the other fibres in the fibre mix **11**. Typically, the degree of crimp in the fibres will be in the range of from about 2 to about 10 crimps per cm.

[0040] As regards the natural vegetable fibres present in the fibre mix **11**, it has been found that the nature of those fibres also has an influence on the resilience of the web **12** produced in the web-forming equipment **10**, and thus on the ability of the web to be roll-coated in the station **13** without being crushed to such an extent that its open nature is destroyed. Some natural vegetable fibres can provide comparatively-resilient open webs even when combined with only comparatively-small amounts of crimped synthetic fibres, whereas other natural vegetable fibres may need to be combined with larger amounts of crimped synthetic fibres to enable open webs with the required resilience to be produced. When selecting the natural vegetable fibres, account should be taken of the wide variation in length and linear density that occurs even among fibres derived from the same plants.

[0041] Examples of natural vegetable fibres capable of providing comparatively-resilient open webs even when combined with only comparatively-small amounts of crimped synthetic fibres include:

(i) fibres from the hearts (also known as the pine cones) of *Agave tequilana* (hereinafter referred to as agave fibres, available in various grades depending on the washing and-or drying treatment to which the fibres have been subjected);

(ii) fibres from the leaves of *Agave sisalana* (hereinafter referred to as sisal fibres); and

(iii) fibres from the tissues surrounding the seed of *Cocos nucifera* (hereinafter referred to as coco fibres and also known as coir).

[0042] Mixtures of those fibres may be used and, in some case, the fibres may be mixed with finer natural vegetable fibres, for example, hemp fibres.

[0043] When heat-sensitive fibres are included in the fibre mix **11** as described above with reference to FIG. **4**, they should be selected to ensure that they melt and bond to the other fibres in the web at a temperature below that at which those other fibres would be degraded or melted. Heat-sensitive fibres may be either mono-component or multi-component fibres.

[0044] A multi-component fibre is a synthetic fibre having at least a first portion and a second portion, where the first portion has a melting point lower than the second portion. A variety of different types and configurations of multi-component fibre exist. One type of multi-component fibre is a bi-component fibre, examples of which are described in U.S. Pat. No. 5,082,720 of Minnesota Mining and Manufacturing Company. One form of bi-component fibre has a sheath/core structure, where the sheath that surrounds the core has the lower melting point. Another form of multi-component fibre has a layered structure, where one layer has a lower melting point than another layer.

[0045] During heating, the first (lower melting point) portion of a multi-component fibre will melt, while the second (higher melting point) portion remains intact. During melting, the first portion tends to collect at junction points where fibres contact one another. Then, upon cooling, the material of the first portion will re-solidify to secure the fibres together.

[0046] The first (lower melting point) portion of a multi-component fibre may be comprised of such materials as copolyester or polyethylene; and the second portion may be comprised of such materials as polypropylene or polyester.

[0047] When multi-component fibres are included in the fibre mix, the higher melting point portion may contribute to the content of crimped synthetic fibre in the scouring material produced (see above).

The Binder Resin

[0048] Any resin known to be suitable for roll-coating and for use in the manufacture of scouring materials can be used in the roll-coating stations **13** of the apparatus shown in FIGS. **3** and **4** although, for environmental reasons, water-based resins are preferred. The resin should be selected to provide the scouring material with sufficient flexibility and strength for its intended use, and with the appropriate degree of water and heat resistance. Suitable resins include phenolic resins, polyurethane resins, polyureas, styrene-butadiene rubbers, nitrile rubbers, epoxies, acrylics, and polyisoprene. The resin is preferably water soluble. Examples of water soluble resins include modified styrene-butadiene rubbers, polyethylene glycol, polyvinylpyrrolidones, polylactic acid (PLA), polyvinylpyrrolidone/vinyl acetate copolymers, polyvinyl alcohols, carboxymethyl celluloses, hydroxypropyl cellulose starches, polyethylene oxides, polyacrylamides, polyacrylic acids, cellulose ether polymers, polyethyl oxazolines, esters of polyethylene oxide, esters of polyethylene oxide and polypropylene oxide copolymers, urethanes of polyethylene oxide, and urethanes of polyethylene oxide and polypropylene oxide copolymers.

[0049] The coating weight of the binder resin may be in the range of from 50 to 300 g/m^2 (dry), more specifically 100 to 200 g/m^2 (dry).

The Optional Make-Coat Resin or Abrasive-Resin Slurry

[0050] The slurry applied in the spray booths **18**, **19**, when used, typically comprises abrasive particles in an amount in the range of from 30 to 55% by weight.

[0051] The abrasive particles used in the slurry can be of any type known to be suitable for scouring materials, taking into account the nature of the surfaces to be cleaned and the abrasive action that the scouring material is required to produce. Suitable abrasive materials include inorganic materials, for example aluminium oxide (including ceramic aluminium oxide, heat-treated aluminium oxide, and white-fused aluminium oxide), silicon carbide, tungsten carbide, alumina zirconia, diamond, ceria, cubic boron nitride, silicon nitride, garnet, and combinations thereof. Suitable abrasive materials also include softer, less aggressive materials such as polymeric particles and crushed natural materials (for example, crushed nut shells). Suitable polymeric materials for the abrasive particles include polyamide, polyester, poly(vinyl chloride, poly(methacrylic) acid, polymethylmethacrylate, polycarbonate, polystyrene, and melamine-formaldehyde condensates. The abrasive particles should have a particle size small enough to allow them to penetrate into the bonded web **12'** and, subject to that, it is contemplated that abrasive agglomerates, for example those described in U.S. Pat. No. 4,625,275 and U.S. Pat. No. 4,799,939, may also be used.

[0052] The make-coat resin used, with or without the abrasive particles, can be any resin known to be suitable for spray-coating and as a make-coat in scouring materials although, for environmental reasons, water-based resins are preferred. The resin should be selected to provide the scouring material with sufficient flexibility and strength for its intended use, and with the appropriate degree of water and heat resistance. Suitable resins include any of the resins listed above for use in the roll-coating equipment. Preferred resins include water-based phenolic resins (especially for harder-wearing scouring material) and water-based latex resins (especially for non-scratch scouring materials for use in bathrooms etc.).

[0053] The coating weight of the make-coat resin may be in the range of from 50 to 400 gsm(wet), more specifically 150 to 250 gsm(wet).

[0054] Dispersed throughout the binder or make-coat resin, or separately applied following application of the resin may be a crosslinker, filler, catalyst, fragrance, perfume, microcapsules, antibacterial agents, antimicrobial agents, antifungal agents, antifoaming agents, thickeners, or fillers.

EXAMPLES

[0055] Scouring materials in accordance with the disclosure, and methods for producing them, are described in the following non-limiting examples. All parts and percentages are by weight unless otherwise indicated. The examples used the following materials and equipment:

Materials

[0056] Agave fibres: Grade 1 natural fibres from the leaves of *Agave tequilana* plants, available through Vinmexco of Stanton, Calif. 90680, USA.

Sisal fibres: natural fibres from the leaves of *Agave sisalana* plants, available from CORONA Comercio Industria of Salvador, Brazil.

Coco fibres (also known as coir): natural fibres from the tissues surrounding the seed of *Cocos nucifera* (the coconut palm), available from AVW Vietnam Ltd of Buggenhout, Belgium.

Hemp fibres: natural fibres from the leaves of *Musa textilis* plants, available from Caruso GmbH of Ebersdorf, Germany.

Curaua fibres: natural fibres from the leaves of *Ananas lucidus* Miller plants, available from Pematec-Triangel do Brazil Ltda. of Sao Bernardo Do Campo, Brazil.

Heat-sensitive fibres: bi-component polyester fibres having, a linear density of 72 dtex and a length of 53 mm, available from Fiber Innovation Technology, Inc. of Johnson City, Tenn., USA; and bi-component copolyester/polyester fibres having a linear density of 15 dtex and a length of 40 mm, available from Huvis Corporation of Guangzhou, Guangdong Province, China.
Polyamide fibres: nylon 6.6 fibres having a linear density of 22 dtex and a length of 40 mm, available from Rhodia SA, of Paris La Défense, France.
Water-based latex resin: SBR latex resin, available from PolymerLatex GmbH of Marl, Germany.
Water-based acrylic resin: Acrodur 3558 resin, available from BASF of Ludwigshafen, Germany.
Abrasive particles: grade P400 aluminium oxide particles available, under the trade designation "Corundum FRPL", from Treibacher Schleifmittel AG of Villach, Austria.

Equipment:

[0057] Web-forming equipment: a pilot or an industrial scale "Rando Webber" machine, both available from the Rando Machine Co. of Macedon, N.Y., USA; or a "DOA Webber" machine available from DOA of Linz, Austria.
Roll coating apparatus: equipment available, under the trade designation PSI-33737, from CAVITEC AG of Tobel, Germany.
Ovens: through-air bonding ovens available from CAVITEC AG of Tobel, Germany.
Spray equipment: Spray guns (type A25 with type 227T nozzles) available, under the trade name "Kremlin", from KREMLIN REXON of Stains, France.

Example 1

[0058] A fibre mixture comprising, by weight, 80% agave fibres and 20% heat-sensitive fibres (72 dtex linear density) was used in the pilot scale "Rando Webber" to form a non-woven web of fibres having a thickness of about 25 mm and a basis weight of about 400 g/m^2. The web was then passed through an oven which was operated at a temperature of 140° C. The web had a dwell time of 3 minutes in the oven to soften the heat-sensitive fibres so that, when the web left the oven and cooled, some of the fibres in the web were bonded together, giving the web a greater degree of cohesion.

[0059] The pre-bonded web was then passed between the rolls of the roll-coating apparatus in which it was impregnated with the latex resin. The web was passed once again through an oven, operated this time at 170° C. The web had a dwell time of 8 minutes in the oven to cure the resin and was then allowed to cool forming a bonded web.

Examples 2 to 5

[0060] Example 1 was repeated, except that the agave fibres were replaced with sisal fibres (Example 2); coco fibres (Example 3); hemp fibres (Example 4); and curaua fibres (Example 5).

Example 6

[0061] Example 1 was repeated, except that the latex resin applied by the roll coating apparatus was replaced by the acrylic resin.

Examples 7 and 8

[0062] Example 1 was repeated, except that the bonded web from the roll-coating apparatus was sprayed on both sides, using the spray equipment, with a slurry of the latex resin and the abrasive particles (the latter making up 45% by weight of the slurry). The slurry was applied at rates of 150 g/m^2 (Example 7) and 200 g/m^2 (Example 8).

Example 9

[0063] A fibre mixture comprising, by weight, 80% agave fibres and 20% polyamide fibres was used in the industrial scale "Rando Webber" to form a non-woven web of fibres. The web was produced under operating conditions similar to those used to produce non-woven webs of synthetic fibres for scouring materials and had a basis weight of about 220 g/m^2. The web was then passed between the rolls of the roll-coating apparatus in which it was impregnated with the latex resin. The web was then passed through an oven which was operated at a temperature of 150° C. to cure the resin, the dwell time of the web in the oven being about 1 minute. The web was then allowed to cool, forming a bonded web.

Example 10

[0064] Example 9 was repeated except that the fibre mixture comprised, by weight, 60% agave fibres and 40% polyamide fibres and was used in the industrial scale "Rando Webber" to form a non-woven web of fibres having a basis weight of about 215 g/m^2.

Example 11

[0065] Example 1 was repeated except that the fibre mixture comprised, by weight, 70% agave fibres, 15% polyamide fibres and 15% heat-sensitive fibres (15 dtex linear density) and was used in the "DOA Webber" to form a non-woven web of fibres having a thickness of about 10 mm and basis weight of about 200 g/m^2.

Results

[0066] The webs of Examples 1 to 3 exhibited only a limited decrease in thickness as a result of the roll-coating step. In each case, the open structure of the web was retained sufficiently to provide samples suitable for use as a scouring material. Of these webs, that of Example 1 exhibited the lowest decrease in thickness as a result of the roll-coating step. The webs of Examples 4 and 5, on the other hand, exhibited a substantial decrease in thickness as a result of the roll-coating step and were considered to be too compacted to be of use as scouring materials.

[0067] The web of Example 6 indicated that the use of a different water-based resin for the roll-coating step also did not produce any significant change in the results.

[0068] The webs of Examples 7 and 8 demonstrated that the bonded webs could be sprayed with an abrasive slurry in the same way as conventional non-woven scouring materials formed from synthetic fibres.

[0069] The webs of Examples 9 and 10, prepared without the use of heat-sensitive fibres and the formation of a pre-bonded web also exhibited only a limited decrease in thickness as a result of the roll-coating step. In each case, the open structure of the web was retained sufficiently to provide samples suitable for use as a scouring material.

[0070] The web of Example 11 exhibited very little change in thickness as a result of the roll-coating step. The open structure of the web was retained sufficiently to provide samples suitable for use as a scouring material. It was also observed that less dust was produced during the web-forming process.

CONCLUSIONS

[0071] The Examples show that non-woven fibrous scouring materials comprising a substantial amount of natural vegetable fibres can be produced using a conventional process (in some cases one that involves the formation of a pre-bonded web), through an appropriate selection of the natural vegetable fibres employed and by including, with the natural fibres, an appropriate amount of crimped synthetic fibres.

What is claimed is:

1. A scouring material comprising a three-dimensional non-woven web of entangled fibres bonded to one another at mutual contact points, wherein:

(i) the fibres comprise natural vegetable fibres in an amount of at least 50% by weight, and crimped synthetic fibres in an amount of at least 5% by weight;

(ii) the fibres, throughout the web, have a substantially continuous coating of binder resin; and

(iii) the web of bonded fibres has a maximum density of 60 kg/m^3.

2. The scouring material of claim **1**, wherein the natural vegetable fibres comprise fibres from the hearts of *Agave tequilana*; fibres from the leaves of *Agave sisalana*; or fibres from the tissues surrounding the seeds of *Cocos nucifera*; or mixtures thereof.

3. The scouring material of claim **1**, wherein the amount of natural vegetable fibres in the non-woven web is greater than 50% by weight.

4. The scouring material of claim **3**, wherein the amount of natural vegetable fibres in the non-woven web is at least 60% by weight.

5. The scouring material of claim **2**, wherein the natural vegetable fibres also comprise finer fibres.

6. The scouring material of claim **1**, wherein the crimped synthetic fibres comprise polyamide fibres; polyester fibres; polypropylene fibres; or mixtures thereof.

7. The scouring material of claim **1**, wherein the crimped fibres have a denier of at least 2 dtex, preferably at least 15 dtex.

8. The scouring material of claim **1**, wherein the binder resin is a water-based resin, for example a latex resin or an acrylic resin.

9. The scouring material of claim **1**, wherein at least some of the fibres are bonded to one another at mutual contact points by a pre-bond resin.

10. The scouring material of claim **9**, wherein the pre-bond resin is a polyester resin.

11. The scouring material of claim **1**, further comprising abrasive particles adhered to the web by a make-coat resin.

12. The scouring material of claim **11**, wherein the abrasive particles comprise aluminium oxide particles or poly(vinyl chloride) particles.

13. The scouring material of claim **11**, wherein the make-coat resin is a water-based resin, for example a latex resin or an acrylic resin.

14. A method of making a scouring material of claim **1**, the method comprising the steps of:

(a) forming a three-dimensional non-woven web of entangled fibres;

(b) roll-coating the web with a binder resin; and

(c) curing the binder resin to form the scouring material.

15. The method of claim **14**, wherein the fibres include heat-sensitive fibres and the method comprises the further step, between steps (a) and (b), of applying heat to the web to form a pre-bonded web in which some at least of the fibres are bonded to one another at mutual contact points by a pre-bond resin provided by the heat-sensitive fibres.

16. The method of claim **15**, wherein the heat-sensitive fibres are polyester fibres.

17. The method of claim **15**, wherein the heat-sensitive fibres also provide at least some of the crimped synthetic fibres in the scouring material.

18. The method of claim **14**, comprising the further step, after step (c), of spraying the web with a slurry of abrasive particles in a make-coat resin.

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