The water-soluble non-woven fabric according to the present invention is prepared by (a) preparing a non-woven fabric with cellulose fibers, (b) mercerizing the non-woven fabric with aqueous sodium hydroxide in a solvent in a bath, (c) carrying out etherification of the mercerized fabric by adding monochloro acetic acid solution, (d) neutralizing the fabric with a hydrochloric acid solution to be a pH of about 6.0 to 9.0 in the bath, and (e) post-treating the fabric through dehydration and drying. The dissolving time of the non-woven fabric can be controlled depending on the amounts of the solid monochloro acetic acid, solid sodium hydroxide and hydrochloric acid to be used.
METHOD OF PREPARING WATER-SOLUBLE NON-WOVEN FABRIC

FIELD OF THE INVENTION

[0001] The present invention relates to a method of preparing a water-soluble non-woven fabric or cloth. More particularly, the present invention relates to a method of preparing a water-soluble non-woven fabric or cloth that is prepared from cellulose fibers. The present invention includes a non-woven fabric or cloth, sheet, film, woven fabric, knitted fabric, yarn and the like, which are water-soluble by preparing in accordance with the method of the present invention.

BACKGROUND OF THE INVENTION

[0002] Non-woven fabric is widely used in various applications, for example, baby's napkin, women's sanitary napkin and toilet paper, packaging materials of foods and detergents, adsorbents, adhesives, base fabric for embroidery, head rest for airplane seat and the like. The conventional various non-woven fabric is made of synthetic fibers or natural fibers. As the synthetic fibers are not water-soluble, the non-woven fabric causes a serious environmental problem. Although the non-woven fabric is made of natural fibers, the natural fibers are not water-soluble, the non-woven fabric causes an environmental problem, too.

[0003] The natural fibers are cellulose fibers and are classified into pure natural fibers such as cotton and wool, regenerated fibers such as viscose rayon, and pulp fibers. The synthetic fibers are prepared from polymers such as polyethylene, polypropylene, polyamide, polyester and the like. Such natural and synthetic fibers are not water-soluble. Therefore, most of the conventional non-woven fabrics including the packaging material and the head rest are water insoluble.

[0004] Such non-woven fabrics are rarely recycled and disposed by burial in the ground or by combustion. The burial or combustion of the non-woven fabric causes serious environmental problems. If the non-woven fabric is water-soluble, however, such environmental problems could be prevented.

[0005] When a water-soluble non-woven fabric is absolutely needed, a special method to dissolve the non-woven fabric has been applied. For example, a base fabric for embroidery should be water-soluble. The base fabric for embroidery is typically a non-woven fabric and is used for embroidery in lingerie. Once the base fabric is used to embroider on the lingerie, the base fabric should be removed by dissolving. The conventional non-woven base fabric for embroidery is prepared from polyvinyl alcohol staple fibers. To remove the base fabric after embroidery, the product should be treated in a hot bath over 95°C. As the product is treated in a hot bath to remove the base fabric, the lingerie can be damaged, the cost for manufacturing increases, and the material of the lingerie should be resistant to the hot temperature.

[0006] If a base fabric for embroidery which is water-soluble at room temperature is developed, the disadvantages described above can be solved. If so, it is not necessary to treat the lingerie at a hot bath to remove the base fabric, the cost for manufacturing shall go down, the material of the lingerie can be diversified to choose, and there is no risk for the product to be damaged from the hot bath.

[0007] If a non-woven fabric which is water-soluble at room temperature is developed, the applications can be expanded, for example, to the packaging materials, mulch films for agriculture, gauze for medical use and the like. The conventional gauze is agglomerated with blood on the skin of a human body. Accordingly, when the gauze is removed, a pain occurs. If the gauze is water-soluble at room temperature or hot water-soluble, the gauze can be easily removed without pain by dissolving the gauze in the water.

[0008] Further, if a water-soluble non-woven fabric is developed, the non-woven fabric can be applied to mulch film for agriculture. There has been a lot of effort to develop a water-soluble, biodgradable or ultraviolet degradable mulch film to obviate environmental problems. However, conventional mulch films are collected to dispose after harvest. Although a water-soluble non-woven fabric is developed, the non-woven fabric should not be dissolved for a certain period. Usually the non-woven fabric for mulch film should not be dissolved for about three months which is a cultivation period. In other words, if a non-woven fabric should have a dissolving time for about three months, the fabric can be applied to a mulch film.

[0009] U.S. Pat. No. 5,041,252 teaches a non-woven fabric consisting of water-soluble resin fine fibers having a mean fiber diameter of at most 30 μm and a basis weight of 5 to 500 g/m², which is prepared by extruding an aqueous solution containing a water-soluble resin or a melt of a water-soluble resin plasticized with water through nozzles, stretching the extruded material to form fibers by a high speed gas flow, heating the fibers to evaporate the water in the fibers and then collecting the fibers.

[0010] Korean Patent Laid-Open No. 1999-67946 discloses a water degradable non-woven fabric which is treated with a water jet, and has a high density portion and a low density portion, and has a breaking strength of at most 100 g/25 mm at wet state, and contains a water-soluble or water swelling binder. The present invention, however, is distinct from the inventions of the U.S. patent and the Korean patent application above.

[0011] The present inventor has developed a new method of preparing a non-woven fabric which is water-soluble at room temperature, and whose dissolving time can be controlled for use.

OBJECTS OF THE INVENTION

[0012] A feature of the present invention is the provision of a non-woven fabric which is water-soluble at room temperature.

[0013] Another feature of the present invention is the provision of a water-soluble non-woven fabric which does not cause environmental pollution.

[0014] A further feature of the present invention is the provision of a water-soluble non-woven fabric which is used as a base fabric for embroidery for lingerie, thereby the product is not treated in a hot bath, the lingerie cannot be damaged, the cost for manufacturing decreases, and more materials for lingerie are available.
A further feature of the present invention is the provision of a water-soluble non-woven fabric which is used as mulch film for agriculture.

A further feature of the present invention is the provision of a water-soluble non-woven fabric which is used as a head rest for airplanes or buses.

A further feature of the present invention is the provision of a water-soluble non-woven fabric whose dissolving time can be controlled for use.

A feature of the present invention is the provision of a method of preparing a non-woven fabric which is water-soluble at room temperature.

Other objects and advantages of this invention will be apparent from the ensuing disclosure and appended claims.

SUMMARY OF THE INVENTION

The water-soluble non-woven fabric according to the present invention is prepared by (a) preparing a non-woven fabric with cellulose fibers, (b) mercerizing the non-woven fabric with aqueous sodium hydroxide in a solvent in a bath, (c) carrying out etherification of the mercerized fabric by adding monochloro acetic acid solution, (d) neutralizing the fabric with a hydrochloric acid solution to be a pH of about 6.0 to 9.0 in the bath, and (e) post-treating the fabric through dehydration and drying. The dissolving time of the non-woven fabric can be controlled depending on the amounts of the solid monochloro acetic acid, solid sodium hydroxide and hydrochloric acid to be used.

DETAILED DESCRIPTION OF THE INVENTION

To prepare a water-soluble non-woven fabric according to the present invention, a non-woven fabric should be prepared with cellulose fibers. The non-woven fabric is treated to provide water solubility in accordance with the method of the present invention. A non-woven fabric prepared with synthetic fibers cannot be applied to the method of the present invention. A woven fabric, a knitted fabric, a sheet and a film which are prepared with cellulose fibers can be applied to a method of the present invention. Therefore, in the present invention, the non-woven fabric prepared with cellulose fibers includes a woven fabric, a knitted fabric, a sheet and a film which are prepared with cellulose fibers.

The cellulose fibers are classified into pure natural fibers such as cotton, wool, linen, hemp and the like, regenerated fibers such as viscose rayon, and pulp fibers. The products prepared with the cellulose fibers can be water-soluble at room temperature when they are treated in accordance with the method of the present invention.

The non-woven fabric prepared with cellulose fibers is treated with aqueous sodium hydroxide in a solvent in a bath. The treatment of a cellulose fibers product with aqueous sodium hydroxide is known as mercerization. The mercerization is easily carried out by an ordinary skilled person in the art to which the present invention pertains. A solvent is used for mercerization. Alcohols and acetones can be used as the solvent. The representative examples of alcohols are methyl alcohol, ethyl alcohol, isopropyl alcohol and the like, and the acetones can be easily selected by an ordinary skilled person in the art.

For mercerization in the present invention, aqueous sodium hydroxide and solvent are put into a closed reactor. Into the reactor is a non-woven fabric prepared with cellulose fibers. The aqueous sodium hydroxide is prepared by dissolving about 50-80 g of solid sodium hydroxide in powder per 100 g of the non-woven fabric in about 30-180 g of water. A solvent is added to the reactor in the amount of about 600-1000 ml per 100 g of the non-woven fabric. The amount of sodium hydroxide controls the dissolving time of the water-soluble non-woven fabric. In other words, the dissolving time of the water-soluble non-woven fabric depends on the amount of the sodium hydroxide to be used in the mercerization step (b). The more the solid sodium hydroxide is used, the shorter the dissolving time is. The closed reactor is kept at the temperature of about 30-60°C. The mercerization is conducted for about 1-4 hours.

After completion of mercerization of the non-woven fabric, etherification of the mercerized non-woven fabric is carried out by adding monochloro acetic acid solution to the closed reactor. The monochloro acetic acid solution is prepared by dissolving about 10-120 g of monochloro acetic acid in solid per 100 g of the non-woven fabric in about 20-720 g of a solvent. Alcohols and acetones can be used as the solvent. The closed reactor is kept at the temperature of about 60-90°C. The etherification is conducted for about 1-3 hours. The amount of monochloro acetic acid in solid controls the dissolving time of the water-soluble non-woven fabric. In other words, the dissolving time of the water-soluble non-woven fabric depends on the amount of the monochloro acetic acid in solid to be used in the etherification step (c). The more the monochloro acetic acid is used, the shorter the dissolving time is. For example, if about 80-120 g of monochloro acetic acid in solid per 100 g of the non-woven fabric is used, the dissolving time is controlled within about 2 hours. If about 10-40 g of monochloro acetic acid in solid per 100 g of the non-woven fabric is used, the dissolving time can be extended up to about 1 through 3 months. In case that a shorter dissolving time is required as in the base fabric for embroidery, gauze and the like, the etherification of the non-woven fabric is conducted with a monochloro acetic acid solution containing a more amount of monochloro acetic acid. And, in case that a longer dissolving time is required as in a mulch film for agriculture and the like, the etherification of the non-woven fabric is conducted with a monochloro acetic acid solution containing a smaller amount of monochloro acetic acid.

After completion of etherification of the non-woven fabric, the non-woven fabric is neutralized with a hydrochloric acid solution. The neutralization of the non-woven fabric is conducted in the closed bath by adding a hydrochloric acid solution. The neutralization of the non-woven fabric may also be conducted in a separate bath in which the etherified non-woven fabric is neutralized with a mixed solution of hydrochloric acid and water. The amount of hydrochloric acid controls the dissolving time of the water-soluble non-woven fabric. In other words, the dissolving time of the water-soluble non-woven fabric depends on the amount of the hydrochloric acid to be used in the neutralization step (d). The bath for neutralization should be...
kept at a pH of about 6.0-9.0. The hydrochloric acid solution is prepared by mixing about 10-40 ml of hydrochloric acid with about 300-500 ml of a solvent per 100 g of the non-woven fabric.

[0027] After completion of neutralization of the non-woven fabric, the non-woven fabric is post-treated through dehydrodation and drying. In the post-treating step, the non-woven fabric is dehydrated by a conventional method which is easily carried out by an ordinary skilled person in the art. The dehydrated non-woven fabric is preferably dried at the temperature of about 50-150° C.

[0028] As the non-woven fabric according to the present invention is prepared with cellulose fibers and is completely water-soluble, the non-woven fabric can prevent any environmental problem. In particular, as the dissolving time of the non-woven fabric can be controlled, the non-woven fabric according to the present invention has various applications upon the uses.

[0029] The invention may be better understood by reference to the following examples which are intended for the purpose of illustration and are not to be construed as in any way limiting the scope of the present invention, which is defined in the claims appended hereto. In the following examples, all parts and percentage are by weight unless otherwise indicated.

EXAMPLES 1A-1D

[0030] Non-woven fabric was prepared with cotton fibers. Four specimens of the non-woven fabric were prepared. Each specimen weighed 100 g. The specimens were put into four reactors separately (Examples 1A-1D). To the reactors were added 50, 60, 70 and 80 g of solid sodium hydroxide in powder, respectively. Next, 75, 90, 105 and 120 g of water added were added to each of the reactors, respectively. Methyl alcohol of 800 ml was used in each reactor as the solvent. The reactors were kept at 50° C. Mercerization was conducted in the reactors for three hours.

[0031] To each of the closed reactors of Examples 1A-1D were added 100 g of solid monochloro acetic acid and 300 ml of methyl alcohol added for neutralization. The treated non-woven fabrics were dehydrated and dried at 100° C.

[0032] To each of the closed reactors was a mixed solution of 30 ml of hydrochloric acid and 400 ml of methyl alcohol added for neutralization. The treated non-woven fabrics were dehydrated and dried at 100° C.

[0033] The water-soluble non-woven fabrics of Examples 1A-1D were obtained. The dissolving times of the non-woven fabrics of Examples 1A-1D were measured as 1.5, 1.2, 0.5 and 0.2 hour, respectively.

EXAMPLES 2A-2D

[0034] Non-woven fabric was prepared with cotton fibers. Four specimens of the non-woven fabric were prepared. Each specimen weighed 100 g. The specimens were put into four reactors separately (Examples 2A-2D). To the reactors was added 70 g of solid sodium hydroxide in powder, respectively. Next, 105 g of water added was added to each of the reactors. Ethyl alcohol of 800 ml was used for each reactor as the solvent. The reactors were kept at 50° C. Mercerization was conducted in the reactors for three hours.

[0035] To the closed reactors of Examples 2A-2D, 10, 50, 90 and 120 g of solid monochloro acetic acid were added, respectively. To each of the reactors 300 ml of ethyl alcohol was added. Etherification was conducted in the reactors at 80° C. for 2 hours.

[0036] To the closed reactors a mixed solution of 30 ml of hydrochloric acid and 400 ml of ethyl alcohol was added for neutralization. The treated non-woven fabrics were dehydrated and dried at 100° C.

[0037] The water-soluble non-woven fabrics of Examples 2A-2D were obtained. The dissolving times of the non-woven fabrics of Examples 2A-2D were measured as over 1 month, 3 days, 5 hours and 5 minutes, respectively.

EXAMPLES 3A-3D

[0038] Non-woven fabric was prepared with cotton fibers. Four specimens of the non-woven fabric were prepared. Each specimen weighed 100 g. The specimens were put into four reactors separately (Examples 3A-3D). To each of the reactors, 70 g of solid sodium hydroxide powder was added. Next, 105 g of water was added to each of the reactors. Methyl ketone of 800 ml was used in each reactor as the solvent. The reactors were kept at 50° C. Mercerization was conducted in the reactors for three hours.

[0039] To the closed reactors of Examples 3A-3D, 00 g of solid monochloro acetic acid was added, followed by 300 ml of methyl ketone. Etherification was conducted in the reactors at 80° C. for 2 hours.

[0040] To the closed reactors was a mixed solution of 10, 20, 30 and 40 ml of hydrochloric acid and 400 ml of methyl ketone added for neutralization, respectively. The treated non-woven fabrics were dehydrated and dried at 100° C.

[0041] The water-soluble non-woven fabrics of Examples 3A-3D were obtained. The dissolving times of the non-woven fabrics of Examples 3A-3D were measured as 1.3 hour, 0.5 hour, 5 minutes and 1 minute, respectively.

[0042] The present invention can be easily carried out by an ordinary skilled person in the art. Many modifications and changes may be deemed to be with the scope of the present invention as defined in the following claims.

What is claimed is:

1. A method of preparing a water-soluble non-woven fabric, comprising the steps of:
   (a) preparing a non-woven fabric being made of cellulose fibers;
   (b) mercerizing the non-woven fabric with aqueous sodium hydroxide in a solvent in a bath;
   (c) carrying out etherification of the mercerized fabric by adding monochloro acetic acid solution;
   (d) neutralizing the fabric with a hydrochloric acid solution to be a pH of about 6.0 to 9.0 in the bath; and
   (e) post-treating the fabric through dehydation and drying.

2. The method as defined in claim 1, wherein said non-woven fabric is a woven fabric, a knitted fabric, a sheet or a film being made of cellulose fibers.

3. The method as defined in claim 1, wherein said solvent is an alcohol or an ester.
4. The method as defined in claim 1, wherein said alcohol is selected from the group consisting of methyl alcohol, ethyl alcohol and isopropyl alcohol.

5. The method as defined in claim 1, wherein said mercerization (step (b)) is conducted in aqueous sodium hydroxide prepared by dissolving about 50-80 g of solid sodium hydroxide in powder per 100 g of the non-woven fabric in about 30-180 g of water and in a solvent of about 600-1000 ml per 100 g of the non-woven fabric at the temperature of about 30-60°C. for about 1-4 hours.

6. The method as defined in claim 1, wherein said etherification (step (c)) is conducted by adding monochloroacetic acid solution prepared by dissolving about 10-120 g of monochloroacetic acid in solid per 100 g of the non-woven fabric in about 20-720 g of a solvent at the temperature of about 60-90°C. for about 1-3 hours.

7. The method as defined in claim 1, wherein said neutralization (step (d)) is conducted by adding hydrochloric acid solution prepared by mixing about 10-40 ml of hydrochloric acid with about 300-500 ml of a solvent per 100 g of the non-woven fabric to be the pH in the range of about 6.0-9.0.

8. The method as defined in claim 1, wherein said neutralization (step (d)) is conducted in a separate reactor filled with hydrochloric acid solution prepared by mixing about 10-40 ml of hydrochloric acid with about 300-500 ml of a solvent per 100 g of the non-woven fabric to be the pH in the range of about 6.0-9.0.

9. The method as defined in claim 1, wherein said drying in step (e) is conducted in a dryer in the range of about 50-150°C.

10. The method as defined in claim 6, wherein said monochloroacetic acid in solid is used in the amount of about 10-40 g of per 100 g of the non-woven fabric.

11. The method as defined in claim 6, wherein said monochloroacetic acid in solid is used in the amount of about 40-80 g of per 100 g of the non-woven fabric.

12. The method as defined in claim 6, wherein said monochloroacetic acid in solid is used in the amount of about 80-120 g of per 100 g of the non-woven fabric.

13. A water-soluble non-woven fabric which is prepared in accordance with the method of claim 1.

14. A water-soluble non-woven fabric which is prepared in accordance with the method of claim 10 and has a dissolving time of at least 1 month.

15. A water-soluble non-woven fabric which is prepared in accordance with the method of claim 11 and has a dissolving time between at least 2 hours and at most 1 month.

16. A water-soluble non-woven fabric which is prepared in accordance with the method of claim 12 and has a dissolving time of at most 2 hours.

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