

MULTI-LAYERED WATER-DECOMPOSABLE WIPER SHEET**BACKGROUND OF THE INVENTION****FIELD OF THE INVENTION**

The present invention generally relates to a water-decomposable wiper sheet having high strength and capable of being readily dispersed in water flow. More precisely, the present invention relates to such a water-decomposable wiper sheet having a multi-layered structure and having an excellent ability to catch dust.

DESCRIPTION OF THE RELATED ART

For cleaning objects and for wiping the skin of bodies, used are disposable wiper sheets made of paper or non-woven fabric. For these, water-decomposable wiper sheets that could be directly disposed of in toilets after use have been developed, as being convenient for such purposes. However, if they are so constituted that they have an increased mechanical strength enough for wiper applications, their decomposability in water will decrease, and, if so, they will take a lot of time until they are dispersed in septic tanks or will clog the drainpipes around toilets, when disposed of in toilets after use.

Such wiper sheets are often used for wiping off wet dirt for cleaning toilets and thereabouts. Accordingly, their strength must be such that the sheets are not broken even in wet condition of containing a small amount of water.

Furthermore, for easy and effective use, some wiper sheets are packaged while being wetted with a detergent chemical or the like, and are put on the market. Therefore, water-decomposable wiper sheets must have high dry strength enough for wiper applications, preferably high wet strength enough for wet wiper applications containing water, and must be readily decomposed in water when disposed of in toilets.

As water-decomposable wiper sheets, Japanese Unexamined Patent Publication (Kokai) No. Heisei 3-113098 discloses a water-decomposable cleaning article. The cleaning article comprises a binder-free water-decomposable fibrous sheet of which both surfaces are laminated with a water-decomposable fibrous sheet via a water-soluble binder therebetween, and it is embossed. However, the cleaning article could hardly catch relatively large-sized dust, and is not easy to use as its surface is often slippery.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a water-decomposable wiper sheet which is well decomposed in water and has high strength and which has an excellent ability to catch dust.

According to an aspect of the invention, a multi-layered water-decomposable wiper sheet may comprise a water-decomposable top sheet of water-dispersible fibers and a

water-decomposable back sheet layered on the top sheet, wherein;

the top sheet is provided with a large number of through-holes, the through-holes are closed by the back sheet at the interface between the top sheet and the back sheet.

Preferably, the back sheet is formed of water-dispersible fibers and provided with a large number of through-holes, the through-holes of the top sheet are closed by the back sheet at the interface between the top sheet and the back sheet, and the through-holes of the back sheet are closed by the top sheet at the interface.

According to another aspect of the invention, a multi-layered water-decomposable wiper sheet may comprise a water-decomposable top sheet of water-dispersible fibers, a water-decomposable back sheet of water-dispersible fibers and a water-decomposable interlayer sheet sandwiched between the top sheet and the back sheet, wherein;

the top sheet and the back sheet are provided with a large number of through-holes, the through-holes are closed by the interlayer sheet at the interface between the top sheet and the interlayer sheet and at the interface between the back sheet and the interlayer sheet.

As having such a multi-layered structure, the water-decomposable wiper sheet of the invention has a relatively high strength, and, when disposed of in toilets after use and dipped

in a large amount of water therein, it is decomposed to lose its shape. In addition, since the sheet surface for wiper applications is provided with the through-holes, the sheet can catch even relatively large-sized dust to keep it in its through-holes. Furthermore, since the through-holes do not extend to the back surface of the sheet, it prevents the dust caught by the sheet from passing through the sheet to soil the hand and the holder for holding the sheet.

Preferably, the fibers constituting the peripheral edge of each through-hole are raised from the wiper sheet.

Also preferably, the sheet provided with the through-holes contains fibrillated rayon that comprises primary fibers having a predetermined fiber length and microfibers extending from the primary fibers, and has a degree of beating of at most 700 cc. Also preferably, the fibrillated rayon comprises the primary fibers having a length of between 1.8 mm and 10 mm at the peak of the mass distribution curve of the primary fibers, and the microfibers having a length of at most 1 mm which account for from 0.1 to 65 % by weight of the self-weight of the fibrillated rayon.

The sheet provided with the through-holes may be a non-woven fabric having been subjected to water-jetting treatment.

Preferably, the total weight (this may be referred to as "Metsuke") of the fibers constituting the multi-layered sheet

falls between 15 and 150 g/m².

Also preferably, the decomposability in water of the multi-layered wiper sheet is at most 200 seconds.

Still preferably, the wet strength of the multi-layered wiper sheet is at least 1.1 N/25 mm.

Also preferably, the dry strength of the multi-layered wiper sheet is at least 3.4 N/25 mm.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1A is a perspective view of the first embodiment of a wiper sheet of the invention; and Fig. 1B is an enlarged schematic view showing the constitution of the wiper sheet;

Fig. 2 is a partially enlarged cross-sectional view of the wiper sheet of Fig. 1A and Fig. 1B;

Fig. 3 is an enlarged schematic view showing the constitution of the second embodiment of the wiper sheet of the invention;

Fig. 4 is a plan view showing further embodiment of the wiper sheet of the invention; and

Fig. 5 is a plan view showing still further embodiment of the wiper sheet of the invention.

DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

The invention will be described hereinafter with reference to the accompanying drawings. Fig. 1A is a

perspective view of the first embodiment of a wiper sheet of the invention; Fig. 1B is an enlarged schematic view showing in more detail the constitution of the wiper sheet; and Fig. 2 is a partially enlarged cross-sectional view of the wiper sheet of Fig. 1A and Fig. 1B.

As shown in Fig. 1A, a wiper sheet 10 has a layered structure of independent sheets, a top sheet 1 with through-holes 3 and a back sheet 2 with no through-hole that are separately produced and are then laminated. The top sheet 1 has a plurality of the through-holes 3 formed over the entire surface thereof. A surface 1s of the top sheet 1 formed with the through-holes 3 is for wiper application when the wiper sheet 10 is used for cleaning objects. The wiper sheet 10 is disassembled into the constituent sheets, and the respective sheets are enlarged, as shown in Fig. 1B. In further detail, the top sheet 1 with through-holes 3 overlies the back sheet 2 with no through-hole, in such a manner that the back sheet 2 closes the through-holes 3 of the top sheet 1 and therefore the through-holes 3 do not pass through the wiper sheet 10 in the direction of the thickness of the wiper sheet 10, as shown in Fig. 2.

As the surface 1s for wiper application has the through-holes 3 opening outside, the multi-layered wiper sheet 10 can catch even relatively large-sized dust. In addition, the dust thus caught by the wiper sheet 10 is well kept in the

through-holes 3 and does not run to the outer surface of the back sheet 2. Accordingly, even though the outer surface of the back sheet 2 is held by the hand or a mop holder and the like when the wiper sheet 10 is used for cleaning objects, the hand or the mop holder and the like are not soiled and the wiper sheet 10 can be used comfortably. In addition, the wiper sheet 10 is decomposable in water. Therefore, when the wiper sheet 10 is disposed of in toilets after used for wiper applications, it is readily separated into constituent layers and decomposed in water to lose its shape.

Preferably, the top sheet 1 is formed of fibers well dispersible in water, or that is, water-dispersible fibers. The dispersibility in water referred to herein has the same meaning as the decomposability in water, and is meant to indicate that the fibers are dispersed well in water to thereby decompose the sheet comprising them, when kept in contact with a large amount of water. More preferably, these fibers are biodegradable fibers. The biodegradable fibers naturally decompose by themselves even though being disposed of in the natural world. Still preferably, the length of the fibers falls between 1 mm and 10 mm in view of the balance of the decomposability thereof in water and the mechanical strength thereof. The fiber length referred to herein indicates the mean length of the fibers.

The fibers may be those of at least one sort selected from

the group consisting of natural fibers and chemical fibers. The natural fibers include those from wood pulp such as soft wood pulp, hard wood pulp, etc.; and also those from Manila hemp, linter pulp, etc. These natural fibers are biodegradable. Among those, preferred are bleached soft-wood kraft pulp and bleached hard-wood kraft pulp, as having high dispersibility in water. Also usable herein are chemical fibers such as regenerated fibers of rayon or fibrillated rayon, etc.; synthetic fibers of polypropylene, polyvinyl alcohol, polyester, polyacrylonitrile, etc.; biodegradable synthetic fibers; synthetic pulp of polyethylene, etc. Among those, preferred is rayon, as being biodegradable. Further usable are still other biodegradable fibers of polylactic acid, polycaprolactone, aliphatic polyesters such as polybutylene succinate, polyvinyl alcohol, collagen, etc. Needless to say, any fibers other than those mentioned above are usable herein so far as they are dispersible in water.

Among the fibers mentioned above, preferred are fibrillated rayon. When the top sheet 1 contains fibrillated rayon, the microfibers extending from the fibrillated rayon enhance the wiper effect of the sheet to catch and keep fine dust. In addition, when the wiper sheet 10 has caught relatively large-sized dust in the through-holes 3, the microfibers act to prevent the dust from dropping off from the wiper sheet 10. Accordingly, the ability of the wiper sheet

10 to catch dust is significantly enhanced. Furthermore, since the microfibers extending from the fibrillated rayon in the top sheet 1 are essentially brought into contact with the surface of the objects to be wiped with the wiper sheet 10, the frictional force directly applied to the wiper sheet 10 will be reduced. Accordingly, the water-decomposable wiper sheet of the invention ensures an increased strength to friction. Furthermore, the microfibers of the fibrillated rayon can be entangled with other fibers constituting the wiper sheet and also with the microfibers of such other fibers, and can be further bonded to them through hydrogen-bonding to ensure a further increased mechanical strength. When having received a large amount of water, the entangled microfibers will come loose or the hydrogen bonding of the microfibers will be cut, thereby facilitating decomposition of the wiper sheet in water.

The fibrillated rayon for use in the invention is meant to indicate fibers of regenerated cellulose rayon having finely-fibrillated surfaces, that is, those with submicron-sized microfibers being peeled and extending from the surfaces of the primary fibers (of the fibrillated rayon). The surface of ordinary regenerated cellulose is smooth, while that of the fibrillated rayon is fibrillated; and the former and the latter have different structures.

The fibrillated fibers can be produced, for example, by mechanically processing rayon while it has absorbed water and

is still wetted. Concretely, they may be produced, for example, according to a method of strongly stirring rayon in water in a mixer, or a method of beating rayon in a pulper, a refiner, a beater or the like (this is a wet-beating method). More precisely, the fibrillated rayon includes fibers as produced by processing wet-spun rayon such as polynosic or the like with an acid followed by mechanically fibrillating it, fibers as produced by mechanically fibrillating solvent-spun rayon, etc. Apart from those, the fibrillated rayon can also be produced from ordinary, wet-spun regenerated cellulose.

In general, the self-weighted, average fiber length distribution (mass distribution) profile of the fibrillated rayon gives two apparent peaks. The "self-weighted, average fiber length" may be referred to as the weighted average length by weight. The area except that for short fiber lengths of shorter than 1 mm is principally for the primary fibers of the fibrillated rayon, and the remaining area for the short fiber lengths of shorter than 1 mm includes long extending microfibers and chopped rayon fibers all resulting from too much promoted fibrillation. The fiber length of the primary fibers of the beaten, fibrillated rayon may be shorter in some degree than that of the fibers of the original, non-beaten rayon, or may be seemingly longer in some degree owing to the microfibers that extend from the primary fibers at their ends. Accordingly, in the beaten, fibrillated rayon, the fiber length of the primary

fibers at the mass distribution peak falls within a range of the nominal fiber length of the non-beaten rayon ± 0.5 mm or so, more precisely, within a range of from -0.3 mm to $+0.1$ mm or so relative to the nominal fiber length of the non-beaten rayon.

To that effect, the fibrillated rayon for use in the invention is identified as one having the fiber length peak for the primary fibers of the fibrillated rayon itself and the fiber length peak for the fibrillated microfibers. If rayon is beaten in an ordinary free-beating manner to promote its beating, it will be entirely pulverized into small particles and most of the small particles will lose the original fiber length. The free-beaten rayon differs from the fibrillated rayon usable in the invention.

Preferred examples of the fibrillated rayon usable herein are described. In case where rayon having an original fiber length of from 3 mm to smaller than 5 mm is beaten (in this case, the mass distribution peak for the primary fibers of the resulting, beaten rayon appears within a fiber length range of from 2.5 mm to smaller than 4.5 mm) and where the degree of beating is smaller than 400 cc, the microfibers having a length of at most 1 mm account for from 0.5 to 15 % by mass (by weight) of the self-weight (that is, the total mass) of the fibrillated rayon. However, in case where the rayon is beaten in a pulper or a refiner to such a degree, the uppermost limit of the

microfibers is 8 % by mass or so. On the other hand, in case where the rayon is beaten to a degree of from 400 cc to 700 cc, the microfibers having a length of at most 1 mm account for from 0.1 to 5 % by mass of the self-weight of the fibrillated rayon. However, in case where the rayon is beaten in the pulper or the refiner to such a degree, the uppermost limit of the microfibers is 3 % by mass or so. Still on the other hand, in case where the rayon is beaten in a pulper or refiner to a degree of from 400 cc to 600 cc, the lowermost limit of the microfibers is 0.2 % by mass.

In case where rayon having an original fiber length of from 5 mm to 7 mm is beaten (in this case, the mass distribution peak for the primary fibers of the resulting, beaten rayon appears within a fiber length range of from 4.5 mm to 7.5 mm) and where the degree of beating is smaller than 400 cc, the microfibers having a length of at most 1 mm account for from 8 to 65 % by mass of the self-weight of the fibrillated rayon. However, in case where the rayon is beaten in the pulper or the refiner, the uppermost limit of the microfibers is 30 % by mass or so and the lowermost limit thereof can be 5 % by mass. On the other hand, in case where the rayon is beaten to a degree of from 400 cc to 700 cc, the microfibers having a length of at most 1 mm account for from 0.3 to 50 % by mass of the self-weight of the fibrillated rayon. However, in case where the rayon is beaten in the pulper or the refiner to such a degree,

the uppermost limit of the microfibers is 20 % by mass or so. Still on the other hand, in case where the rayon is beaten in the pulper or the refiner to a degree of from 400 cc to 600 cc, the lowermost limit of the microfibers is 2 % by mass.

The degree of beating of the fibrillated rayon preferred for use in the invention is at most 700 cc. The degree of beating to give fibrillated rayon can be controlled by varying the beating time and by selecting the beating means. Where beating rayon is promoted (to give a beaten, fibrillated rayon that shall have a lowered numerical value indicating its degree of beating), the ratio of short fibers (including microfibers) in mass distribution of the resulting fibrillated rayon will increase. Fibrillated rayon having a degree of beating of larger than 700 cc contains a small amount of microfibers formed therein and its strength will be not enough for the wiper sheet of the invention. More preferably, the fibrillated rayon for use herein has a degree of beating of at most 600 cc in order that it can contain a suitable amount of microfibers formed therein. In this case, the fibrillated rayon of that type is preferred, since the microfibers constituting it significantly enhance the strength of the wiper sheet. Even more preferably, the degree of beating is at most 400 cc. However, fibrillated rayon having a degree of beating of at most 200 cc, or even at most 100 cc (for example, 50 cc or 0 cc) may also be used in producing the wiper sheet of the invention.

The fineness of the fibrillated rayon (in terms of denier) is preferably from 1.1 to 7.7 dtex or so. If its fineness is smaller than the lowermost limit of the defined range, the primary fibers of the fibrillated rayon will be too much entangled, and the decomposability in water of the wiper sheet comprising it will be poor. If, on the other hand, its fineness is larger than the uppermost limit of the defined range, the formation of the fibrous sheet will be degraded and, in addition, the productivity thereof will be low. More preferably, the fineness falls between 1.2 and 1.9 dtex.

The top sheet 1 may be formed of fibrillated rayon only. However, since fibrillated rayon is relatively expensive, it is desirable that the top sheet 1 contains other water-dispersible fibers in addition to fibrillated rayon.

Preferably, the top sheet 1 contains soft wood pulp of high dispersibility in water. However, if the top sheet 1 is formed of soft wood pulp only, its strength will lower. Preferably, therefore, the top sheet 1 is formed of soft wood pulp combined with other water-dispersible fibers of fibrillated rayon and/or rayon, etc. More preferably, soft wood pulp accounts for at most 70 % by mass or so of the fibers that constitute the top sheet 1. Also preferably, the degree of beating of the soft wood pulp falls between 500 and 750 cc or so. If the degree of beating of the soft wood pulp therein is smaller than the lowermost limit of the defined range, the

top sheet 1 will be have a paper-like feel and its texture will be degraded. On the other hand, if the degree of beating thereof is larger than the uppermost limit thereof, the mechanical strength of the top sheet 1 will be poor.

The top sheet 1 is formed of the fibers mentioned above. Preferably, the weight (Metsuke) of the fibers constituting the top sheet 1 falls between 8 and 70 g/m² or so. The top sheet 1 may be any of a fibrous sheet formed in a paper-making process or a non-woven fabric prepared by subjecting a fibrous web to water-jetting treatment. Such a fibrous sheet or a non-woven fabric is processed to have through-holes to form the top sheet 1 of the invention.

Any method is employable for forming the through-holes 3 in the fibrous sheet or the non-woven fabric. For example, it may be processed with water jets (water-jetting treatment); or may be punched with needles (needle-punching); or may be perforated to have circular through-holes by use of a perforator or the like. Among those, preferred is water-jetting treatment or needle-punching. In this case, when the fibers constituting the top sheet 1 are pushed out from one surface of the top sheet 1 to the other surface thereof to form the intended through-holes 3, a fuzzy portion or fluffy portion 4 in which the fibers constituting the peripheral edge of each through-hole are raised from the wiper sheet, is formed around each through-hole 3 on the surface opposite to that to which

the water jets or the punching needles is applied, as shown in Fig. 1B and Fig. 2. The top sheet 1 thus having the fuzzy portion 4 around each through-hole 3 is laminated on the back sheet 2 with the fuzzy portion 4 being outside, so that the resulting two-layered wiper sheet can effectively catch dust, hair leavings and the like. Alternatively to this, however, the top sheet 1 may be laminated on the back sheet 2 with the fuzzy portions 4 being inside. In this case, the through-holes 3 are not closed by the fuzz around them. Therefore, the two-layered wiper sheet of this type with such through-holes 3 is more effective for scraping dirt-caked objects.

Preferably, the diameter (opening width) of each through-hole 3 falls between 1 and 5 mm or so. When the through-holes 3 are formed in water-jetting treatment, the horizontal openings of the through-holes 3 will be oval or elliptical with the major axis being faced to the direction of processing the fibrous web (i.e., the machine direction). In this case, it is desirable that the minor axis falls between 0.2 and 3 mm or so and the major axis falls between 1 and 5 mm or so. Also preferably, the opening area (in which the through-holes 3 are formed) falls between 1 % and 40 %, more preferably between 5 % and 20 % of the surface area of the wiper sheet. Still preferably, the number of the through-holes 3 falls between 10 and 100 per 1 cm² or so (i.e., the density of the through-holes 3 falls between 10 and 100/cm² or so). In

the condition as set forth above, the wiper sheet ensures an increased dust-catching effect when used for wiping and cleaning objects.

As is the case with the top sheet 1, the back sheet 2 may be a water-decomposable fibrous web or water-decomposable non-woven fabric formed of water-dispersible fibers and having a weight (Metsuke) of from 8 to 70 g/m² or so. Being different from the top sheet 1, however, the back sheet 2 has no through-hole.

The back sheet 2 may also be a water-soluble resin sheet. The water-soluble resin sheet may be formed of, for example, any of water-soluble polyvinyl alcohol, polyvinyl alcohol derivatives, polyvinyl pyrrolidone, or polysaccharide derivatives such as methyl cellulose or starch, or polyacrylic acid, polymethacrylic acid, polymaleic acid and their derivatives, or polyether compounds such as polyethylene glycol, etc. When the back sheet 2 is made of such a resin sheet, its weight preferably falls between 5 g/m² and 15 g/m². Also preferably, its thickness falls between 5 μm and 20 μm or so.

The top sheet 1 and the back sheet 2 produced as set forth above are laminated to form the water-decomposable wiper sheet 10. When the back sheet 2 contains fibers, it may be laminated with the top sheet 1 by pressing under heat while a small amount of water is present at the interface between the top sheet 1 and the back sheet 2. In that manner, the two are bonded in

a mode of hydrogen-bonding. If desired, a water-soluble or water-swellaable adhesive may be applied to the interface between the top sheet 1 and the back sheet 2 to bond the two sheets. The water-soluble or water-swellaable adhesive includes, for example, cellulose derivatives such as methyl cellulose, hydroxyethyl cellulose, carboxymethyl cellulose, etc.; water-soluble polymers such as polyvinyl alcohol, sodium alginate, sodium polyacrylate, polyacrylic acid ether, polyvinyl pyrrolidone, isobutylene-maleic anhydride copolymer, etc.; starch, dextrin, etc.

Preferably, the weight (Metsuke) of the fibrous web for the water-decomposable wiper sheet 10 falls between 10 and 100 g/m². If its weight is smaller than the lowermost limit of the defined range, the wiper sheet could not have the necessary wet strength. If, however, its weight is larger than the uppermost limit of the defined range, the wiper sheet will be not flexible. In particular, for application to the skin of human bodies, its weight is more preferably from 30 to 70 g/m², in view of the wet strength and the soft feel of the wiper sheet.

Preferably, the strength at break in dry of the water-decomposable wiper sheet of the invention is at least 3.4 N/25 mm in terms of the root mean square of the strength in the machine direction (MD) of the wiper sheet and that in the cross direction (CD) thereof. The strength at break in dry (this is herein referred to as dry strength) is meant to indicate the

tensile strength at break (N) of the wiper sheet in dry. To obtain its dry strength in terms of the tensile strength at break, a piece of the wiper sheet having a width of 25 mm and a length of 150 mm is pulled until it is broken, by use of a Tensilon tester, for which the chuck distance is 100 mm and the stress rate is 100 mm/min. However, the data thus measured according to the method are merely the criterion for the strength of the wiper sheet, and the wiper sheet of the invention will have a strength that is substantially the same as the dry strength thereof measured in the manner as above.

The water-decomposable wiper sheet of the invention may be used in wet. Therefore, it is desirable that the strength at break in wet of the sheet that contains water is at least 1.1 N/25 mm in terms of the root mean square of the strength in the machine direction (MD) of the sheet and that in the cross direction (CD) thereof. To obtain the strength at break in wet (this is herein referred to as wet strength) of the sheet, a piece of the sheet having a width of 25 mm and a length of 150 mm is immersed in water to thereby infiltrate water of 2.5 times the mass of the sheet into the sheet piece, and the thus-wetted sheet piece is measured in the same manner as above. However, the data thus measured according to the method are merely the criterion for the strength of the sheet, and the sheet of the invention will have a strength that is substantially the same as the wet strength thereof measured in the manner as above.

More preferably, the wet strength of the sheet is at least 1.3 N/25 mm.

Also preferably, the water-decomposable wiper sheet of the invention has a degree of decomposition in water of at most 300 seconds, more preferably at most 200 seconds, even more preferably at most 120 seconds. The degree of decomposition in water is measured according to the test method of JIS P-4501 that indicates the degree of easy degradation of toilet paper in water. The outline of the paper degradation test method is described. A piece of the water-decomposable wiper sheet of the invention having a length of 10 cm and a width of 10 cm is put into a 300-ml beaker filled with 300 ml of ion-exchanged water, and stirred therein with a rotor. The revolution speed of the rotor is 600 rpm. The condition of the test piece being dispersed in water is macroscopically observed at predetermined time intervals, and the time until the test piece is finely dispersed is measured. However, the data thus measured according to the method are merely the criterion for the decomposability in water of the wiper sheet, and the wiper sheet of the invention will have a degree of decomposition in water that is substantially the same as the data measured in the manner as above.

To increase its mechanical strength, the wiper sheet of the invention may contain a binder. The binder may be only in the top sheet 1 or only in the back sheet 2, or in both of the

top sheet 1 and the back sheet 2. The binder may be applied to the interface between the constituent layers or to the surface of the wiper sheet. If swellable in water, the binder may be mixed with the fibers to be formed into the wiper sheet. The binder includes, for example, carboxymethyl cellulose; alkyl celluloses such as methyl cellulose, ethyl cellulose, benzyl cellulose, etc.; polyvinyl alcohol; modified polyvinyl alcohol having a predetermined amount of a sulfonic acid group or a carboxyl group, etc. When the wiper sheet contains such a binder and when it is used in wet, it is desirable that the wiper sheet further contains an inorganic salt such as sodium sulfate, or an organic salt such as sodium tartrate. In addition, the wiper sheet may contain a copolymer of a polymerizable acid anhydride with any other compound, such as (meth) acrylic acid-maleic acid resin, or an amino acid derivative such as trimethylglycine, etc.

Fig. 3 is an enlarged schematic view showing the constitution of the second embodiment of the wiper sheet of the invention. As shown in Fig. 3, a wiper sheet 10A has a laminate structure that comprises a top sheet 5 with through-holes 3, a back sheet 6 with through-holes 3, and an interlayer sheet 7 sandwiched between the top sheet 5 and the back sheet 6.

The top sheet 5 and the back sheet 6 have the same structure, and these are the same as the top sheet 1 in the embodiment of Fig. 1A and Fig. 1B. The through-holes 3 of the top sheet 5

and those of the back sheet 6 are all closed by disposing the interlayer sheet 7 between the top sheet 5 and the back sheet 6. Therefore, the through-holes 3 do not pass through the wiper sheet 10A from the top surface to the back surface thereof. In the wiper sheet 10A of this embodiment, both the outer surface of the top sheet 5 and that of the back sheet 6 can be used for wiper applications.

The interlayer sheet 7 may be made of a fibrous web or non-woven fabric, like the back sheet 2 of the embodiment of Fig. 1A and Fig. 1B. If desired, the interlayer sheet 7 may be made of a water-soluble resin sheet that may be for the back sheet 2.

In the water-decomposable wiper sheet 10A of the embodiment of Fig. 3, the interlayer sheet 7 may be eliminated, if desired. In this case, however, the top sheet 5 and the back sheet 6 are shifted from each other so that the through-holes 3 do not extend from the top surface of the wiper sheet 10A to the back surface thereof.

Fig. 4 and Fig. 5 are plan views showing still other embodiments of the water-decomposable wiper sheet of the invention. The water-decomposable wiper sheets 10 and 10A illustrated in Figs. 1A, 1B and Fig. 3 have the through-holes 3 formed in the entire surface thereof. Apart from these, however, the through-holes 3 may be formed partly in the wiper sheet. For example, the wiper sheet may have striped regions

20 with through-holes formed therein, as shown in Fig. 4; or the wiper sheet may have spaced square regions 21 with through-holes formed therein, as shown in Fig. 5.

The water-decomposable wiper sheet of the invention may contain, in addition to the compounds set forth above, any other substances without interfering with the effect of the invention. For example, it may contain oil that enhances the ability of the sheet to adsorb dust, as well as surfactant, microbicide, preservative, deodorizer, moisturizer, alcohol such as ethanol, polyalcohol such as glycerin, etc. The oil may be mineral oil such as paraffin; synthetic oil such as polyolefin; and silicone oil, etc.

The wiper sheet of the invention may be used in wet. When it is previously wetted with water, surfactant or liquid detergent such as alcohol, glycerin or the like, and is packaged for public sale, it shall be airtightly packaged and put on the market so that it is not spontaneously dried. On the other hand, the water-decomposable wiper sheet of the invention may be marketed in dry. The users who have bought the dry water-decomposable wiper sheet may wet it with water or liquid chemicals before use.

EXAMPLES

The invention is described in more detail with reference to the following Examples, which, however, are not intended to

restrict the scope of the invention.

Wiper sheets of the invention and comparative wiper sheets produced in the following Examples and Comparative Examples were tested for the ability to catch dust (wiper test), the decomposability in water, and the wet strength.

Example 1:

A water-decomposable non-woven fabric (Weight: 30 g/m²) was needle-punched to form through-holes therein. This serves as the top sheet 1. A sheet of water-decomposable paper (Weight: 20 g/m²) having no through-hole was prepared. This serves as the back sheet 2. The two were laminated to form a wiper sheet as shown in Fig. 1A and Fig. 1B.

Example 2:

Needle-punched, water-decomposable non-woven fabrics (Weight: 20 g/m²) were prepared for the top sheet 5 and the back sheet 6. A sheet of water-decomposable paper (Weight: 10 g/m²) having no through-hole was prepared for the interlayer sheet 7. The interlayer sheet 7 was sandwiched between the top sheet 5 and the back sheet 6, and these were laminated to form a wiper sheet as shown in Fig. 3.

Example 3:

As is the case with the Example 2, the two water-decomposable non-woven fabrics (Weight: 25 g/m²) were laminated to form a wiper sheet, which, however, did not have the interlayer sheet 7 to be sandwiched between the top sheet 5 and

the back sheet 6. In this case, the top sheet 5 and the back sheet 6 were shifted from each other by 0.5 pitch so that the through-holes did not extend from the top surface of the wiper sheet to the back surface thereof.

Example 4:

As is the case with the Example 3, a wiper sheet was formed. In this case, however, the top sheet 5 and the back sheet 6 were so laminated that the fuzzy portions 4 formed in the top sheet 5 face to the fuzzy portions 4 formed in the back sheet 6 (i.e., the fuzzy portions 4 of the top sheet 5 and the back sheet 6 are mutually opposed).

In these Examples 1 to 4, the water-decomposable non-woven fabric for the top sheet (including the back sheet in case of the Examples 2 to 4) with through-holes was formed of NBKP (degree of beating: 600 cc) and fibrillated rayon (degree of beating: 200 cc, 1.7 dtex, fiber length before beating: 5 mm) to be mixed in a ratio by mass of 70 % : 30 %. The water-decomposable paper was formed of NBKP (degree of beating: 600 cc) alone.

Comparative Example 1:

A wiper sheet having a three-layered structure of top sheet (25 g/m²) + interlayer sheet (40 g/m²) + back sheet (25 g/m²) was prepared. This is a 0.9 mm steel match-embossed sheet, and its constituent layers are all fibrous layers of pulp alone. The respective layers have no through-hole. The top sheet was

coated with 3 % by mass of carboxymethyl cellulose. In addition, a calcium chloride solution was applied to the laminated wiper sheet, which was then dried. The calcium chloride content of the sheet was 2 % by mass of the overall weight of the sheet.

Comparative Example 2:

A wiper sheet having a three layered structure of top sheet (15 g/m²) + interlayer sheet (15 g/m²) + back sheet (15 g/m²) was prepared. Its constituent layers are all fibrous layers of pulp alone. The top sheet and the back sheet were both creped to a degree of creping of 50 %.

Wiper Application Test:

110 mg of test dust, a mixture of mud dust and pulp dust, is uniformly spread in a region of 50 cm x 50 cm. This region is wiped with any of the wiper sheets formed herein, crosswise (i.e., vertically and horizontally) three times. Based on the mass of deposit per unit area of the mud dust or the pulp dust, the wiper sheet is evaluated in 5 points (i.e., on a scale of one to five). A higher point means that the ability of the tested wiper sheet to catch the dust is better. The point of the wiper sheet for the mud dust is multiplied by 3.5 to obtain a point for total evaluation of the wiper sheet. Also, the point of the wiper sheet for the pulp dust is multiplied by 3.5 to obtain a point for total evaluation of the wiper sheet. In addition, the degree of the dirt of the tested wiper sheet is evaluated in 5 points (i.e., on a scale of one to five), depending

on the dirt area of the wiper sheet. A higher point means that the broader area of the wiper sheet served for wiper application. The point of the wiper sheet is multiplied by 3 to obtain a point for total evaluation of the wiper sheet. The data of the total evaluation of the tested wiper sheets are given in Table 1. In Table 1, the highest point is 50 ($= 5 \times 3.5 + 5 \times 3.5 + 5 \times 3$); and the lowest point is 10 ($= 1 \times 3.5 + 1 \times 3.5 + 1 \times 3$).

Decomposition in Water:

The test for decomposability in water was based on the test of JIS P-4501 indicating the degree of degradability of toilet paper. Precisely, the wiper sheet to be tested was cut into a piece having a length of 10 cm and a width of 10 cm. This was put into a 300-ml beaker filled with 300 ml of ion-exchanged water, and stirred therein with a rotor. The revolution speed of the rotor was 600 rpm. The condition of the test piece being dispersed in water was macroscopically observed at predetermined time intervals, and the time until the test piece was dispersed was measured (see the following Table - the data are expressed in seconds).

Wet Strength:

The wet strength was measured according to the test method stipulated in JIS P-8135. Briefly, a piece of the wiper paper to be tested, having a width of 25 mm and a length of 150 mm, was pulled both in the machine direction (MD) and in the cross direction (CD), by use of a Tensilon tester, for which the chuck

distance was 100 mm and the stress rate was 100 mm/min.

Table 1

		Example 1	Example 2	Example 3	Example 4	Comparative Example 1	Comparative Example 2
Wiper Application Test	point	43.5	34	40.5	28	16	20
Decomposabil- ity in Water	sec	60	69	56	52	45	90
Wet Strength (MD)	N/25 mm	1.84	2.31	1.61	1.54	0.85	0.96
Wet Strength (CD)	N/25 mm	1.23	2.05	1.13	1.09	0.72	0.88

From the test data as above, it is understood that the ability of the wiper sheets with through-holes of the invention to catch dust is higher than that of the conventional wiper sheets.

As having a multi-layered structure, the water-decomposable wiper sheet of the invention has a relatively high strength, and when disposed of in toilets after use and put in a large amount of water therein, it is readily decomposed to lose its shape. In addition, since the top surface of the sheet that is directly applied to the objects to be wiped with it is processed to have through-holes therein, the wiper sheet can easily catch relatively large-sized dust and can keep it in the through-holes. Furthermore, since the through-holes of the sheet do not extend to the back surface of sheet, the dust caught by the sheet does not pass through the back surface of the sheet, thereby avoiding soiling the hand and the holder for holding

the sheet.

Both the dry strength and the wet strength of the wiper sheet are good, and when the wiper sheet is disposed of in toilets after use, the respective layers thereof are separated so that it is readily decomposed to lose its shape.

The materials to form the wiper sheet of the invention have no negative influences on human bodies.

While the invention has been described in detail and with reference to specific embodiments thereof, it will be apparent to one skilled in the art that various changes and modifications can be made therein without departing from the spirit and scope thereof.



What is claimed is:

1. A multi-layered water-decomposable wiper sheet comprising a water-decomposable top sheet of water-dispersible fibers and a water-decomposable back sheet layered on the top sheet, wherein;

the top sheet is provided with a large number of through-holes, the through-holes are closed by the back sheet at the interface between the top sheet and the back sheet.

2. The water-decomposable wiper sheet as set forth in claim 1, wherein the back sheet is formed of water-dispersible fibers and provided with a large number of through-holes, the through-holes of the top sheet are closed by the back sheet at the interface between the top sheet and the back sheet, and the through-holes of the back sheet are closed by the top sheet at the interface therebetween.

3. The water-decomposable wiper sheet as set forth in claim 1, wherein the fibers constituting the peripheral edge of each through-hole are raised from the wiper sheet.

4. The water-decomposable wiper sheet as set forth in claim 1, wherein the sheet provided with the through-holes contains fibrillated rayon that comprises primary fibers having a predetermined fiber length and microfibers extending from the



primary fibers, and has a degree of beating of at most 700 cc.

5. The water-decomposable wiper sheet as set forth in claim 4, wherein the fibrillated rayon comprises the primary fibers having a length of between 1.8 mm and 10 mm at the peak of the mass distribution curve of the primary fibers, and the microfibers having a length of at most 1 mm which account for from 0.1 to 65 % by weight of the self-weight of the fibrillated rayon.

6. The water-decomposable wiper sheet as set forth in claim 1, wherein the sheet provided with the through-holes is a non-woven fabric having been subjected to water-jetting treatment.

7. The water-decomposable wiper sheet as set forth in claim 1, wherein the total weight of the fibers constituting the multi-layered sheet falls between 15 and 150 g/m².

8. The water-decomposable wiper sheet as set forth in claim 1, of which the decomposability in water is at most 200 seconds.

9. The water-decomposable wiper sheet as set forth in claim 1, which has a wet strength of at least 1.1 N/25 mm.



10. The water-decomposable wiper sheet as set forth in claim 1, which has a dry strength of at least 3.4 N/25 mm.

11. A multi-layered water-decomposable wiper sheet comprising a water-decomposable top sheet of water-dispersible fibers, a water-decomposable back sheet of water-dispersible fibers and a water-decomposable interlayer sheet sandwiched between the top sheet and the back sheet, wherein;

the top sheet and the back sheet are provided with a large number of through-holes, the through-holes are closed by the interlayer sheet at the interface between the top sheet and the interlayer sheet and at the interface between the back sheet and the interlayer sheet.

12. The water-decomposable wiper sheet as set forth in claim 11, wherein the fibers constituting the peripheral edge of each through-hole are raised from the wiper sheet.

13. The water-decomposable wiper sheet as set forth in claim 11, wherein the sheet provided with the through-holes contains fibrillated rayon that comprises primary fibers having a predetermined fiber length and microfibers extending from the primary fibers, and has a degree of beating of at most 700 cc.



14. The water-decomposable wiper sheet as set forth in claim 13, wherein the fibrillated rayon comprises the primary fibers having a length of between 1.8 mm and 10 mm at the peak of the mass distribution curve of the primary fibers, and the microfibers having a length of at most 1 mm which account for from 0.1 to 65 % by weight of the self-weight of the fibrillated rayon.

15. The water-decomposable wiper sheet as set forth in claim 11, wherein the sheet provided with the through-holes is a non-woven fabric having been subjected to water-jetting treatment.

16. The water-decomposable wiper sheet as set forth in claim 11, wherein the total weight of the fibers constituting the multi-layered sheet falls between 15 and 150 g/m².

17. The water-decomposable wiper sheet as set forth in claim 11, of which the decomposability in water is at most 200 seconds.

18. The water-decomposable wiper sheet as set forth in claim 11, which has a wet strength of at least 1.1 N/25 mm.

19. The water-decomposable wiper sheet as set forth in



claim 11, which has a dry strength of at least 3.4 N/25 mm.