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(54) **Process for treating secondary cotton fibers and use of the regenerated fibers in the manufacture of tissue paper**

(57) Process for treating secondary cotton fibers re-generated from cotton rags, wherein the rags are crushed in dry conditions by the action of a set of blades and a set of counter-blades rotating in relation to each other, and the resulting crushed material is graded, collecting the fraction smaller than a preset value. Then a

water suspension is prepared, containing said crushed material in clumps, which is treated in a disperser to separate the clumps into single fibers. Finally, the water content of the suspension is reduced for the storage of the resulting fibers in damp or dry form.

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Description

[0001] This invention generally relates to the papermaking industry and, more precisely, it refers to a process for treating secondary cotton fibers and using the cotton fibers thus regenerated in the production of tissue paper, mainly for personal hygiene and for domestic and sanitary uses, e.g. toilet paper, kitchen paper, paper napkins, paper handkerchiefs and so on.

[0002] It is common knowledge that the essential qualities required of tissue paper for the above-mentioned uses are softness and absorbency. Very soft tissue paper can currently be obtained by using very soft fibers (e.g. eucalyptus) in its production, but these are considerably more expensive than the commonly used fibers (conifers and broad-leaved trees), or soft-type mechanical processes can be used in paper machines, but this coincides with either a significant reduction in productivity or a considerable increase in energy costs.

[0003] Adding variable proportions of virgin cotton as a raw material to the cellulose enables tissue paper of adequate softness and absorbency to be obtained thanks to the chemical and physical properties of cotton fiber. In fact, it has a larger lumen than other cellulose fibers, a longer staple, and almost twice the capillary force of conventional cellulose fibers; in practical terms, conventional cellulose fiber can absorb 5-6 g of water per g of fiber, whereas cotton fiber can reach 10-12 g of water per g of fiber. The cost of cotton fiber is currently approximately 3-4 times the cost of conventional cellulose fiber, however, which makes it economically unfeasible to recommend its use in this application.

[0004] It is also common knowledge that, for cellulose fibers to be suitable for use in the papermaking sector, their mean staple must be reduced to 1.5-2.5 mm, at least, before they can enter the production cycle. Shorter staples can be used, of course, but this generally reduces the strength of the end-product. Despite their cost, cotton linters have been used for special purposes in the papermaking sector (paper securities, paper money, lithographic paper, wedding invitations, etc.), but these fibers are between 10 and 50 mm long and 12-40 μ wide, so they have to undergo a size reduction treatment, which currently means a considerable additional cost, especially in terms of energy consumption.

[0005] Using currently-available methods, even higher production costs are involved in the use of secondary cotton fibers regenerated from recycled textile products, such as cotton rags obtained from bed linen, T-shirts, tablecloths, trousers, shirts, etc., so despite the ready availability on the market of such materials at convenient prices (as little as a quarter of the cost of cellulose), this option has hitherto met with little success. The main reason for the high production costs lies in the fact that the cotton fibers used in the textile sector have a much longer staple because they come from the cotton flower, whose fibers have staple lengths in the order of several centimeters. Fibers of this length could not be used in the papermaking sector because they would give rise to "threads" that would clog piping and tuns. The known process for reducing the staple of cellulose and cotton fibers involves suspending the material from which the fiber is to be obtained in water, and opening and cutting these materials with the aid of deflakers and refiners to reduce the fibers down to the required staple. This treatment is water- and electrical energy-intensive, and their consumption is obviously all the greater the longer the staple of the fiber contained in the original material. It is also worth mentioning that hydrating the cotton fiber during this treatment reduces the fiber's absorbency and softness (though it improves the mechanical strength of the paper) and the subsequent drying process on the hydrated fiber is even more expensive in terms of the heat energy required.

[0006] The object of the present invention is to provide a process for treating secondary cotton fibers to enable their use in the papermaking sector, and the production of tissue paper in particular, with operating costs such that make it economically convenient to use secondary cotton fibers for this application.

[0007] Another object of the present invention is to provide a process for treating secondary cotton fibers of the above-mentioned type that does not involve any heavy hydration of the fibers being treated, thereby avoiding the softness and absorbency of the fibers being negatively affected and containing the related energy consumption.

[0008] A further object of the present invention is to provide a treatment process of the above-mentioned type that also enables the use of colored fabrics as raw materials.

[0009] Yet another object of the present invention is to enable the cotton fiber treated and regenerated according to the above-mentioned process to be used as a raw material for the production of very soft and absorbent tissue paper at a cost comparable with that of the tissue paper currently on the market.

[0010] These objects are achieved by the process for treating secondary cotton fibers according to the present invention, the fundamental characteristics of which are set forth in claim 1.

[0011] Further important features are illustrated in the dependent claims.

[0012] The essential characteristic element of the treatment process according to the present invention consists in the fact that the raw material, comprising cotton rags, undergoes a dry size reduction and grading treatment, progressively collecting the smaller-staple fibers at a preset value as they are produced by the size reduction treatment. The collected fibers are sent to a tank where they are mixed with water to form a suspension that subsequently undergoes a deflaking treatment to separate the single fibers, an operation that is preferably achieved in a "dispenser" after the suspension has passed through a heated tunnel to increase its concentration.

[0013] In the event of starting with colored rags, the fibers obtained are bleached using a chemical-thermal process

to restore them to their natural raw cotton color, then they are washed and, if necessary, submitted to an additional whitening process. After these treatments, the fibers are ready for storage and/or sale in damp or dry form. In the former case, they are spread into sheets and pressed to obtain a partial mechanical dewatering to achieve a dry content coming between 35 and 50%, while in the latter case they are sent to a drier and then collected in bales with a dry content of approximately 95%.

[0014] According to a preferred embodiment of the invention, the bulk material to be treated (cotton rags of various origin, size and color) is loaded manually onto a conveyor belt fitted with a metal detector to eliminate any concealed metal parts, which must be removed to avoid damaging the machinery downstream. After this check, the material is sent to the size reduction stage, involving a machine that consists of a rotor carrying a number of blades staggered to form a wedge shape and a counterplate fitted with a corresponding number of blades, hermetically sealed inside an outer casing, the bottom of which contains a perforated metal sheet with calibrated holes. Depending on the diameter of the holes in the sheet, the material will continue to be reduced by the rotating movement of the blades and counter-blades until it reaches the required staple, corresponding to the diameter of the holes in the sheet. Machines of this type are not in use in the papermaking sector, because this is a mill/grinder type of machine. The machine can enable very high production rates to be obtained by comparison with other conventional mills, or it can enable over 50% installed power reduction for the same output. This "mill" can be loaded horizontally (from the front) or vertically (from above) and ensures the grinding/cutting of the fibers to the required staple length by means of a presser coming to bear against the rotor. In fact, it comprises a rotor-supporting casing made of thick electrowelded metal, a central rotor with interchangeable plates with a constant profile on the diameter, that are staggered and at a cutting angle studied specifically to ensure a good productivity with a limited power requirement and a low noise coefficient. The set of axially-adjustable fixed blades, made of special hardened and ground steel, includes a water cooling system serving various parts of the journal boxes and bearings, in the area of the blades and where overheating can easily occur. A forced lubrication is also provided in the bearings. Such machinery has hitherto been used for treating medium- and large-sized hard products (plastic, rubber tires, vulcanized rubber, fitted carpets, seals, wood, paper and cardboard boxes, etc.).

[0015] The material, reduced to small clumps of fibers, is drawn into a duct underneath the plate by the action of a suction fan that conveys the fibers to a tank where they are mixed with water. In practical terms, the dry fibers obtained after the size reduction treatment are sent to a tank of water to obtain a suspension containing 4-4.5% of fibers. This concentration of the suspension ensures the optimal balance between the opposing needs to have a sufficiently consistent mixture without inducing any circulation problems inside the piping, while containing the energy consumption and the dimensions of the equipment.

[0016] The consistency of the suspension is kept constant by means of a consistency regulator installed on the piping that draws the material from the bottom of the tank and circulates the water suspension in the tank with the aid of a pump. Any heavyweight contaminants (e.g. fragments of crushed buttons, etc.) or lightweight contaminants (e.g. synthetic fibers from labels, etc.) contained in the original material are simultaneously removed by means of a high-density cleaning process performed by static cleaners, machines that are well known in the papermaking sector.

[0017] The suspension containing the clumps of fibers is heated by passing it through a heating tunnel, then sent to a disperser (such as the dispersion system manufactured by Cellwood Machinery AB). This equipment carries out the deflaking of the clumps of fibers, and their separation to unitary fibers by passing them through two sets of blades with triangular teeth set at an electronically-adjusted distance from each other. The concentration of the suspension leaving the disperser is maintained preferably at approximately 30% in fiber content in order to contain the energy consumption. In a variant of this embodiment, the disperser may be made to run without heating, but the absorbed power would be much higher.

[0018] If necessary, the 30% suspension leaving the disperser can be sent to a bleaching stage, conducted in a substantially known manner, using an alkaline-based chemical-thermal process. Tests showed that placing the colored cotton fibers in water with sodium hypochlorite and hydrochloric acid, heating the mixture to boiling point for a given amount of time and subsequently washing the cotton fibers while stirring the mixture thoroughly can result in a complete bleaching of the fibers, while any synthetic or mixed fibers will be unaffected by this bleaching action. The strong concentration of the suspension enables savings on the quantity of chemical products required, while the high temperature (around 100°C) facilitates the chemical aggression on the coloring agents.

[0019] The bleached fibers are washed and, if they are destined for the production of quality personal hygiene products, they are also whitened using ozone or high-volume oxygenated water processes, according to well-known methods.

[0020] The washed and, where necessary, whitened fibers can then be sent for storage and/or sale in damp form (40-50% of dry content). For this purpose, they are sent to a sheet-forming machine that also includes a pair of mechanical dewatering presses. Alternatively, they can be stocked and/or sold in dry form, in which case they are sent to a drier and then packaged in bales.

[0021] The fibers obtained by the process according to the present invention can be used in the manufacture of

tissue paper (toilet paper, kitchen paper, facial tissues, industrial uses, etc.) or in combination with cellulose fibers of various nature and origin. Particularly good results have been obtained by adding 20-22% of cotton fibers as obtained using the process according to the present invention to a cellulose mixture of the type conventionally used in the production of tissue paper. The resulting tissue paper is characterized by a greater final thickness (from 5 to 25% more than conventional tissue paper, depending on the percentage of secondary cotton fibers), and a greater water absorbency than similar products made with cellulose (from 5 to 70% more, depending on the percentage of secondary cotton fibers). In addition, the use of these cotton fibers also offers an energy saving in the production of tissue paper because their greater drying capacity means they demand a lower hood temperature and a consequently lower gas consumption.

[0022] Industrial tests performed on the tissue paper made from cellulose fiber mixtures containing 20-22% of secondary cotton fibers manufactured with the process according to the present invention produced the following results:

TEST	GR/M ²	LONGITUDINAL STRENGTH	TRANSVERSAL STRENGTH	THICKNESS OF 10 SHEETS	MACHINE M/MIN	WINDER M/MIN	% CREPING
1	16.4	950	660	1.14	1440	615	54
2	16.9	890	610	1.35	1400	760	54
3	17.1	940	600	1.15	1400	860	49

[0023] Concerning the outcome of these tests, the following should be noted:

1. the values obtained in test No. 1 refer to the mechanical and physical characteristics of conventional tissue paper;
2. test No. 2 represents the mechanical and physical characteristics of a first type of tissue paper achieved with secondary cotton fibers. Clearly, although the paper was 18% thicker than the conventional tissue paper, the production rate was increased by approximately 23% thanks to the greater drying capacity achieved by including the cotton fibers in the mixture;
3. test No. 3 represents the mechanical and physical characteristics of a second type of tissue paper produced with secondary cotton fibers. In this case, the thickness was the same as that of the conventional tissue paper, but there was an approximately 39% further increase in productivity;
4. the tissue paper illustrated in test No. 3 has a 46% higher water absorbency than the conventional tissue paper in test No. 1.

[0024] The tests showed that the softness and absorbency of the tissue paper manufactured are greater, the greater the proportion of regenerated cotton fibers in the mixture, starting from a minimum value of 5%, below which any improvements are imperceptible. A concentration of 20-25% of regenerated cotton fibers in the mixture can be considered ideal, also in relation to the rising costs that greater concentrations entail.

[0025] The cost of cotton fibers regenerated with the process according to the present invention is currently approximately 20% higher than the cost of cellulose, so the fibers are more expensive than cellulose, but much less expensive than virgin cotton, though they produce the same effects. A similar product cannot be obtained with the conventional paper machine (C-Former, S-Former, Crescent Former, Fourdrinier table, etc.) for technological reasons, while the TAD (Through Air Dryer) paper machine means an initial investment cost corresponding to approximately 2.7 times the cost of the traditional system, along with running costs that involve a 50% reduction in energy costs, a tenfold saving on the chemical products, a 1.7-fold reduction in terms of the gas consumption and a 7-8% increase in the efficiency of the paper machine. In practice, while the TAD process has to stop frequently due to technological problems or tearing of the paper or for more intensive servicing of the machinery, the process according to the present invention is not only more straightforward, but also enables these frequent stoppages to be avoided.

[0026] Variants and/or modifications can be made to the secondary cotton fibers treatment process and their usage in the production of tissue paper, without this departing from the scope of the invention, as specified in the following claims.

Claims

1. Process for treating secondary cotton fibers regenerated from cotton rags **characterized in that** it comprises the following stages:

- crushing said rags in dry conditions due to the action of a set of blades and a set of counter-blades rotating

in relation to each other;

- grading the resulting crushed material and collecting the fraction reduced to a size smaller than a preset value;
- preparing a water suspension containing clumps of said crushed material;
- treating said suspension in a disperser to separate the clumps into single fibers;
- reducing the water content in said suspension for the storage of the fibers thus obtained in damp or dry form.

2. Process according to claim 1, wherein the crushing of the rags is conducted in dry conditions in a machine with a rotor carrying a number of blades staggered in a wedge shape and a counter-plate fitted with the same number of blades, hermetically sealed inside an outer casing.

3. Process according to claims 1 or 2, wherein the grading of the crushed material is done by means of a perforated metal sheet with calibrated holes situated at the bottom of the outer casing.

4. Process according to any of the previous claims, wherein said water suspension is heated before it is treated in the disperser.

5. Process according to any of the previous claims, wherein said water suspension entering the disperser has a concentration of fibers preferably corresponding to 4-4.5% w/w.

6. Process according to any of the previous claims, wherein the concentration of fibers in the suspension leaving the disperser is preferably around 30% w/w.

7. Process according to any of the previous claims, wherein the suspension leaving the disperser undergoes a fiber bleaching and subsequent washing stage.

8. Process according to any of the previous claims, wherein the bleached fibers undergo a whitening treatment.

9. Process according to any of the previous claims, wherein the fibers contained in the suspension leaving the disperser, after any bleaching and whitening, are dewatered to obtain a 35-50% of fiber content and pressed into sheets.

10. Process according to any of the claims from 1 to 8, wherein the fibers contained in the suspension leaving the disperser, after any bleaching and whitening, are dewatered to approximately 95% w/w of fiber.

11. Use of the cotton fibers regenerated from cotton rags by the process according to any of the previous claims for the production of tissue paper.



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EUROPEAN SEARCH REPORT

Application Number
EP 04 42 5306

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 13 October 2004	Examiner Fiocco, M
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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