A process for producing surface-postcrosslinked water-absorbent polymer particles

Description

The present invention relates to a process for producing surface-postcrosslinked water-absorbent polymer particles by coating of water-absorbent polymer particles having a content of residual monomers in the range from 0.03 to 15% by weight with at least one surface-postcrosslinker and thermal surface-postcrosslinking at temperatures in the range from 100 to 180°C.

The preparation of water-absorbent polymer particles is described in the monograph "Modern Superabsorbent Polymer Technology", F.L. Buchholz and A.T. Graham, Wiley-VCH, 1998, on pages 71 to 103.

Being products which absorb aqueous solutions, water-absorbent polymer particles are used to produce diapers, tampons, sanitary napkins and other hygiene articles, but also as water-retaining agents in market gardening. Water-absorbent polymer particles are also referred to as "superabsorbent polymers" or "superabsorbents".

The preparation of water-absorbent polymer particles by polymerizing droplets of a monomer solution is described, for example, in EP 0 348 180 A1, WO 96/40427 A1, US 5,269,980, WO 2008/009580 A1, WO 2008/052971 A1, WO2011/026876 A1, and WO 2011/117263 A1.

Polymerization of monomer solution droplets in a gas phase surrounding the droplets ("dropletization polymerization") affords round water-absorbent polymer particles of high mean sphericity (mSPHT). The mean sphericity is a measure of the roundness of the polymer particles and can be determined, for example, with the Camsizer® image analysis system (Retsch Technology GmbH; Haan; Germany).

It was an object of the ~~present invention~~embodiments disclosed herein to provide water-absorbent polymer particles having improved properties, i.e. water-absorbent polymer particles having a high centrifuge retention capacity (CRC) and a high absorption under a load of 49.2 g/cm² (AUHL).

It was another object of the ~~present invention~~embodiments disclosed herein to provide water-absorbent polymer particles that possess a high centrifuge retention capacity and which impart good liquid distribution when used in hygiene articles.

Yet another object of the ~~present invention~~embodiments disclosed herein is to provide water-absorbent polymer particles that allow usage reduction in hygiene articles while maintaining excellent dryness.

The object is achieved by a process for producing water-absorbent polymer, comprising the steps forming water-absorbent polymer particles by polymerizing a monomer solution, coating

of water-absorbent polymer particles with at least one surface-postcrosslinker and thermal surface-postcrosslinking of the coated water-absorbent polymer particles, wherein the content of residual monomers in the water-absorbent polymer particles prior to the coating with the surface-postcrosslinker is in the range from 0.03 to 15% by weight, and the temperature during the thermal surface-postcrosslinking is in the range from 100 to 180°C.

The present ~~invention~~ disclosure further provides a process for producing water-absorbent polymer, comprising the steps forming water-absorbent polymer particles by polymerizing a monomer solution, coating of water-absorbent polymer particles with at least one surface-postcrosslinker and thermal surface-postcrosslinking of the coated water-absorbent polymer particles, wherein the content of residual monomers in the water-absorbent polymer particles prior to the coating with the surface-postcrosslinker is in the range from 0.1 to 10% by weight, the surface-postcrosslinker is an alkylene carbonate, and the temperature during the thermal surface-postcrosslinking is in the range from 100 to 180°C.

In an aspect, there is provided a process for producing surface-postcrosslinked water-absorbent polymer particles, comprising the steps forming water-absorbent polymer particles by polymerizing a monomer solution, comprising

(a) at least one ethylenically unsaturated monomer which bears acid groups and may be at least partly neutralized,
(b) optionally one or more crosslinker,
(c) at least one initiator,
(d) optionally one or more ethylenically unsaturated monomers copolymerizable with the monomers mentioned under a),
(e) optionally one or more water-soluble polymers, and
(f) water,

coating of water-absorbent polymer particles with at least one surface-postcrosslinker and thermal surface-postcrosslinking of the coated water-absorbent polymer particles, wherein the content of residual monomers in the water-absorbent polymer particles prior to the coating with the surface-postcrosslinker is in the range from 0.03 to 15% by weight, and the temperature during the thermal surface-postcrosslinking is in the range from 100 to 180°C.

In another aspect, there is provided a surface-postcrosslinked water-absorbent polymer particles obtainable as defined above.

The present ~~invention~~ disclosure is based on the finding that the level of residual monomers in the water-absorbent polymer particles prior to the thermal surface-postcrosslinking, the temperature of the thermal surface-postcrosslinking, and the surface-postcrosslinker itself have an important impact on the properties of the formed surface-postcrosslinked water-absorbent polymer particles.

The result of the specific conditions according to the process of the present ~~invention~~ disclosure are water-absorbent polymer particles having a high centrifuge retention capacity (CRC) and a high absorption under a load of 49.2 g/cm² (AUHL). That is a surprising result. It is known that the centrifuge retention capacity (CRC) significantly decreases during thermal surface-

postcrosslinking as proven by Ullmann's Encyclopedia of Industrial Chemistry, 6th Ed., Vol. 35, page 84, Figure 7. Further surprising is that the less reactive alkylene carbonate reacts under the inventive conditions at unusual low temperatures. Other cyclic surface-postcrosslinkers, for example 2-oxazoliidinone, show a very similar behaviour. According to the monograph "Modern Superabsorbent Polymer Technology", F.L. Buchholz and A.T. Graham, Wiley-VCH, 1998, page 98, the recommended reaction temperatures for alkylene carbonates are in the range from 180 to 215°C.

The combination of having a high centrifuge retention capacity (CRC) and a high absorption under a load of 49.2 g/cm² (AUHL) results in water-absorbent polymer particles having a high total liquid uptake in the wicking absorption test.

The specific conditions result further in water-absorbent polymer particles having a reduced pressure dependency of the characteristic swelling time in the VAUL test at high centrifuge retention capacities (CRC).

~~The present invention further provides~~In another aspect, there is provided a surface-postcrosslinked water-absorbent polymer particles having a centrifuge retention capacity (CRC) from 35 to 75 g/g, an absorption under high

load (AUHL) from 20 to 50 g/g, a level of extractable constituents of less than 10% by weight, and a porosity from 20 to 40%.

~~The present invention further provides~~In a further aspect, there is provided a surface-postcrosslinked water-absorbent polymer particles having a total liquid uptake of

$$Y > -500 \times \ln(X) + 1880$$

wherein Y [g] is the total liquid uptake and X [g/g] is the centrifuge retention capacity, wherein the centrifuge retention capacity is at least 25 g/g and the liquid uptake is at least 30 g.

~~The present invention further provides~~In a further aspect, there is provided a surface-postcrosslinked water-absorbent polymer particles having a change of characteristic swelling time of less than 0.6 and a centrifuge retention capacity of at least 35 g/g, wherein the change of characteristic swelling time is

$$Z < (\tau_{0.5} - \tau_{0.1}) / \tau_{0.5}$$

wherein Z is the change of characteristic swelling time, $\tau_{0.1}$ is the characteristic swelling time under a pressure of 0.1 psi (6.9 g/cm²) and $\tau_{0.5}$ is the characteristic swelling time under a pressure of 0.5 psi (35.0 g/cm²).

The present disclosure~~invention~~ further provides fluid-absorbent articles which comprise the *inventive water-absorbent polymer particles*.

In another aspect, there is provided a fluid-absorbent article, comprising

(A) an upper liquid-pervious layer,
(B) a lower liquid-impervious layer and
(C) a fluid-absorbent core between the layer (A) and the layer (B), comprising from 5 to 90% by weight fibrous material and from 10 to 95% by weight water-absorbent polymer particles as defined above,
(D) an optional acquisition-distribution layer between (A) and (C), comprising from 80 to 100% by weight fibrous material and from 0 to 20% by weight water-absorbent polymer particles as defined above,
(E) an optional tissue layer disposed immediately above and/or below (C); and
(F) other optional components.

Detailed description of the invention

The water-absorbent polymer particles are prepared by a process, comprising the steps forming water-absorbent polymer particles by polymerizing a monomer solution, comprising

a) at least one ethylenically unsaturated monomer which bears acid groups and may be at least partly neutralized,

b) optionally one or more crosslinker,
c) at least one initiator,
d) optionally one or more ethylenically unsaturated monomers copolymerizable with the monomers mentioned under a),
e) optionally one or more water-soluble polymers, and
f) water,

coating of water-absorbent polymer particles with at least one surface-postcrosslinker and thermal surface-postcrosslinking of the coated water-absorbent polymer particles, wherein the content of residual monomers in the water-absorbent polymer particles prior to the coating with