Candidate's answer

CLAIMS

1. Use of superabsorbent polymer consisting of cross-linked sodium carboxymethylcellulose (CMCNa) and hydroxyethylcellulose (HEC), wherein the weight ratio of CMCNa to HEC is from 0.5 to 5.0 and a degree of crosslinking is from 2 to 10 %, in absorbent products for absorbing bodily fluids.

2. An absorbent product for absorbing bodily fluids, containing a liquid-impermeable first layer and a second layer made from a non-woven material and an absorbent core between these two layers, characterized in that the absorbent core contains a superabsorbent polymer consisting of cross-linked CMCNa and HEC, wherein the degree of cross-linking is from 2 to 10 % and the weight ratio of CMCNa to HEC is from 0.5 to 5.0.

3. The absorbent product according to claim 2, wherein the absorbent core additionally contains fibres.

4. The absorbent product according to claim 3, wherein the fibres are cellulosic fibres.

5. The absorbent product according to any of claims 2 to 4, which is a baby diaper, an adult incontinence item, female hygiene product or bandage.

6. A method of preparing the absorbent product of claim 2, comprising the following steps:
(i) reacting an aqueous solution of CMCNa and HEC with a carbodiimide cross-linking agent in the presence of an acid catalyst to produce a polymer gel, wherein the sum of concentrations of CMCNa and HEC in the aqueous solution is from 3 to 10 wt. %, the weight ratio of CMCNa to HEC is from 0.5 to 5.0, the concentration of carbodiimide in the solution is from 5 to 15 %;
(ii) washing the gel with water;
(iii) drying the gel into granules;
(iv) optionally mixing the granules with fibres in hot air in a rotating vacuum drum to make the absorbent core;
(v) laminating the granules or absorbent core between the first layer and the second layer in order to make the absorbent product.
7. The method according to claim 6, wherein in step (ii) the gel is washed with deionised water and in step (iii) the gel is dried by phase inversion.

8. The method according to claim 6, wherein the carbodiimide is 1-ethyl-3-(3-dimethylaminopropyl)carbodiimide.

9. The method according to claim 6, wherein the pH in step (i) is from 3 to 6.

10. An absorbent core obtainable by mixing a superabsorbent polymer consisting of cross-linked CMCNa and HEC having the degree of cross-linking from 2 to 10 % and the weight ratio of CMCNa to HEC of from 0.5 to 5.0 in the form of granules with fibres in hot air in a rotating vacuum drum.

11. A superabsorbent polymer consisting of cross-linked sodium carboxymethylcellulose (CMCNa) and hydroxyethylcellulose (HEC), wherein the weight ratio of CMCNa to HEC is 2.0 to 3.0 and the degree of crosslinking is from 2 to 10 %.

12. A method of preparing the superabsorbent polymer of claim 11, comprising the steps of:
(i) reacting an aqueous solution of CMCNa and HEC with a carbodiimide cross-linking agent in the presence of an acid catalyst to produce a polymer gel, wherein the sum of concentrations of CMCNa and HEC in the aqueous solution is from 3 to 10 wt. %, the weight ratio of CMCNa to HEC is from 2.0 to 3.0, the concentration of carbodiimide in the solution is from 5 to 15 %;
(ii) washing the gel with water;
(iii) drying the gel.

13. The method according to claim 12, wherein in step (ii) the gel is washed with deionised water and in step (iii) the gel is dried by phase inversion.

14. The method according to claim 12, wherein the carbodiimide is 1-ethyl-3-(3-dimethylaminopropyl)carbodiimide.

15. The method according to claim 12, wherein the pH in step (i) is from 3 to 6.

DESCRIPTION

Field of the Invention

The invention relates to absorbent products for absorbing bodily fluids.

Background art

Products for absorbing bodily fluids normally comprise a liquid-impermeable first layer, a second layer made of non-woven material and an adsorbent core arranged between these two layers. The absorbent core comprises polyacrylic superabsorbent polymers and cellulosic fibres. Such products are described in document D2. The polyacrylic polymers are not biodegradable and still impart quite a rough feeling against the skin.

Biodegradable superabsorbent polymers are known from D1. These polymers consist of cross-linked CMCNa and HEC and absorb up to 39 % water. These polymers are used for improving soil and are able to release the absorbed water to plants. In the absorbing bodily fluids field, it is, on the contrary, necessary to have a high water retention.

D1 also discloses a method of preparation of the polymers by crosslinking using carbodiimides, and also absorbent products made of polymer granules placed in a bag made from biodegradable cellulosic fibres.

At present it is desirable to provide absorbent products for absorbing bodily fluids containing a biodegradable polymer while retaining or even improving the properties such as water absorption capacity, water retention, shear modulus and perceived softness.

Disclosure of the Invention

The technical problem is solved by the absorbent products and methods of preparation thereof as well as the use of suitable polymers and the absorbent cores as described in the claims.

Also, this invention provides polymers consisting of cross-linked CMCNa and HEC having the degree of crosslinking of 2 - 10 % and the weight ratio of CMCNa to HEC 2.0 – 3.0. These polymers have surprisingly high water absorption capacity and the fact that this narrow interval of the weight ratios provides this effect was not derivable from what is described in D1, neither is anything in this range disclosed there.

The method of production of the superabsorbent polymers comprises the steps of:
(i) reacting an aq. solution of CMCNa and HEC with a carbodiimide cross-linking agent in the presence of an acid catalyst to produce a polymer gel;
(ii) washing the gel with water, deionised water being preferred, as this results in polymers with higher absorption capacity;
(iii) drying the gel, which can be made by phase inversion resulting in a much higher absorption capacity, or by air drying.

The pH in step (i) is usually from 3 to 6, preferably 3.5 – 4.5. Any acid can be used, e.g., a citric acid. The sum of the concentrations of CMCNa and HEC in the aq. solution must be 3 to 10 %, otherwise cross-linking is impeded. Usually it is 4 – 9 wt. %. The weight ratio of CMCNa to HEC has to be 0.5 – 5.0, preferably 0.6 – 3.2, more preferably 2.0 – 3.0. The concentration of carbodiimide in the solution is 5 – 15 wt. % in order to obtain a gel with good mechanical properties, usually 5 – 10 wt. % is used.

In the phase inversion drying the gel is contacted with a liquid which does not dissolve the polymer, but absorbs water. The polymer gel is contacted with the liquid until it precipitates as white granules. Acetone can be used as the liquid.

The conditions described above result in a degree of cross-linking of 2 – 10 %, which is essential for a useful superabsorbent polymer. The degree of cross-linking is measured according to Italian standard ITNA0011 published in 1990.

In the absorbent products, the absorbent core is usually a mixture of a superabsorbent polymer and fibres. It is also possible to use a superabsorbent polymer on its own, but this is less preferred. The fibers may be cellulosic fibers, which is preferred to achieve a better perceived softness, or synthetic fibres.

The absorbent product is formed by conventional methods. The polymer granules may be mixed in hot air with fibres in a rotating vacuum drum to make the absorbent core.
The absorbent core is laminated between the first layer and the second layer in order to make the absorbent product.

Carbodiimides are unconventional cross-linking agents. They induce the formation of ester bonds between CMCNa and HEC without participating in a bond themselves. It has been confirmed experimentally that no trace of carbodiimide remains in the final product. A particularly preferred carbodiimide is 1-ethyl-3-(3-dimethylaminopropyl)carbodiimide (EDC).

EXAMINATION COMMITTEE I

Candidate No.

Paper A (Chemistry) 2011 - Marking Sheet

Category		Maximum possible	Marks awarded	
			Marker	Marker
Independent claims	Polymer	30	30	30
	Method / polymer	10	10	10
	Absorbent product	25	25	25
	Method / absorbent product	5	3	3
Dependent claims		15	12	13
Description		15	11	12
Total		**100**	**91**	**93**

Examination Committee I agrees on 92 marks and recommends the following grade to the Examination Board:

[X] PASS (50-100)

[ ] COMPENSABLE FAIL (45-49)

[ ] FAIL (0-44)

30 June 2011

Chairman of Examination Committee I