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(54) PAPER SHEET AND METHOD FOR MANUFACTURING PAPER SHEET

(57) A paper sheet includes: cellulose ester staple fibers; pulp fibers; and a binder. A plurality of creped portions are formed on a surface of the paper sheet, such that the creped portions are arranged in a flow direction of the cellulose ester staple fibers and the pulp fibers and extend in an orthogonal direction orthogonal to the flow direction.

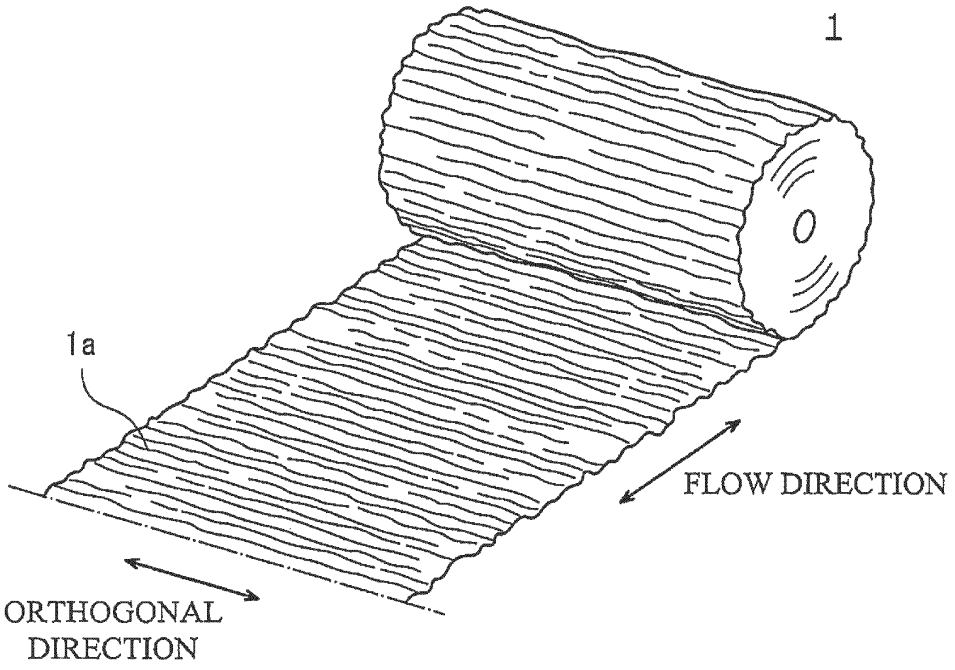

FIG.1

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Description

Technical Field

[0001] The present invention relates to a paper sheet having excellent processability, the paper sheet realizing excellent production efficiency of processed products made thereof, and also relates to a method of producing the paper sheet.

Background Art

[0002] Cellulose ester compounds typically represented by cellulose acetate are excellent natural polymer compounds that are safe and highly processable. Cellulose ester compounds are widely utilized for clothing fibers, various plastics, cigarette filters, etc. For example, cellulose ester compounds are made from cellulose obtained from plant resources (biomass) that are produced in the greatest quantity on earth, such as wood pulp and cotton. Therefore, such environmental-friendly cellulose ester compounds are regarded as suitable raw materials for a recycling-oriented society, and the expansion of the use of cellulose ester compounds instead of chemical fibers and plastics that are made from petroleum is expected.

[0003] For example, Patent Literature 1 discloses a technique for producing a paper sheet containing cellulose ester staple fibers, pulp fibers, and a binder. Such a paper sheet is, for example, usable as the material of a processed product, such as a cigarette filter, as disclosed in Patent Literatures 2 and 3.

[0004] The paper sheet is, for example, produced in a continuous belt-like shape by using a wet paper machine. The continuous belt-shaped paper sheet is subjected to slitting to have a required width, and is then wound into a roll. In a processing machine, the wound paper sheet is drawn from the roll and subjected to continuous processing while being fed at a predetermined feeding speed.

Citation List

Patent Literature

[0005]

PTL 1: Japanese Patent No. 5225489
PTL 2: Japanese Patent No. 3606950
PTL 3: Japanese Laid-Open Patent Application Publication No. 2001-120248

Summary of Invention

Technical Problem

[0006] When the wound paper sheet is drawn from the roll to continuously produce processed products by using the paper sheet, if tension is exerted on the paper sheet in the feeding direction to a certain degree or greater, the paper sheet may become damaged. As a result, the processability of the paper sheet may be lowered. Consequently, it may become difficult to improve the production efficiency of the processed products by increasing the feeding speed of the paper sheet.

[0007] In view of the above, an objective of the present invention is to, in the case of producing processed products by using a paper sheet containing cellulose ester staple fibers, make it possible to prevent damage to the paper sheet and improve production efficiency of the processed products.

Solution to Problem

[0008] In order to solve the above-described problems, a paper sheet according to one aspect of the present invention includes: cellulose ester staple fibers; pulp fibers; and a binder, wherein a plurality of creped portions are formed on the paper sheet, such that the creped portions are arranged in a flow direction of the cellulose ester staple fibers and the pulp fibers and extend in an orthogonal direction orthogonal to the flow direction.

[0009] According to the above configuration, the plurality of creped portions (continuous or non-continuous wrinkles), which are arranged in the flow direction of the cellulose ester staple fibers and the pulp fibers and extend in the orthogonal direction orthogonal to the flow direction, are formed on the paper sheet. Accordingly, when producing processed products by using the paper sheet while feeding the paper sheet in the flow direction, if tension is exerted on the paper sheet in the flow direction, the paper sheet stretches in the flow direction. This makes it possible to prevent damage to the paper

sheet and prevent the processability of the paper sheet from being lowered. Since damage to the paper sheet due to the tension being exerted on the paper sheet in the flow direction is prevented, the feeding speed of the paper sheet in a processing machine can be increased, and thereby the production efficiency of the processed products can be improved.

[0010] The paper sheet may be formed in a belt-like shape, such that a longitudinal direction of the paper sheet is the flow direction. Accordingly, when the paper sheet that has been wound into a roll is drawn from the roll and fed in order to be continuously processed by a processing machine, even if tension is exerted on the paper sheet in the longitudinal direction (feeding direction), damage to the paper sheet is less likely to occur, which makes it possible to further improve the production efficiency of the processed products.

[0011] A crepe ratio of the paper sheet may be set to a value within a range of not less than 5% and not greater than 35%. Since the crepe ratio is set to such a value, when tension is exerted on the paper sheet in the flow direction, the paper sheet stretches in the flow direction, and thereby damage to the paper sheet can be suitably prevented.

[0012] A breaking elongation of the paper sheet in the flow direction may be set to a value within a range of not less than 10% and not greater than 70%. Since the breaking elongation is set to such a value, when tension is exerted on the paper sheet in the flow direction, damage to the paper sheet can be favorably prevented.

[0013] A tensile strength of the paper sheet in the flow direction may be set to a value within a range of not less than 1.5 N/25 mm width and less than 40 N/25 mm width. Accordingly, when reeling in the paper sheet in the flow direction, the paper sheet can be prevented from breaking due to the tension exerted on the paper sheet in the flow direction, and also, the processability of the paper sheet can be suitably kept.

[0014] The binder may be an alkali salt of a polysaccharide containing a carboxyl group. The use of the binder of this kind makes it possible to efficiently produce a processed product having high water disintegrability by using the paper sheet.

[0015] The paper sheet may be a filter material of a cigarette filter. Since the plurality of creped portions, which are arranged in the flow direction and extend more in the orthogonal direction than in the flow direction, are formed on the paper sheet, the paper sheet has a large area. Accordingly, by using the paper sheet as a filter material of the cigarette filter, plenty of fine spaces can be uniformly formed inside the cigarette filter. As a result of the fine spaces being uniformly formed, a cigarette filter having a beautiful cross section with no unevenness can be produced.

[0016] A method of producing a paper sheet according to another aspect of the present invention includes: a sheet body forming step of forming a sheet body containing cellulose ester staple fibers, pulp fibers, and a binder; and a creping step of forming a plurality of creped portions on the sheet body, such that the creped portions are arranged in a flow direction of the cellulose ester staple fibers and the pulp fibers and extend in an orthogonal direction orthogonal to the flow direction.

[0017] The sheet body forming step may include forming the sheet body in a belt-like shape, such that a longitudinal direction of the sheet body is the flow direction.

[0018] In the above producing method, a crepe ratio of the paper sheet may be set to a value within a range of not less than 5% and not greater than 35%.

[0019] In the above producing method, by setting the crepe ratio to the value, a tensile elongation of the paper sheet in the flow direction may be set to a value within a range of not less than 10% and not greater than 70%.

[0020] In the sheet body forming step of the above producing method, a tensile strength of the paper sheet in the flow direction may be set to a value within a range of not less than 1.5 N/25 mm width and less than 40 N/25 mm width by adjusting at least one of a blending ratio of the cellulose ester staple fibers, the pulp fibers, and the binder, a basis weight of the paper sheet, a beating degree of the cellulose ester staple fibers and the pulp fibers, and a crepe ratio of the paper sheet.

[0021] In the above producing method, an alkali salt of a polysaccharide containing a carboxyl group may be used as the binder.

Advantageous Effects of Invention

[0022] Each of the above aspects of the present invention makes it possible to, in the case of producing processed products by using a paper sheet containing cellulose ester staple fibers, prevent damage to the paper sheet and improve the production efficiency of the processed products.

Brief Description of Drawings

[0023]

FIG. 1 shows a paper sheet according to an embodiment.

FIG. 2 is a general view of a paper machine for producing the paper sheet of FIG. 1.

FIG. 3 is a production process chart that shows processes for producing the paper sheet of FIG. 1.

FIG. 4 is a graph showing a relationship between the breaking elongation and the tensile strength of each of paper sheets of Comparative Examples and Examples.
FIG. 5 is a graph showing a relationship between the crepe ratio and the tensile strength of each of the paper sheets of Comparative Examples and Examples.
FIG. 6 is a graph showing a relationship between the crepe ratio and the breaking elongation of each of the paper sheets of Comparative Examples and Examples.
FIG. 7 is a graph showing a relationship between the crepe ratio and the air resistance of each of the paper sheets of Comparative Examples and Examples.

Description of Embodiments

[Paper sheet]

[0024] FIG. 1 shows a paper sheet 1 according to an embodiment of the present invention. The paper sheet 1 contains cellulose ester staple fibers, pulp fibers, and a binder. As one example, the paper sheet 1 is produced in a belt-like shape by a paper machine 10 (see FIG. 2), and wound into a roll. FIG. 1 schematically shows, in an enlarged manner, creped portions 1a formed on the paper sheet 1. For example, the roll of the paper sheet 1 is subjected to slitting to have a required width in the subsequent processes, and drawn from the roll continuously for producing processed products.

[0025] As one example, the cellulose ester is cellulose acetate, which is a typical cellulose ester. The cellulose ester staple fibers may be crimped. In the case of imparting water disintegrability to the paper sheet 1, the cellulose ester staple fibers are preferably non-crimped fibers (uncrimped fibers). The definition of the non-crimped fibers herein includes not only fully straight fibers but also slightly curved fibers.

[0026] The non-crimped fibers can be obtained by a general chemical fiber spinning technique (e.g., dry spinning, wet spinning, or melt spinning). Alternatively, the non-crimped fibers can be obtained by applying tension to crimped fibers whose crimps have previously been formed in a spinning process while heating the crimped fibers by heating means such as heated steam, thereby fully removing the crimps and stretching the fibers.

[0027] By means of guillotine equipment or rotary cutter equipment whose feeding interval and feeding speed are adjustable, the cellulose ester staple fibers can be obtained from a filament fiber bundle that is obtained in the aforementioned spinning process. The process of turning cellulose ester fibers into the staple fibers by means of the guillotine equipment or the rotary cutter equipment may be performed continuously with the spinning process.

[0028] The average fiber length of the cellulose ester staple fibers (in the case of crimped fibers, the average value of the end-to-end distances of the crimped fibers in a natural state) can be set to, for example, a value within the range of not less than 1 mm and not greater than 6 mm, preferably a value within the range of not less than 1.5 mm and not greater than 5.0 mm, and more preferably a value within the range of not less than 2.0 mm and not greater than 4.5 mm.

[0029] The average fiber diameter of the cellulose ester staple fibers can be set to, for example, a value within the range of not less than 1.5 denier and not greater than 8.0 denier, preferably a value within the range of not less than 2.0 denier and not greater than 7.0 denier, and more preferably a value within the range of not less than 2.5 denier and not greater than 6.0 denier. Each of the cellulose ester staple fibers has, for example, a Y-shaped cross section. However, the cross-sectional shape of the cellulose ester staple fibers is not limited to a Y shape.

[0030] The crimpability, the average fiber length, the average fiber diameter, and the cross-sectional shape of the cellulose ester staple fibers can be confirmed by disintegrating the paper sheet 1 in water and observing the resulting water-disintegrated product with a microscope. The paper sheet 1 may also contain other fibers (synthetic fibers, recycled fibers, etc.) different from the cellulose ester fibers and the pulp fibers.

[0031] The pulp fibers are entangled with the cellulose ester staple fibers, and thereby the pulp fibers and the cellulose ester staple fibers are bonded to each other. Thus, by using the pulp fibers, the mechanical strength of the paper sheet 1 can be improved. In the case of producing a filter material, such as a cigarette filter, by using the paper sheet 1, the gaps between the fibers can be adjusted by adjusting the amount of pulp fibers, the amount of cellulose ester staple fibers, and the blending ratio of the pulp fibers and the cellulose ester staple fibers, and thereby a required filtration rate of, for example, smoke components can be adjusted.

[0032] The pulp can be made from natural fibers, such as wood and cotton linter. In a case where the pulp is made from wood, the wood may be either softwood or hardwood. Also in a case where the pulp is made from wood, a suitable pulping process to be adopted is a chemical pulping process, such as a sulfite process or kraft process. Among chemical pulps, kraft pulp is superior to the other pulps in terms of obtaining higher strength of the paper sheet 1 with the same composition ratio. The pulp may be any of bleached pulp, unbleached pulp, and a mixture of bleached pulp and unbleached pulp. The pulp is beaten by a common beater or disintegrator, and thus prepared for use.

[0033] The weight ratio of the weight of the cellulose ester staple fibers contained in the paper sheet 1 to the weight of the pulp fibers contained in the paper sheet 1 is suitably adjustable in accordance with, for example, a processed product that is produced by using the paper sheet 1. In the case of producing, for example, a cigarette filter by using the

paper sheet 1, the weight ratio is adjusted in accordance with required smoke filtration performance of the cigarette filter. The weight ratio of the weight of the cellulose ester staple fibers contained in the paper sheet 1 to the weight of the pulp fibers contained in the paper sheet 1 can be adjusted such that the weight ratio M1/M2 of the weight M1 of the cellulose ester staple fibers contained in the cigarette filter to the weight M2 of the pulp fibers contained in the cigarette filter is, for example, 30/70 to 95/5, preferably 40/60 to 80/20, and more preferably 50/50 to 70/30.

[0034] The binder causes the cellulose ester staple fibers and the pulp fibers to be bonded to each other. For example, a predetermined amount of water-soluble polymer may be used as the binder of the paper sheet 1, and thereby both strength of the paper sheet 1 in a dry state and water disintegrability of the paper sheet 1 can be realized.

[0035] As one example, a binder capable of imparting water disintegrability to the paper sheet 1 is used as the binder of the present embodiment. The binder of the present embodiment is an alkali metal salt of a water-soluble anionic polymer. Examples of the water-soluble anionic polymer include polysaccharides (e.g., a polysaccharide containing a carboxyl group, for example, carboxymethyl cellulose, carboxymethyl C_{2-3} alkyl cellulose such as carboxymethylethyl cellulose, carboxymethyl starch, or alginic acid; and a polysaccharide containing a sulfo group, for example, pectin, carageenan, hyaluronic acid, or chondroitin sulfuric acid) and polyacrylic acid. The binder of the present embodiment is an alkali salt of a polysaccharide containing a carboxyl group.

[0036] If the alkali metal salt of the water-soluble anionic polymer is contained in a predetermined amount in the paper sheet 1 as a binder, the bonding force between the cellulose ester staple fibers, the bonding force between the pulp fibers, and the bonding force between these two kinds of fibers when the paper sheet 1 is in a dry state are increased by the binder, and thereby the strength of the paper sheet 1 can be improved.

[0037] The acidic group (such as the carboxyl group or the sulfo group) of the water-soluble anionic polymer forms a salt with an alkali metal. Examples of the alkali metal include lithium, sodium, and potassium. Among these alkali metals, sodium is preferred. A single kind or two or more kinds of alkali metals may be used.

[0038] In the alkali metal salt of the polysaccharide containing the carboxyl group (e.g., carboxymethyl cellulose), the average substitution degree of the carboxyl group (e.g., carboxymethyl group) forming the alkali metal salt (e.g., average substitution degree with respect to hydroxyl groups at the second, third, and sixth positions of a glucose unit constituting the polysaccharide; average etherification degree; or DS) can be set to, for example, a value within the range of not less than 0.4 and not greater than 2.5, preferably a value within the range of not less than 0.55 and not greater than 2.0, and more preferably a value within the range of not less than 0.65 and not greater than 1.5.

[0039] The alkali metal content in the paper sheet 1 can be set to, for example, a value within the range of not less than 2 μmol and not greater than 100 μmol per gram of the paper sheet 1, preferably a value within the range of not less than 2 μmol and not greater than 90 μmol, more preferably a value within the range of not less than 2 μmol and not greater than 87 μmol, and particularly preferably a value within the range of not less than 3 μmol and not greater than 75 μmol.

[0040] The water-soluble anionic polymer alkali metal salt content (molar quantity of anionic group) in the paper sheet 1 may be the same as the alkali metal content (molar quantity) in the paper sheet 1. In the case of producing a cigarette filter by using the paper sheet 1, the water-soluble anionic polymer alkali metal salt content (molar quantity of anionic group) in the paper sheet 1 can be set, per gram of the cigarette filter, to a value within the same range as that mentioned above (e.g., to a value within the range of not less than 2 μmol and not greater than 100 μmol). It should be noted that the binder may be different from an alkali metal salt of a water-soluble anionic polymer.

[0041] The basis weight of the paper sheet can be set to, for example, a value within the range of not less than 10 g/m^2 and not great than 60g/m^2, and preferably a value within the range of not less than 15 g/m^2 and not greater than 50 g/m^2. The basis weight of the paper sheet 1 of the present embodiment is set to a value within the range of not less than 21 g/m^2 and not greater than 40 g/m^2.

[0042] It should be noted that the paper sheet 1 may contain at least one kind of additive agent. The additive agent is, for example, at least one of a sizing agent, a stabilizer, a colorant, an oil solution, a retention aid, a defoaming agent, and activated carbon. The additive agent is not limited to these examples.

[0043] On the paper sheet 1, a plurality of creped portions are formed such that the creped portions are arranged in a flow direction of the cellulose acetate staple fibers and the pulp fibers (hereinafter, this direction may be simply referred to as "the flow direction") and extend in an orthogonal direction orthogonal to the flow direction (hereinafter, this direction may be simply referred to as "the orthogonal direction"). In the present embodiment, the plurality of creped portions 1a extend parallel to the orthogonal direction.

[0044] The flow direction herein is the substantial orientation direction of the cellulose acetate staple fibers and the pulp fibers (i.e., the grain direction). In the process of continuously producing the paper sheet 1, these fibers are oriented in the orientation direction, because the speed of the flow of a composition that is the raw material of the paper sheet 1 when the composition is fed to a wire mesh 21 of the paper machine 10 is lower than the feeding speed of the wire mesh 21 (see FIG. 2). Accordingly, the fibers in the composition are deposited such that they are oriented more in the flow direction than in the other directions. That is, the flow direction coincides with the direction in which the composition is fed to the next process. As a result of the cellulose acetate staple fibers and the pulp fibers being deposited such that

they are oriented more in the flow direction, the strength and elongation of the paper sheet 1 in the flow direction differ from those of the paper sheet 1 in the orthogonal direction.

[0045] Generally speaking, the tensile strength of the paper sheet is greatest in the flow direction. Therefore, the flow direction of the paper sheet 1 and the orthogonal direction thereto can be confirmed by observing the tensile strength difference in the paper sheet 1 between two different directions, or by observing the fiber orientation in the paper sheet 1 with a microscope.

[0046] The paper sheet 1 is formed in a belt-like shape, and the longitudinal direction thereof is the flow direction. As a result of the plurality of creped portions 1a being formed on the paper sheet 1, stretchability is imparted to the paper sheet 1 such that the paper sheet 1 is stretchable in the flow direction, and also, the surface area of the paper sheet 1 per unit length in the flow direction is increased.

[0047] It should be noted that the "orthogonal direction orthogonal to the flow direction" herein is not limited to the direction that is exactly orthogonal to the flow direction, but includes, for example, directions that are each shifted from the exactly orthogonal direction by an angular value within the range of 10°.

[0048] The crepe ratio R of the paper sheet 1 is set to a value within the range of not less than 5% and not greater than 35%. The crepe ratio R is represented by Math. 1 shown below.

[Math. 1]

$$R = (V1 - V2) / V1 \times 100$$

In Math. 1, V1 is the peripheral speed of a heating roller 26 of the paper machine 10 when producing the paper sheet 1, and V2 is the peripheral speed of a winding reel 28 of the paper machine 10 when producing the paper sheet 1 (see FIG. 2).

[0049] The breaking elongation of the paper sheet 1 in the flow direction is set to a value within the range of not less than 10% and not greater than 70%. The tensile strength (N/25 mm width) of the paper sheet 1 can be set to, for example, a value within the range of not less than 1.0 N/25 mm width and not greater than 80 N/25 mm width, and preferably a value within the range of not less than 1.5 N/25 mm width and not greater than 40 N/25 mm width. In the present embodiment, the tensile strength of the paper sheet 1 in the flow direction is set to a value within the range of not less than 1.5 N/25 mm width and less than 40 N/25 mm width. The tensile strength of the paper sheet 1 can be measured, for example, in conformity with the method of JIS P8113.

[0050] As described above, the plurality of creped portions 1a, which are arranged in the flow direction and extend in the orthogonal direction orthogonal to the flow direction, are formed on the paper sheet 1. Accordingly, when producing processed products by using the paper sheet 1 while feeding the paper sheet 1 in the flow direction, if tension is exerted on the paper sheet 1 in the flow direction, the paper sheet 1 stretches in the flow direction. This makes it possible to prevent damage to the paper sheet 1 and prevent the processability of the paper sheet 1 from being lowered.

[0051] Since damage to the paper sheet 1 due to the tension being exerted on the paper sheet 1 in the flow direction is prevented, the feeding speed of the paper sheet in a processing machine can be increased to improve the production efficiency of the processed products, and thereby secondary processability of the paper sheet 1 can be improved.

[0052] To be specific, since the paper sheet 1 can be made less likely to tear, the paper sheet 1 can be subjected to, for example, three-dimensional processing using a mold, and thereby the paper sheet 1 can be processed to have a fine three-dimensional structure. Accordingly, for example, a face mask having a three-dimensional structure can be favorably produced by using the paper sheet 1.

[0053] The paper sheet 1 is formed in a belt-like shape, such that the longitudinal direction thereof is the flow direction. Accordingly, when the paper sheet 1 that has been wound into a roll is drawn from the roll and fed to be continuously subjected to processing by a processing machine, even if tension is exerted on the paper sheet 1 in the longitudinal direction (feeding direction), damage to the paper sheet 1 is less likely to occur, which makes it possible to further improve the production efficiency of the processed products.

[0054] The crepe ratio R of the paper sheet 1 is set to a value within the range of not less than 5% and not greater than 35%. Accordingly, when tension is exerted on the paper sheet 1 in the flow direction, the paper sheet 1 stretches in the flow direction, and thereby damage to the paper sheet 1 can be suitably prevented.

[0055] The breaking elongation of the paper sheet 1 in the flow direction is set to a value within the range of not less than 10% and not greater than 70%. Accordingly, when tension is exerted on the paper sheet 1 in the flow direction, damage to the paper sheet 1 can be favorably prevented.

[0056] The tensile strength of the paper sheet 1 in the flow direction is set to a value within the range of not less than 1.5 N/25 mm width and less than 40 N/25 mm width. Accordingly, when reeling in the paper sheet 1 in the flow direction, the paper sheet 1 can be prevented from breaking due to the tension exerted on the paper sheet 1 in the flow direction, and also, the processability of the paper sheet 1 can be suitably kept.

[0057] The binder is an alkali salt of a polysaccharide containing a carboxyl group. This makes it possible to produce a processed product having high water disintegrability by using the paper sheet 1.

[0058] One example of the processed product produced by using the paper sheet 1 is a makeup removing sheet (nonwoven fabric). Owing to the plurality of creped portions 1a, the makeup removing sheet has a larger surface area, and therefore exerts a better makeup removing effect than makeup removing sheets having a flat surface.

[0059] The cellulose ester staple fibers used in the makeup removing sheet have higher lipophilicity than, for example, rayon fibers that are an existing fiber material. Therefore, even if makeup agents contain oil components, a high makeup removing effect can be obtained with the makeup removing sheet. Owing to the plurality of creped portions 1a, the makeup removing sheet also has improved softness. Therefore, the makeup removing sheet easily deforms when coming into contact with the skin, thereby realizing favorable texture and low irritation to the skin, and thus excellent feeling of use can be expected.

[0060] Another example of the processed product produced by using the paper sheet 1 is a cleaning sheet (nonwoven fabric). Owing to the plurality of creped portions 1a, the cleaning sheet has a larger surface area and the bulkiness of the cleaning sheet is not easily lost. Therefore, the cleaning sheet is capable of adsorbing dirt and extraneous matter present on a cleaning object, thereby making it possible to readily wipe them off the cleaning object. Moreover, the cleaning sheet does not easily tear since the cleaning sheet is highly stretchable, and also, the cleaning sheet is capable of following the shape of the surface of the cleaning object. Therefore, the cleaning work can be performed efficiently with the cleaning sheet.

[0061] If the paper sheet 1 having water disintegrability is produced by using, as a binder, an alkali salt of a polysaccharide containing a carboxyl group, then the processed product produced by using the paper sheet 1, such as a cleaning sheet, can be disintegrated in water for disposal after use.

[0062] Cellulose esters are natural compounds containing cellulose, as a base material, which is the same cellulose as that of pulp. Accordingly, it is known that when such a cellulose ester is dispersed in water, the cellulose ester is decomposed by microorganisms with a relatively long period of time. Thus, the cleaning sheet produced by using the paper sheet 1 is degradable in a natural environment.

[0063] Yet another example of the processed product produced by using the paper sheet 1 is a cigarette filter. As one example, the cigarette filter is produced in the following manner: form the paper sheet 1 into a columnar shape; wrap rolling paper around the outside of the columnar paper sheet 1; and cut it to have a predetermined length. In this case, the paper sheet 1 is used as a filter material of the cigarette filter.

[0064] Since the plurality of creped portions 1a are formed on the paper sheet 1, the paper sheet 1 has a large surface area. Accordingly, by using the paper sheet 1 as a filter material of the cigarette filter, plenty of fine spaces can be uniformly formed inside the cigarette filter. As a result of the fine spaces being uniformly formed, a columnar cigarette filter having a beautiful cross section with no unevenness can be produced. Thus, by using the paper sheet 1, a cigarette filter with less pressure drop (PD), which is easy to smoke and capable of efficiently capturing smoke particles, can be obtained with stable quality.

[0065] Therefore, for example, even in the case of producing the cigarette filter of a cigarette having a smaller diameter than normal cigarettes, such as a "slim", "super-slim", or "micro-slim" cigarette, the cigarette filter can be favorably produced while suppressing increase in the pressure drop and adjusting the packing weight of the paper sheet 1.

[0066] As a further example, the paper sheet 1 with the plurality of creped portions 1a formed thereon may be additionally subjected to three-dimensional processing to form, for example, raised and recessed portions on the paper sheet 1, such that the raised and recessed portions extend in a direction crossing the plurality of creped portions 1a. In this manner, the pressure drop of the cigarette filter can be adjusted more finely.

[0067] Conventionally, pulp fibers and fibers of cellulose acetate, which is a typical cellulose ester, have been used as cigarette filter materials. Therefore, the paper sheet 1 is highly acceptable for consumers as a cigarette filter material. The cigarette filter produced by using the paper sheet 1 is capable of causing phenols and the like that are harmful compounds contained in the smoke components to be efficiently adsorbed by the cellulose acetate fibers, and also, capable of causing water to be efficiently adsorbed by the pulp fibers.

[0068] Moreover, by producing the water-disintegrable paper sheet 1 by using a water-soluble binder and then producing a cigarette filter by using the paper sheet 1, the cigarette filter can be disintegrated in water in a natural environment for disposal after smoking.

[0069] Other examples of the processed product produced by using the paper sheet 1 include sanitary products such as a disposable diaper, a sanitary napkin, and a sanitary mask. In a case where the paper sheet 1 is used in any of these sanitary products, since the paper sheet 1 has high air permeability, when the user wears the sanitary product, uncomfortable stuffiness and stickiness are reduced , which realizes excellent wearing feeling. Therefore, the paper sheet 1 is also suitable as the material of such a sanitary product.

[Paper machine]

[0070] FIG. 2 is a schematic diagram of the paper machine 10 according to the embodiment. As one example, the paper machine 10 is a fourdrinier paper machine. The paper machine 10 includes a composition preparation part 11, a wire part 12, a press part 13, a dryer part 14, and the winding reel 28. Each of the composition preparation part 11, the wire part 12, the press part 13, and the dryer part 14 has a known configuration. It should be noted that the terms "preceding" and "subsequent" in the description below mean "preceding something else" and "subsequent to something else" in the paper machine 10 in the feeding direction of a composition, a sheet body 30, and a paper sheet 1.

[0071] The composition preparation part 11 is, in the paper machine 10, disposed at a position preceding the wire part 12, the press part 13, the dryer part 14, and the winding reel 28. The composition preparation part 11 prepares a liquid composition (slurry) that is the raw material of the paper sheet 1. The composition preparation part 11 includes a reservoir 20, which stores the composition.

[0072] The wire part 12 is disposed at a position subsequent to the composition preparation part 11. The wire part 12 spreads the composition fed from the reservoir 20 into a sheet-like shape to dewater the composition, and feeds the resulting sheet-shaped composition in the feeding direction.

[0073] The wire part 12 includes the wire mesh 21 and a plurality of feeding rollers 22. The wire mesh 21 is configured by forming a wire net made of a plurality of wires into an endless belt. The plurality of feeding rollers 22 rotate the wire mesh 21. In the paper machine 10, for example, at least one of the fiber concentration in the composition fed from the reservoir 20 to the wire part 12, the feeding speed of the composition fed from the reservoir 20 to the wire part 12, and the feeding speed of the composition fed by the wire mesh 21 is adjusted, and thereby the basis weight of the paper sheet 1 is adjusted. In the description hereinafter, the composition that has been fed from the reservoir 20 to the wire part 12 is referred to as the sheet body 30.

[0074] The press part 13 is disposed at a position subsequent to the wire part 12. The press part 13 further dewaters the sheet body 30 having passed through the wire part 12 while feeding the sheet body 30 in the feeding direction. The press part 13 includes: a plurality of felt bodies 23; a plurality of feeding rollers 24; and at least one press roller 25. Each of the felt bodies 23 is configured by forming a belt-shaped felt material into an endless belt. The plurality of feeding rollers 24 rotate the felt bodies 23. The press roller 25 is pivotally supported at a position where the press roller 25 faces the peripheral surfaces of the feeding rollers 24 via the felt bodies 23.

[0075] The dryer part 14 is disposed at a position subsequent to the press part 13. The dryer part 14 dries the sheet body 30 having passed through the press part 13 while feeding the sheet body 30 in the feeding direction. The dryer part 14 includes at least one heating roller (such as a yankee dryer) 26. The heating roller 26 rotates at the peripheral speed V1.

[0076] The winding reel 28 is disposed at a position subsequent to the dryer part 14. The winding reel 28 reels in the paper sheet 1 into a roll when the paper sheet 1 is obtained by being separated from the peripheral surface of the heating roller 26. The heating roller 26 rotates at the peripheral speed V2. It should be noted that the paper machine 10 is of course not limited to a fourdrinier paper machine, but may be a different type of machine. For example, the paper machine 10 may be a cylinder paper machine.

[Method of producing a paper sheet]

[0077] FIG. 3 is a production process chart that shows processes for producing the paper sheet 1 according to the embodiment. As shown in FIG. 3, in the method of producing the paper sheet 1 according to the embodiment, a raw material preparing process S1, a wire process S2, a pressing process S3, a drying process S4, a creping process S5, a reeling process S6, and a slitting process S7 are performed sequentially. Here, processes S1 to S6 are performed sequentially by using the paper machine 10.

[0078] In the raw material preparing process S1, the cellulose ester staple fibers, the pulp fibers, and the binder are uniformly dispersed in water, and thereby the composition is prepared. The prepared composition is temporarily stored in the reservoir 20.

[0079] It should be noted that the raw material preparing process S1 may include a beating process for adjusting the entanglement of the fibers. In the beating process, for example, a known refiner is used to mechanically beat the fibers contained in the composition in the presence of water, thereby grinding the fibers. As a result, the fibers are cut and torn into small pieces. Consequently, the fibers are disintegrated, and also, the fibers become highly hydrated and swollen, which results in increased entanglement of the fibers after the paper is formed.

[0080] In the wire process S2, the composition stored in the reservoir 20 is spread over the wire mesh 21 of the wire part 12, and thereby the sheet body 30 is formed. Also, the plurality of feeding rollers 22 are rotated to feed the sheet body 30 in the feeding direction together with the wire mesh 21. Part of the water in the sheet body 30 penetrates through the gaps of the wire mesh 21, and is thereby removed from the sheet body 30. In this manner, the sheet body 30 is dewatered to some extent.

[0081] In the pressing process S3, the sheet body 30 having passed through the wire part 12 is placed on the felt bodies 23, and the plurality of feeding rollers 24 are rotated to feed the sheet body 30 in the feeding direction together with the felt bodies 23. Part of the water in the sheet body 30 is absorbed by the surface of the felt bodies 23. In this manner, the sheet body 30 is further dewatered. Then, the sheet body 30 is passed between the press roller 25 and the felt bodies 23 to press the sheet body 30 in the thickness direction, thereby further dewatering the sheet body 30.

[0082] It should be noted that, in the pressing process S3, only one pair of felt bodies 23 may be used, or two or more pairs of felt bodies 23 arranged continuously in the feeding direction may be used. In the pressing process S3, a press machine for pressing the sheet body 30, or suction dewatering equipment for forcibly dewatering the sheet body 30, may be used.

[0083] In the drying process S4, the sheet body 30 having passed through the press part 13 is fed in the feeding direction while being in contact with the peripheral surface of the heating roller 26. At the time, heat from the peripheral surface of the heating roller 26 is transferred to the sheet body 30, and thereby the sheet body 30 is heated and dried. In the drying process S4, a heating device, such as a hot air hood, may be used together with the heating roller 26.

[0084] As shown in FIG. 2, in the creping process S5, for example, a doctor blade 27 is used to separate the sheet body 30 from the peripheral surface of the heating roller 26. As a result, a plurality of creped portions 1a, which are arranged in the flow direction and extend in the orthogonal direction orthogonal to the flow direction, are formed on the sheet body 30 when the sheet body 30 passes through the dryer part 14.

[0085] The longitudinal direction of the doctor blade 27 coincides with the axial direction of the heating roller 26. As a result, in the present embodiment, the plurality of creped portions 1a arranged in the flow direction and extending in the orthogonal direction are formed on the sheet body 30.

[0086] In the creping process S5, by adjusting the peripheral speeds V1 and V2, the crepe ratio R of the paper sheet 1 to be produced is set to, for example, a value within the range of not less than 5% and not greater than 35%. Also, by setting the crepe ratio R to such a value, the breaking elongation of the paper sheet 1 to be produced in the flow direction is set to a value within the range of not less than 10% and not greater than 70%.

[0087] The tensile strength of the paper sheet 1 in the flow direction is set to a predetermined value by at least one of the following methods: a method of adjusting the blending ratio of a plurality of kinds of fibers in the raw material preparing process S1; a method of adjusting the entanglement of the fibers by adjusting the beating degree; a method of adjusting the basis weight (total fiber amount) in the wire process S2; and a method of adjusting the crepe ratio R in the creping process S5. Here, as one example, the tensile strength of the paper sheet 1 in the flow direction is set to a value within the range of not less than 1.5 N/25 mm width and less than 40 N/25 mm width.

[0088] By completing the creping process S5, the belt-shaped paper sheet 1 whose longitudinal direction (feeding direction) is the flow direction is obtained. In the reeling process S6, the paper sheet 1 is wound into a roll by the winding reel 28. In the slitting process S7, the paper sheet 1 previously wound into the roll is subjected to unwinding and slitting (cutting) to have a constant width, and then wound again. In this manner, the paper sheet 1 is obtained as a roll-shaped product.

[0089] As described above, the method of producing the paper sheet 1 according to the present embodiment includes: a sheet body forming process (sheet body forming step) of forming the sheet body 30 containing the cellulose ester staple fibers, the pulp fibers, and the binder; and the creping process (creping step) S5 of forming the plurality of creped portions 1a on the sheet body 30, such that the plurality of creped portions 1a are arranged in the flow direction and extend in the orthogonal direction orthogonal to the flow direction. (In this example, the sheet body forming process includes the raw material preparing process S1, the wire process S2, the pressing process S3, and the drying process S4.)

[0090] In the sheet body forming process, the sheet body 30 is formed in a belt-like shape, such that the longitudinal direction (feeding direction) of the sheet body 30 is the flow direction. In the paper sheet producing method, the crepe ratio R of the paper sheet 1 is set to a value within the range of not less than 5% and not greater than 35%. Also, in the paper sheet producing method, by setting the crepe ratio R to the value, the tensile elongation of the paper sheet 1 in the flow direction is set to a value within the range of not less than 10% and not greater than 70%.

[0091] In the paper sheet producing method, the tensile strength of the paper sheet 1 in the flow direction is set to a value within the range of not less than 1.5 N/25 mm width and less than 40 N/25 mm width by adjusting at least one of the blending ratio of the cellulose ester staple fibers, the pulp fibers, and the binder, the basis weight of the paper sheet 1, the beating degree of the cellulose ester staple fibers and the pulp fibers, and the crepe ratio of the paper sheet 1. In the paper sheet producing method, an alkali salt of a polysaccharide containing a carboxyl group is used as the binder.

[0092] It should be noted that, in the raw material preparing process S1, it is not essential that the binder be included in the components of the composition. That is, for example, depending on the property of the binder, the binder adding process can be performed separately from the raw material preparing process S1. For example, in at least one of the wire process S2, the pressing process S3, and the drying process S4, a liquid containing the binder may be sprayed over or applied to the sheet body, or the sheet body may be immersed in the liquid containing the binder.

(Validation test)

[Test method]

[0093] A paper sheet was produced by using cellulose acetate staple fibers, softwood kraft pulp fibers, and carboxymethyl cellulose sodium salt (with an esterification degree of 0.86; CMC1220 available from Daicel Corporation). The weight ratio of the cellulose acetate staple fibers, the softwood kraft pulp fibers, and the carboxymethyl cellulose sodium salt was set to 49.5 : 49.5 : 1.0.

[0094] In the creping process, creped portions were formed on each of a plurality of sheet bodies, and the crepe ratio R was varied among the plurality of sheet bodies. In this manner, paper sheets of Comparative Examples 1, 2, and Examples 1 to 17 were produced, such that the value of the basis weight of each paper sheet was set to any of 21, 25, 35, and 40 g/m^2.

[0095] A flow-direction breaking elongation (tensile elongation at break) test (conforming with the method of JIS P8113), a flow-direction tensile strength test (conforming with the method of JIS P8113), a water disintegrability test (conforming with the method of JIS P4501), and an air resistance (air permeance) test (conforming with the method of JIS P8117) were performed on each of the paper sheets of Comparative Examples 1, 2, and Examples 1 to 17.

[0096] In the breaking elongation test and the tensile strength test, the width of a test piece of each paper sheet (the width in the orthogonal direction orthogonal to the flow direction) was set to 25 mm width $\pm$ 0.1 mm. Also, the maximum thickness dimension of each of the paper sheets of Comparative Examples 1, 2, and Examples 1 to 17 in a natural state (i.e., a state where no tension is applied to the paper sheet) was measured by a thickness meter (dial thickness gauge).

[0097] Further, equipment including a pair of shaping rollers, the equipment simulating a cigarette filter producing apparatus, was used to check the formability of each of the paper sheets of Comparative Examples 1, 2, and Examples 1 to 17 in the case of producing a cigarette filter by using the paper sheet. Specifically, each of the pair of shaping rollers used herein is provided with a plurality of raised and recessed portions formed on the peripheral surface thereof, such that the raised and recessed portions extend in the circumferential direction of each shaping roller. The pair of shaping rollers was disposed such that the peripheral surfaces of the respective shaping rollers meshed with each other. Each paper sheet was passed between the pair of shaping rollers in the flow direction to subject the paper sheet to three-dimensional processing, and at the time, whether or not cracks were formed in the paper sheet was checked. Also, each paper sheet was fed at a feeding speed of 100/min, and whether or not the paper sheet was able to be rewound without breaking was checked.

[0098] Three-grade evaluation was used to evaluate the formability of each paper sheet. Specifically, in a case where no major cracks were formed on the surface of the paper sheet when the paper sheet was subjected to the three-dimensional processing, and the paper sheet was able to be rewound without breaking frequently, the paper sheet was evaluated as "A". In a case where no major cracks were formed on the surface of the paper sheet when the paper sheet was subjected to the three-dimensional processing, or the paper sheet was able to be rewound without breaking frequently, i.e., in a case where only one of these two conditions was satisfied, the paper sheet was evaluated as "B". In a case where major cracks were formed on the surface of the paper sheet when the paper sheet was subjected to the three-dimensional processing, and breaking of the paper sheet occurred frequently when the paper sheet was rewound, the paper sheet was evaluated as "C". Table 1, Table 2, and FIGS. 4 to 7 show the test results.

[0099] FIG. 4 is a graph showing a relationship between the breaking elongation and the tensile strength of each of the paper sheets of Comparative Examples 1, 2, and Examples 1 to 17. FIG. 5 is a graph showing a relationship between the crepe ratio R and the tensile strength of each of the paper sheets of Comparative Examples 1, 2, and Examples 1 to 17. FIG. 6 is a graph showing a relationship between the crepe ratio R and the breaking elongation of each of the paper sheets of Comparative Examples 1, 2, and Examples 1 to 17. FIG. 7 is a graph showing a relationship between the crepe ratio R and the air resistance of each of the paper sheets of Comparative Examples 1, 2, and Examples 1 to 17.

[Table 1]

	Basis weight (g/m^2)	Crepe ratio (%)	Thickness dimension (mm)	Breaking elongation (%)	Tensile strength (N/25 mm width)	Formability	Water disintegrability (sec)	Air resistance (sec/32 sheets stacked, 300 cc)
Com. EX. 1	25	0	0.11	4	12.4	C	19	6.5
EX. 1	25	5	0.19	12	6.4	B	6	2.8

(continued)

	Basis weight (g/m^2)	Crepe ratio (%)	Thickness dimension (mm)	Breaking elongation (%)	Tensile strength (N/25 mm width)	Formability	Water disintegrability (sec)	Air resistance (sec/32 sheets stacked, 300 cc)
EX. 2	25	10	0.21	18	4.3	A	5	1.5
EX. 3	25	15	0.23	26	3.6	A	6	1.1
EX. 4	25	20	0.24	33	3.2	A	6	1.0
EX. 5	25	25	0.26	38	2.7	A	7	1.0
EX. 6	25	30	0.27	49	2.2	A	7	0.8
EX. 7	25	35	0.29	61	1.8	B	7	0.8
EX. 8	25	40	0.30	70	1.2	B	6	0.6

[Table 2]

	Basis weight (g/m^2)	Crepe ratio (%)	Thickness dimension (mm)	Breaking elongation (%)	Tensile strength (N/25 mm width)	Formability	Water disintegrability (sec)	Air resistance (sec/32 sheets stacked, 300 cc)
Com. EX. 2	35	0	0.12	5	22.0	C	36	11.0
EX. 9	35	5	0.21	10	14.0	B	10	4.0
EX. 10	35	10	0.23	18	9.8	A	9	3.5
EX. 11	35	15	0.26	25	7.9	A	10	2.5
EX. 12	35	20	0.29	30	7.1	A	10	2.1
EX. 13	35	25	0.32	40	6.0	A	9	2.0
EX. 14	35	30	0.33	52	4.8	A	9	1.5
EX. 15	35	35	0.35	63	3.7	A	8	1.4
EX. 16	21	25	0.19	30	1.8	A	8	1.1
EX. 17	40	12	0.27	19	13.0	A	11	3.7

[Test results]

[0100] As shown in Table 1, Table 2, and FIG. 4, it has been confirmed that the tensile strength and the breaking elongation of each of the paper sheets of Comparative Examples 1, 2, and Examples 1 to 17 are substantially inversely proportional to each other, and that the higher the crepe ratio R, the higher the breaking elongation.

[0101] As shown in FIG. 6, the higher the crepe ratio R, the more the paper sheet tends to stretch in the flow direction and the breaking elongation increases. Also, as shown in FIG. 5, the tensile strength decreases in accordance with increase in the crepe ratio R. The decrease in the tensile strength is due to the basis weight (fiber amount) of the sheet body being small in processes S2 to S4, which are the processes performed before the creped portions are formed on the sheet body, i.e., due to the basis weight (fiber amount) of the extended sheet body being small.

[0102] In the creping process S5, external force corresponding to the crepe ratio R is applied to the sheet body at the gap between the heating roller and the doctor blade. The external force loosens the bonding between the fibers of the sheet body, which is another factor causing the decrease in the tensile strength. It has been confirmed from the test results that the less the basis weight of the paper sheet (i.e., the less the fiber amount in the paper sheet), the greater the decrease in the tensile strength of the paper sheet.

[0103] From the data shown in Table 1, Table 2, and FIG. 4, it is considered as follows: within the ranges adopted in the tests, for example, by setting the crepe ratio R of the paper sheet to a value within the range of not less than 5% and not greater than 35% and forming the plurality of creped portions, which are arranged in the flow direction and extend in the orthogonal direction orthogonal to the flow direction, on the paper sheet, or by setting the tensile strength of the paper sheet to a value within the range of not less than 1.5 N/25 mm width and less than 40 N/25 mm width and forming the plurality of creped portions, which are arranged in the flow direction and extend in the orthogonal direction orthogonal to the flow direction, on the surface of the paper sheet, the breaking strength and the tensile strength of the paper sheet can be made well-balanced.

[0104] It has been found that each of the paper sheets of Examples 1 to 17 exhibits a higher breaking elongation and better formability than the paper sheets of Comparative Examples 1 and 2. The reason for this is considered that since the plurality of creped portions extending in the orthogonal direction orthogonal to the flow direction are formed on each of the paper sheets of Examples 1 to 17, when tension in the flow direction is exerted on each of these paper sheets, the paper sheet can stretch in the flow direction, and is less likely to be damaged.

[0105] It is also considered as follows: since each of the paper sheets of Examples 1 to 17 was subjected to the creping process S5, the plurality of creped portions suitable for three-dimensional processing were formed on each of these paper sheets; accordingly, when each paper sheet was subjected to the three-dimensional processing by the pair of shaping rollers, the paper sheet stretched; and as a result, the paper sheet was formed favorably.

[0106] Major cracks were formed in the paper sheet of Comparative Example 1 when the paper sheet was subjected to the three-dimensional processing, and also, breaking of the paper sheet occurred frequently when the paper sheet was rewound. Thus, it was found that the formability of the paper sheet of Comparative Example 1 was low. When the paper sheet of Comparative Example 2 was rewound, frequent breaking of the paper sheet did not occur. However, when the paper sheet of Comparative Example 2 was subjected to the three-dimensional processing, major cracks were formed in the paper sheet. Thus, it was found that the formability of the paper sheet of Comparative Example 2 was low.

[0107] In Example 7, the crepe ratio R was 35%. In Example 8, the crepe ratio R was 40%. Accordingly, each of Examples 7 and 8 exhibited a high and favorable breaking elongation, but the formability thereof was relatively low. Specifically, in each of Examples 7 and 8, no major cracks were found in the paper sheet when it was subjected to the three-dimensional processing. However, at the time of rewinding the paper sheet, when the rotational speed of the rewinding roller was increased, breaking of the paper sheet slightly occurred.

[0108] Since the basis weight of each of the paper sheets of Examples 7 and 8 was a relatively low value of 25 g/m^2, when the creped portions of each of these paper sheets were stretched, the basis weight of the paper sheet, i.e., the fiber amount per unit area, was low, and the entanglement of the fibers with each other was low. These factors are presumed to have caused the slight breaking of the paper sheet. It is also considered that in the case of setting the crepe ratio R to a value greater than 35%, it is desirable to set the basis weight of the paper sheet to be greater than 25 g/m^2.

[0109] It has also been found from Table 1, Table 2, and FIG. 7 that in the case of each of the paper sheets of Examples 1 to 17, the higher the crepe ratio R, the lower the air resistance. The reason for this is considered that in the case of each of the paper sheets of Examples 1 to 17, the higher the crepe ratio R, the more the fibers are dispersed in the thickness direction of the paper sheet to lower the density, allowing gas to pass through the inside of the paper sheet more easily.

[0110] Accordingly, in the case of producing a filter product, such as a cigarette filter, by using the paper sheet 1 of the embodiment, it is considered that, for example, by suitably increasing the crepe ratio R, the pressure drop can be reduced while keeping suitable processability into the filter product. It is considered from the results shown in FIG. 4 that, for example, by setting the crepe ratio R of the paper sheet to a value within the range of not less than 5% and not greater than 35%, a cigarette filter having excellent appearance properties, i.e., not easily dented or bent, and having a suitable pressure drop can be produced. In Examples 1 to 17, by setting the crepe ratio R to such a value, the tensile elongation of the paper sheet in the flow direction is set to a value within the range of not less than 10% and not greater than 70%.

[0111] Through other tests conducted by the inventors of the present invention, it has been confirmed that in the case of producing a cigarette filter by using a paper sheet whose basis weight is 25 g/m^2 or 35 g/m^2, by setting the crepe

ratio R to a value not less than 5%, the formation of cracks in the paper sheet can be suppressed at the time of forming the paper sheet into a columnar shape and the internal structure of the cigarette filter can be made uniform more readily, and consequently, it has been found that the filtration performance of the cigarette filter can be stabilized more readily while obtaining a beautiful circular cross section of the cigarette filter.

[0112] It has been confirmed that in the case of the paper sheets of Examples 1 to 17, the higher the crepe ratio R, the greater the thickness dimension of the paper sheet. The reason for this is that the higher the crepe ratio R, the more the creped portions are formed on the paper sheet, making the paper sheet bulkier.

[0113] Accordingly, it is considered that when producing a makeup removing nonwoven fabric or a cleaning sheet by using the paper sheet 1 of the embodiment, by suitably increasing the crepe ratio R, the processed product can be made bulky, and the makeup removing effect or wiping-off effect of the processed product can be increased.

[0114] It has been found that in the case of using a paper sheet whose basis weight is not less than 21 g/m^2 as a roll-shaped product, by setting the tensile strength of the paper sheet to be greater than 1.5 N/25 mm width, the paper sheet can be stably fed in the rewinding process even at a speed of 100 m/min or higher.

[0115] Here, if the crepe ratio R is too low, it is less likely that sufficient stretchability is imparted to the paper sheet. On the other hand, if the crepe ratio R is too high, there are risks that the sheet body or paper sheet loosens while being fed due to excessive stretching (i.e., tension exerted on the sheet body or paper sheet to feed the sheet body or paper sheet cannot be sufficiently kept) and that the strength is lowered, causing a difficulty in stably producing the paper sheet or processed product.

[0116] Therefore, it is desirable to adjust the crepe ratio R of the paper sheet by taking into account, for example, the type of the processed product to be produced by using the paper sheet, the processing conditions of the paper sheet, and the tension in the feeding direction exerted on the sheet body or paper sheet fed in the paper machine or processing machine.

[0117] The present invention is not limited to the above-described embodiment, and modifications, additions, or deletions can be made to the configuration and the method of the embodiment without departing from the spirit of the present invention.

Industrial Applicability

[0118] As described above, each aspect of the present invention has an excellent advantageous effect of being able to, in the case of producing processed products by using a paper sheet containing cellulose ester staple fibers, prevent damage to the paper sheet and improve the production efficiency of the processed products. Therefore, the present invention is useful when widely applied as a paper sheet, and a paper sheet producing method, that make it possible to exert the above advantageous effect meaningfully.

Reference Signs List

[0119]

1	paper sheet
1 a	creped portion
30	sheet body

Claims

1. A paper sheet comprising:

cellulose ester staple fibers;
pulp fibers; and
a binder, wherein
a plurality of creped portions are formed on the paper sheet, such that the creped portions are arranged in a flow direction of the cellulose ester staple fibers and the pulp fibers and extend in an orthogonal direction orthogonal to the flow direction.

2. The paper sheet according to claim 1, wherein
the paper sheet is formed in a belt-like shape, such that a longitudinal direction of the paper sheet is the flow direction.

3. The paper sheet according to claim 1 or 2, wherein

a crepe ratio of the paper sheet is set to a value within a range of not less than 5% and not greater than 35%.

4. The paper sheet according to any one of claims 1 to 3, wherein
a breaking elongation of the paper sheet in the flow direction is set to a value within a range of not less than 10% and not greater than 70%.

5. The paper sheet according to any one of claims 1 to 4, wherein
a tensile strength of the paper sheet in the flow direction is set to a value within a range of not less than 1.5 N/25 mm width and less than 40 N/25 mm width.

6. The paper sheet according to any one of claims 1 to 5, wherein
the binder is an alkali salt of a polysaccharide containing a carboxyl group.

7. The paper sheet according to any one of claims 1 to 6, wherein
the paper sheet is a filter material of a cigarette filter.

8. A method of producing a paper sheet, comprising:

a sheet body forming step of forming a sheet body containing cellulose ester staple fibers, pulp fibers, and a binder; and
a creping step of forming a plurality of creped portions on the sheet body, such that the creped portions are arranged in a flow direction of the cellulose ester staple fibers and the pulp fibers and extend in an orthogonal direction orthogonal to the flow direction.

9. The method of producing a paper sheet according to claim 8, wherein
the sheet body forming step includes forming the sheet body in a belt-like shape, such that a longitudinal direction of the sheet body is the flow direction.

10. The method of producing a paper sheet according to claim 8 or 9, wherein
a crepe ratio of the paper sheet is set to a value within a range of not less than 5% and not greater than 35%.

11. The method of producing a paper sheet according to claim 10, wherein
by setting the crepe ratio to the value, a tensile elongation of the paper sheet in the flow direction is set to a value within a range of not less than 10% and not greater than 70%.

12. The method of producing a paper sheet according to any one of claims 8 to 11, wherein
a tensile strength of the paper sheet in the flow direction is set to a value within a range of not less than 1.5 N/25 mm width and less than 40 N/25 mm width by adjusting at least one of a blending ratio of the cellulose ester staple fibers, the pulp fibers, and the binder, a basis weight of the paper sheet, a beating degree of the cellulose ester staple fibers and the pulp fibers, and a crepe ratio of the paper sheet.

13. The method of producing a paper sheet according to any one of claims 8 to 12, wherein
an alkali salt of a polysaccharide containing a carboxyl group is used as the binder.

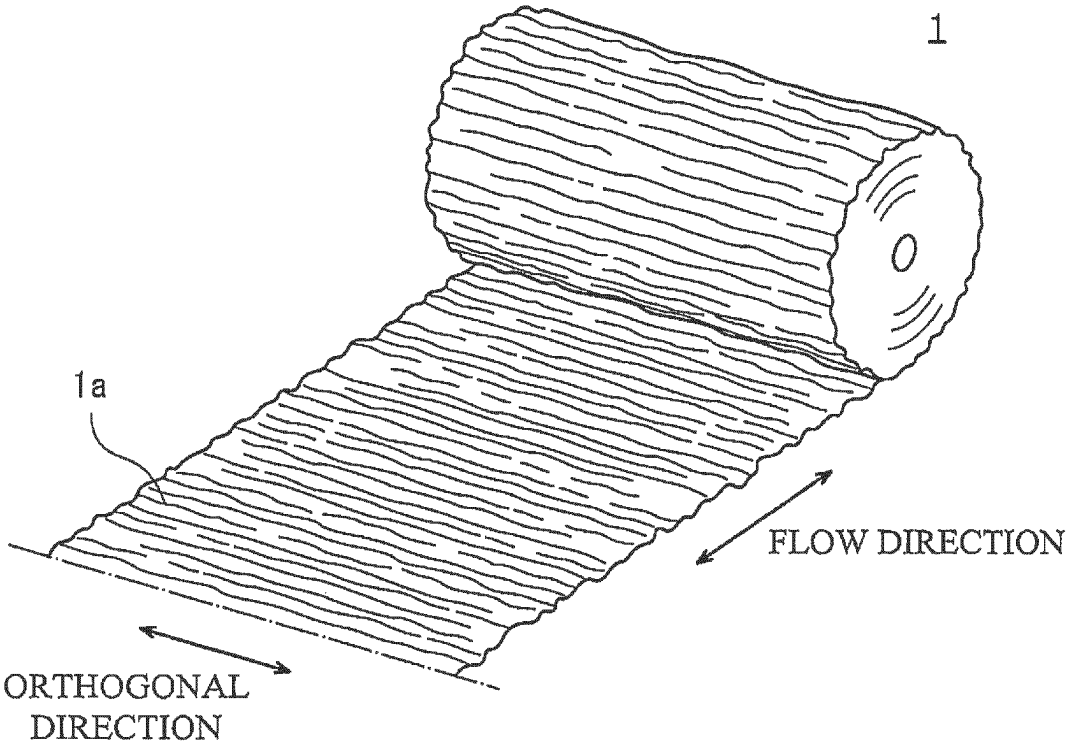
1
1a
FLOW DIRECTION
ORTHOGONAL
DIRECTION

FIG.1

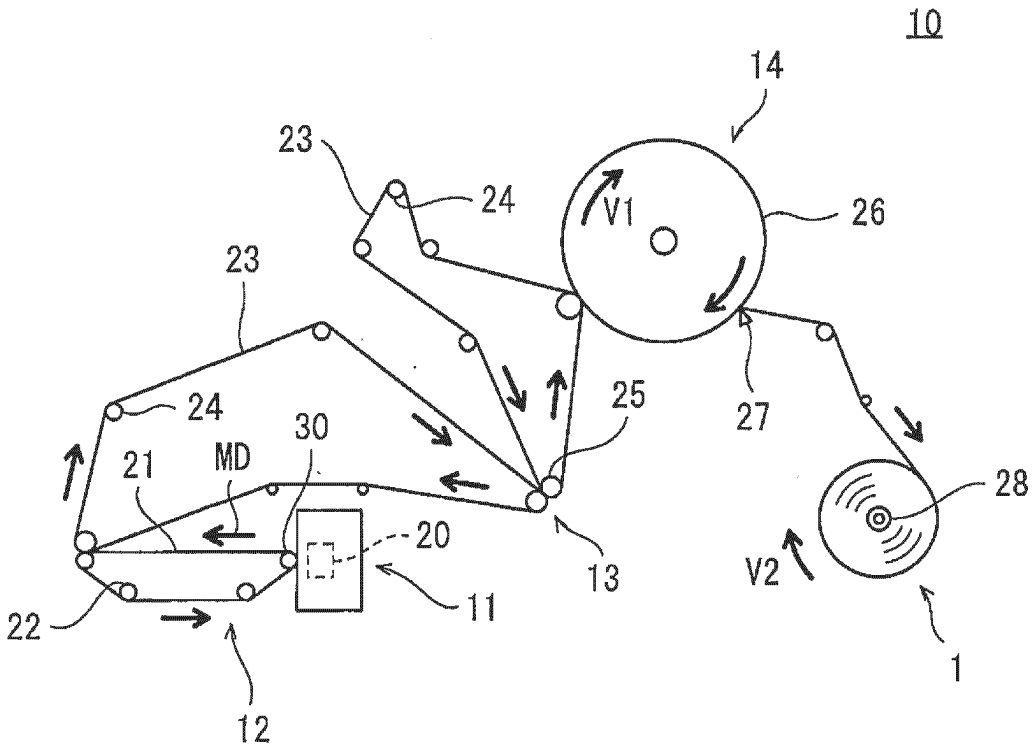
10
14
23
24
V1
26
23
24
25
27
30
MD
21
20
28
V2
13
22
11
1
12

FIG.2

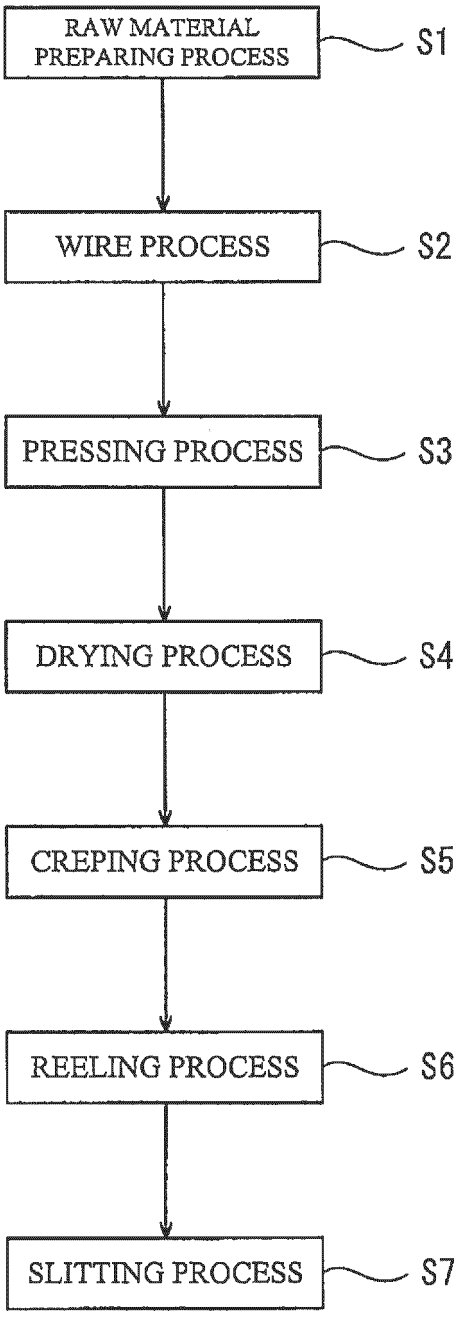
RAW MATERIAL PREPARING PROCESS
S1
WIRE PROCESS
S2
PRESSING PROCESS
S3
DRYING PROCESS
S4
CREPING PROCESS
S5
REELING PROCESS
S6
SLITTING PROCESS
S7

FIG.3

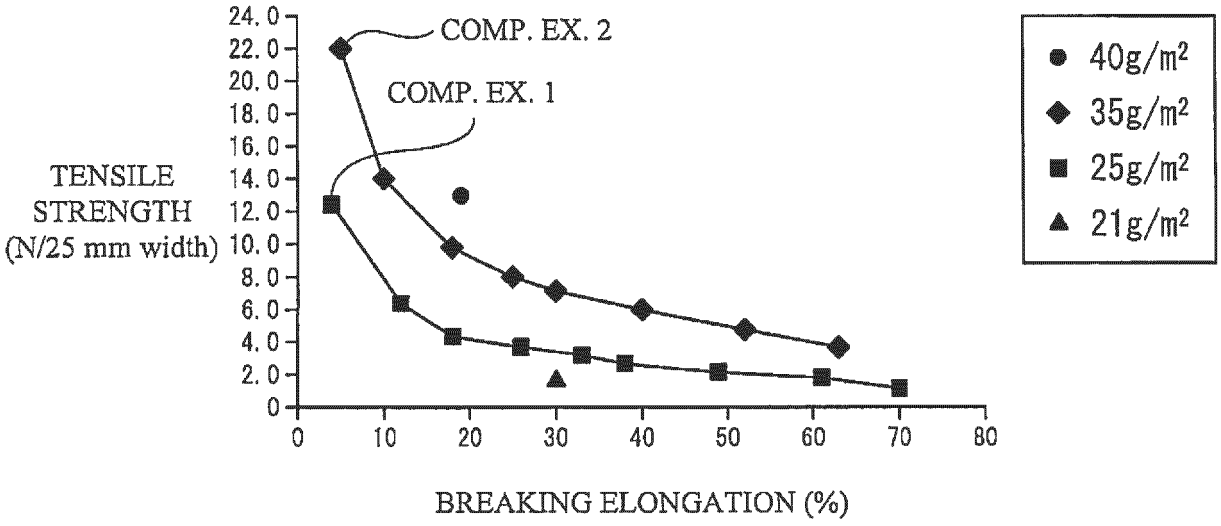
TENSILE STRENGTH (N/25 mm width)
24.0
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0
COMP. EX. 2
COMP. EX. 1
0
10
20
30
40
50
60
70
80
BREAKING ELONGATION (%)
40g/m²
35g/m²
25g/m²
21g/m²

FIG.4

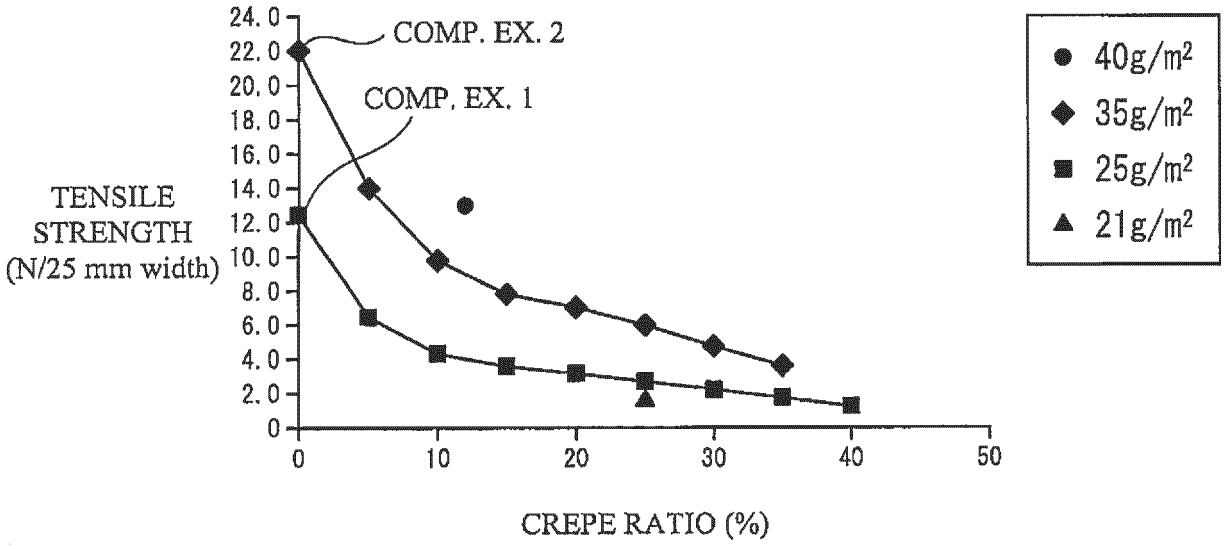
TENSILE STRENGTH (N/25 mm width)
24.0
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0
COMP. EX. 2
COMP. EX. 1
0
10
20
30
40
50
CREPE RATIO (%)
40g/m²
35g/m²
25g/m²
21g/m²

FIG.5

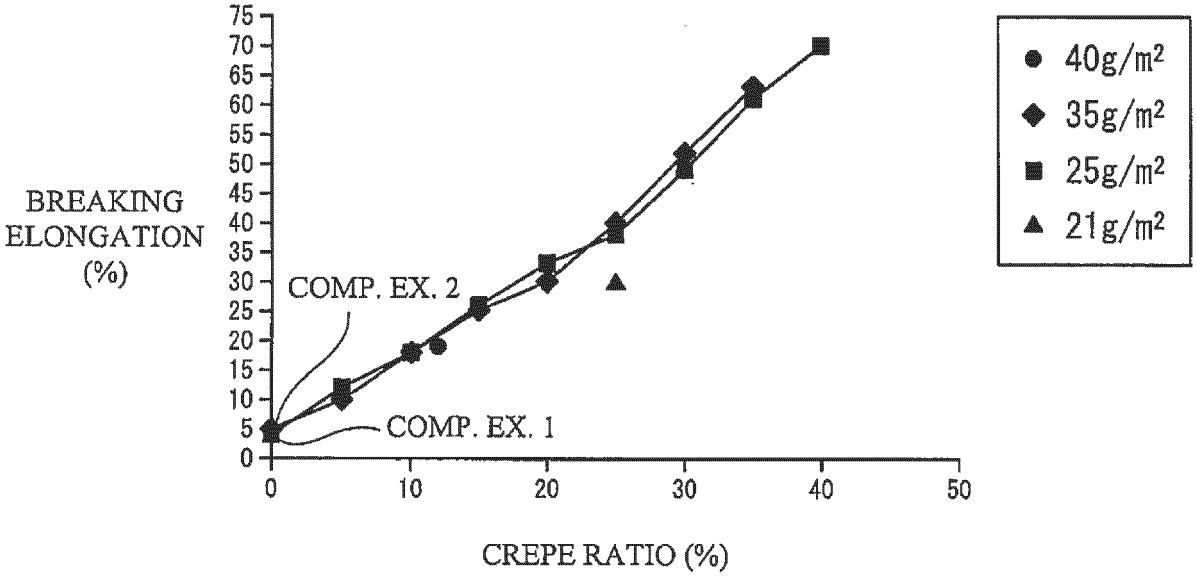
BREAKING ELONGATION (%)
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
COMP. EX. 2
COMP. EX. 1
CREPE RATIO (%)
40g/m²
35g/m²
25g/m²
21g/m²

FIG.6

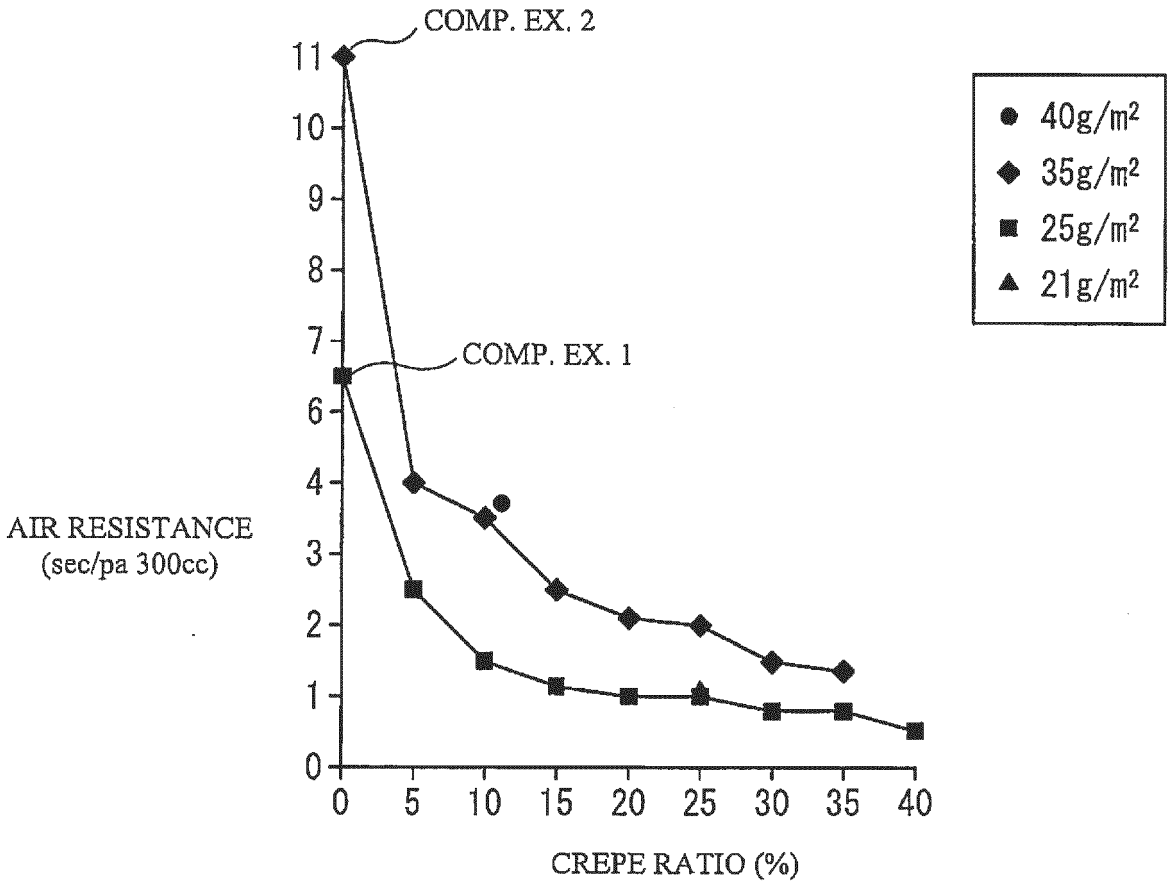
AIR RESISTANCE (sec/pa 300cc)
11
10
9
8
7
6
4
3
2
1
0
0
5
10
15
20
25
30
35
40
COMP. EX. 2
COMP. EX. 1
CREPE RATIO (%)
40g/m²
35g/m²
25g/m²
21g/m²

FIG.7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/036884

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. D21H13/06(2006.01)i, A24D3/10(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. D21H13/06, A24D3/10

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2017
Registered utility model specifications of Japan	1996-2017
Published registered utility model applications of Japan	1994-2017

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 8-47385 A (DICEL CHEMICAL INDUSTRIES, LTD.) 20 February 1996, claims 1, 2, 11, paragraphs [0044], [0053] & US 5711322 A1, claims 1, 2, 9, example 6, lines 26-40, example 7, lines 38-42	1-13
A	JP 5225489 B1 (DAICEL CORPORATION) 03 July 2013, claims 1-3, paragraph [0010] & US 2015/0164134 A1, claims 1-3, paragraph [0012] & EP 2862456 A1 & CN 104379007 A & KR 10-2015-0004433 A	1-13

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"E" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search 18 December 2017 (18.12.2017)	Date of mailing of the international search report 09 January 2018 (09.01.2018)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/036884

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 11-61612 A (MITSUBISHI RAYON CO., LTD.) 05 March 1999, claim 1, paragraph [0038] & WO 1999/009250 A1	1-13
A	JP 2002-204683 A (JAPAN TOBACCO INC.) 23 July 2002, fig. 3 (Family: none)	1-13
A	JP 2012-215369 A (NAGOYA OIL CHEMICAL CO., LTD.) 08 November 2012, paragraphs [0009], [0019] (Family: none)	1-13
A	WO 2016/108119 A1 (PHILIP MORRIS PRODUCTS S. A.) 07 July 2016, page 14, lines 28-31, fig. 2 & EP 3240438 A1 & CN 107105764 A & KR 10-2017-0100502 A	1-13

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 5225489 B **[0005]**
- JP 3606950 B **[0005]**
- JP 2001120248 A **[0005]**