

## CYCLODEXTRIN-CONTAINING ABSORBENT ARTICLE

### BACKGROUND OF THE INVENTION

#### FIELD OF THE INVENTION

The present invention relates to an absorbent article for sanitary napkins, pantliners, incontinence pads, disposable diapers and the like. More particularly, it relates to the absorbent article having a deodorization function.

#### DESCRIPTION OF THE RELATED ART

Absorbent articles for sanitary napkins, pantliners, incontinence pads, disposable diapers and the like are essentially to absorb human discharges such as urine, feces, sweat, vaginal discharges, blood, menstrual discharges, etc., and to retain the thus-absorbed discharges therein so that they do not turn back to the skin of wearers. However, the odor of such discharges is unpleasant to users and also to workers who treat absorbent articles having absorbed the discharges. In addition, when the wearers keep on wearing the absorbent articles having absorbed their discharges, microorganisms such as a bacteria generally present in crotches and therearound will propagate with the nutritives in the discharges, and will give further unpleasant odors.

Some prior arts are known to remove such unpleasant odors. For example, Japanese Unexamined Patent Publication (Kokai) No. Heisei 5-68694 discloses an absorbent article with an absorbent

sheet disposed on the top or back surfaces thereof, in which the absorbent sheet contains antibacterial silica gel or acrylic resin applied thereto by coating or impregnating. In this, the antibacterial silica gel or acrylic resin as antibacterial agents prevents microorganisms from propagating to give unpleasant odors, and the odors of the discharges are deodorized due to the deodorization function of the antibacterial agents with deodorization deodorizes the odor of the discharges. International Unexamined Patent Publication (Kohyo) No. Heisei 10-508218 discloses an absorbent article with bentonite clay for a deodorizer incorporated into an absorbent core thereof.

However, the absorbent articles disclosed by Japanese Unexamined Patent Publication (Kokai) No. Heisei 5-68694 and International Unexamined Patent Publication (Kohyo) No. Heisei 10-508218 are problematic in that, when they have absorbed the discharges, the deodorizer such as silica gel or bentonite clay therein is directly kept in contact with the discharges. Such porous deodorizers, if the surfaces thereof are coated with the discharges, could not satisfactorily fulfill the deodorization function, and, as a result, their deodorization effect will lower.

International Unexamined Patent Publication (Kohyo) No. Heisei 8-508424 discloses a pantiliner containing a deodorizer of uncomplexed (unclathrated) cyclodextrin having a particle

size of at most 12 microns. In this, the cyclodextrin having such a small particle size clathrates (encloses) odor materials existing around it to fulfill the deodorization function. Before use, however, the cyclodextrin in the pantiliner absorbs moisture in the air and clathrates compounds existing in the air. As a result, the capability of the cyclodextrin to absorb odors while being in use of the pantiliner will lower, and the deodorization function of the pantiliner being used is therefore poor. In addition, since the cyclodextrin used in the pantiliner is powdery, having such a specifically defined particle size as above, it easily drops away from the absorbent article. The patent publication also discloses using a polymer as a binder for fixing the powdery cyclodextrin to absorbent articles, in which, however, the polymer binder hardens the absorbent articles containing it, and detracts from their soft feeling.

#### SUMMARY OF THE INVENTION

An object of the invention is to provide an absorbent article containing a deodorizer, in which the function of the deodorizer does not lower before use and the deodorizer exhibits the good deodorization effect while in use.

Another object of the invention is to provide such an absorbent article containing a deodorizer of cyclodextrin, in which the cyclodextrin is well fixed without detracting from

the soft feeling of the components of the absorbent article.

According to an aspect of the invention, an absorbent article may comprise a liquid-pervious top sheet, a back sheet and an absorbent core sandwiched between the top sheet and the back sheet, wherein cyclodextrin is incorporated under the condition of being dissolved in a liquid or semi-solid solvent not volatile at 20°C.

In the absorbent article of the invention, deodorizing cyclodextrin dissolved in such a nonvolatile solvent is fixed by the solvent. Before use, the cyclodextrin exists in the nonvolatile solvent in the absorbent article, without being brought into contact with small amount of moisture in the air, and therefore it does not clathrate (enclose) the odor materials in the air. When the cyclodextrin therein is brought into contact with water in the discharges while being in use of the absorbent article, it clathrates the odor materials in the discharges. As a result, the deodorization function of cyclodextrin in the absorbent article does not lower before use. In addition, since cyclodextrin is fixed in the absorbent article by a liquid or semi-solid solvent not volatile at normal temperature, the solvent does not detract from the softness and the feel of the components of the absorbent article.

Preferably, the cyclodextrin in the absorbent article of the invention is unclathrated.

Also preferably, the solvent therein includes diols or

ester-type organic solvents respectively having a boiling point not lower than 40°C.

The diol is preferably at least one compound selected from propylene glycol, dipropylene glycol and 1,3-butylenediol, and the ester-type organic solvent is preferably at least one compound selected from triethyl citrate and diethyl phthalate.

The cyclodextrin may be a partially methylated and/or acetylated,  $\alpha$ -,  $\beta$ - or  $\gamma$ -cyclodextrin.

The solvent may optionally contain at least one odor inhibitor selected from zeolite, silica gel, activated carbon, diatomaceous earth, and water-soluble antibacterial compounds.

Preferably, the solvent is applied to at least one of the top sheet and the absorbent core.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a partially cutaway perspective view of a pantiliner, one embodiment of an absorbent article of the invention;

Fig. 2 is a cross-sectional view of Fig. 1, cut along the line II-II; and

Fig. 3 is a graph showing the degree of deodorization in Examples and Comparative Examples.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention is described in detail with reference to

the drawings attached hereto. Fig. 1 is a partially cutaway perspective view of a pantiliner, one embodiment of an absorbent article of the invention. Fig. 2 is a cross-sectional view of Fig. 1, cut along the line II-II.

As shown in Fig. 1, a pantiliner 1 has a three-layered structure composed of a liquid-pervious top sheet 2 that shall be kept in direct contact with the skin of a wearer to receive the discharges, a liquid-impervious back sheet 3 that shall be kept in direct contact with the underwear of the wearer, and an absorbent core (liquid-absorbing layer) 4 sandwiched between the top sheet 2 and the back sheet 3. In this, the top sheet 2 and the back sheet 3 are bonded to each other around the absorbent core 4, with a hot-melt adhesive or the like. The absorbent core 4 has a cyclodextrin-containing solvent 8 which is coated in polka-dot pattern on its surface to be faced the top sheet 2.

Cyclodextrin is basically so constituted that the part outside its ring structure is hydrophilic while the part inside its ring structure is hydrophobic. Cyclodextrin clathrates (encloses) molecules (foreign compounds) inside its ring structure in the presence of water. Preferably, the cyclodextrin for use in the invention is unclathrated (uncomplexed: that is, it has clathrated nothing in its ring structure) to easily clathrate the odor materials. However, it may be combined with a small amount of cyclodextrin having

clathrated (enclosed) perfume or the like. Also preferably, the cyclodextrin for use in the invention is essentially  $\alpha$ -,  $\beta$ - or  $\gamma$ -cyclodextrin and/or their mixture. More preferably, it is chemically-modified (methylated or acetylated)  $\alpha$ -,  $\beta$ - and/or  $\gamma$ -cyclodextrin.

In the illustrated pantiliner 1, cyclodextrin is dispersed and dissolved in the solvent 8. The solvent is a liquid or semi-solid, not volatile at normal temperature (20°C). In this, since cyclodextrin is kept dissolved in such a liquid or semi-solid solvent not volatile at normal temperature, it is not almost brought into contact with moisture generally existing in the air. Therefore, before the pantiliner 1 is used, cyclodextrin therein does not clathrate compounds existing in the air. On the other hand, when the pantiliner 1 has absorbed the discharges during its use, water existing in the discharges is brought into contact with the cyclodextrin through the solvent in the pantiliner 1. As a result, the cyclodextrin clathrates the odor materials in the discharges to fulfill the deodorization function.

Since the solvent 8 with which cyclodextrin is fixed in the pantiliner 1 is liquid or semi-solid, it does not harden the pantiliner 1 and does not detract from the soft feeling of the pantiliner 1. However, if cyclodextrin to be dissolved in a solvent volatile at normal temperature is fixed in pantiliners by use of the solvent, the solvent will vaporize while the

pantiliners are stored, and, as a result, the cyclodextrin will solidify in the pantiliners. If so, the pantiliners will be hardened and will lose their soft feeling. The same shall apply to solvents which solidify at normal temperature.

Preferably, the solvent 8 does not irritate the skin of wearers and does not have any harmful influences on human bodies. More preferably, it is acceptable as an additive to cosmetics. For example, preferred are diols such as propylene glycol, dipropylene glycol and 1,3-butylenediol, and ester-type organic solvents such as triethyl citrate and diethyl phthalate, all having a boiling point of not lower than 40°C.

The cyclodextrin content of the solvent 8 is not specifically defined, for example, falling between 1 and 80 % by weight (by mass), but preferably between 20 and 60 % by weight. However, since the viscosity of the solvent 8 having a larger cyclodextrin content will be larger, the solvent 8 will be difficult to handle in the process of applying it to the components of the absorbent article.

Various methods may be employed for applying the cyclodextrin-containing solvent 8 to the absorbent core 4. For example, the solvent 8 may be coated therewith by use of a slot coater or a roll coater, or may be applied thereto by use of a spray.

The cyclodextrin-containing solvent 8 may be applied on the entire surface of the absorbent core 4 with no non-coated

space thereon. If so coated, however, the absorbent core 4 could hardly absorb the discharges. Therefore, it is desirable that the absorbent core 4 has some space not coated with the solvent 8. For example, as shown in Fig. 1 and 2, the absorbent core 4 may be coated with the solvent 8 in polka-dot pattern (dot-pattern). Alternatively, it may be coated with the solvent 8 in stripe pattern or spiral pattern.

In the illustrated embodiment, the cyclodextrin-containing solvent 8 is applied to the surface of the absorbent core 4. As the case may be, however, it may be applied to one surface of the top sheet 2 that faces the absorbent core 4. In the illustrated embodiment, the solvent 8 is applied to the absorbent core 4 on its entire surface that faces the top sheet 2. As the case may be, however, it may be applied to only the center portion in both of the X direction and Y direction of the pantiliner 1 which essentially absorbs the discharges.

If desired, the solvent 8 may contain, in addition to cyclodextrin, any other odor inhibitors (odor controlling agents) such as zeolite, silica gel, activated carbon, bentonite, diatomaceous earth, water-soluble antibacterial compounds or mixtures thereof. Activated carbon usable herein may be additive-deposited activated carbon such as alkali-deposited or acid-deposited activated carbon (i.e., impregnated activated carbon such as that impregnated with alkali or acid). Zeolite may be represented by

$x/nMnAlO_2 \cdot ySiO_2 \cdot zH_2O$ , in which  $x$  and  $y$  each is an integer,  $M$  is a cation, and  $n$  is a charge of the cation.  $M$  includes various cations, for example,  $Na^+$ ,  $K^+$ ,  $NH_4^+$ , alkylammonium cations, heavy metal cations, etc. Bentonite is a natural mineral and includes calcium bentonite and sodium bentonite. However, it is desirable that the additional odor inhibitors are so limited that they do not interfere with the deodorization function of cyclodextrin.

The top sheet 2 of the pantiliner 1 is made of a liquid-pervious sheet through which liquid discharges such as menstrual discharges, urine and sweat can pass. For example, it may be made of perforated, spun-lace non-woven fabric, thermally-bonded non-woven fabric, point-bonded non-woven fabric, air-through non-woven fabric or the like of natural fibers and/or synthetic fibers, or may be made of a perforated resin sheet of polyethylene, polypropylene or the like.

The back sheet 3 is impervious to liquid but pervious to vapor. For example, it is made of a polyolefin resin sheet or the like. The back sheet may be made of non-woven fabric, with a waterproof film being interposed between the back sheet and the absorbent core. In case where the pantiliner is superposed on any other absorbent article, its back sheet may be a liquid-pervious sheet.

The absorbent core 4 is formed of an absorbent material such as beaten pulp or a mixture of beaten pulp and super

absorbent polymer. To form this, the beaten pulp or the mixture of beaten pulp and super absorbent polymer is wrapped in an absorbent sheet of tissue or the like.

The illustrated pantiliner has been described for one embodiment of the absorbent article of the invention. Not limited to this, the invention is applicable to any other absorbent articles, for example, sanitary napkins, open type diapers, panty type diapers, incontinence pads, medical or sanitary absorbent pads, etc. In addition, it is also applicable to water-decomposable absorbent articles that can be disposed of in toilets after use.

Among these absorbent articles, diapers, incontinence pads and others that shall absorb a large amount of water may be so constituted that their absorbent core 4 contains a cyclodextrin-containing solvent. In this case, the solvent 8 is not exposed out of the surface of the top sheet 2, and therefore it is not brought into direct contact with the skin of wearers. If desired, the solvent 8 may be applied to the absorbent core 4 on its surface that faces the back sheet 3, or to the back sheet 3 on its surface that faces the absorbent core 4, or to the peripheral region of the absorbent article in which the absorbent core 4 is not existed.

#### 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.

This is to demonstrate the formation of a pantiline, one embodiment of the absorbent article of the invention. Methylated  $\beta$ -cyclodextrin (Wacker Chemicals' product) was used as cyclodextrin. Methylated  $\beta$ -cyclodextrin was dispersed and dissolved in a solvent (propylene glycol, 1,3-butylenediol, dipropylene glycol or triethyl citrate) to prepare a 50 wt% solution. 0.04 g of the resulting, cyclodextrin-containing solvent was dropped onto a top sheet for a pantiliner comprising a top sheet, a back sheet and an absorbent core therebetween as shown in Fig. 1. The pantiliner having the top sheet with the solvent applied thereto was tested for its deodorization in accordance with the method mentioned below. To monitor its time-dependent change (i.e., time variability), the pantiliner was stored at 40°C for 1 week, 2 weeks, 3 weeks or 4 weeks, and then tested for its deodorization.

For comparative samples, a pantiliner with no cyclodextrin applied thereto, and a pantiliner with cyclodextrin dissolved in distilled water in place of the solvent and applied thereto were prepared in the same manner as above. These comparative pantiliners were also tested for their deodorization in the same manner as herein.

(Measuring method for Deodorization)

Acetic acid was used as an odor material. 5 ml of an

aqueous 10 % acetic acid solution was dropped onto the part of each pantiliner onto which the solvent had been dropped. With that, the pantiliner was put into a 300-ml beaker and heated at 40°C for 10 minutes, and the gas in the beaker was passed through an odor detector to determine the residual odor concentration (the amount of acetic acid) in the beaker. The degree of deodorization is obtained according to the following formula:

Degree of Deodorization

$$= ((\text{residual odor concentration in the beaker in which the cyclodextrin-free, non-aged control comparative sample was heated}) - (\text{residual odor concentration in the beaker in which each test sample was heated})) \div (\text{residual odor concentration in the beaker in which the cyclodextrin-free, non-aged control comparative sample was heated})$$

The obtained data are plotted as shown in Fig. 3, in which the graph of "liner only" indicates the data of the cyclodextrin-free comparative sample, and the graph of "CD + H<sub>2</sub>O" indicates the comparative sample to which cyclodextrin dissolved in distilled water was applied. In Fig. 3, PG means propylene glycol; 1,3-BG means 1,3-butylenediol; DPG means dipropylene glycol; and citric acid is in the form of its triethyl ester (triethyl citrate). Any of these solvents were used in producing the pantiliner samples of the invention.

As shown in the data of Fig. 3, the deodorization of the

pantiliner samples of the invention is higher than that of the comparative pantiliner samples. This is more remarkable in the samples aged with time. The data support that the diol-type organic solvent and the ester-type organic solvent can highly maintain the deodorization function of "methylated  $\beta$ -cyclodextrin" in absorbent articles. The pantiliner samples of the invention were compared with the comparative pantiliner sample to which cyclodextrin dissolved in distilled water had been applied. The surface of the former was more smooth than that of the latter, and the feel of the former was better than that of the latter.

As set forth in detail hereinabove, the cyclodextrin-containing absorbent article of the invention does not lose the deodorization function of cyclodextrin therein before use, and well fulfills the deodorization function of cyclodextrin during use.

In the absorbent article of the invention, cyclodextrin is fixed by use of a liquid or semi-solid solvent in which cyclodextrin is dissolved, so that this does not detract from the soft and good feel of the absorbent article.

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. An absorbent article comprising a liquid-pervious top sheet, a back sheet and an absorbent core sandwiched between the top sheet and the back sheet, wherein cyclodextrin is incorporated under the condition of being dissolved in a liquid or semi-solid solvent not volatile at 20°C.
2. The absorbent article as set forth in claim 1, wherein the cyclodextrin is unclathrated.
3. The absorbent article as set forth in claim 1, wherein the solvent includes diols or ester-type organic solvents respectively having a boiling point not lower than 40°C.
4. The absorbent article as set forth in claim 3, wherein the diol is at least one compound selected from propylene glycol, dipropylene glycol and 1,3-butylenediol, and the ester-type organic solvent is at least one compound selected from triethyl citrate and diethyl phthalate.
5. The absorbent article as set forth in claim 1, wherein the cyclodextrin is a partially methylated and/or acetylated,  $\alpha$ -,  $\beta$ - or  $\gamma$ -cyclodextrin.



6. The absorbent article as set forth in claim 1, wherein the solvent contains at least one odor inhibitor selected from zeolite, silica gel, activated carbon, diatomaceous earth, and water-soluble antibacterial compounds.

7. The absorbent article as set forth in claim 1, wherein the solvent is applied to at least one of the top sheet and the absorbent core.