Claims

Claim 1

A process for production of water-absorbable polyacrylic acid resin powder, comprising:

(a) polymerizing an acrylic acid-based monomer aqueous solution containing bubbles, and

(b) drying a hydrogel crosslinked polymer thus obtained in the step of polymerizing,

the process further comprising:

(c) lowering solubility of dissolved gas in a monomer aqueous solution in the presence of a surfactant and/or a dispersing agent, so as to generate the bubbles in the acrylic acid-based monomer aqueous solution.

Claim 2

The process as set forth in claim 1, wherein the lowering of the solubility of the dissolved gas in the step (c) is carried out by heating the acrylic acid-based monomer aqueous solution containing the surfactant and/or the dispersing agent.

Claim 3

The process as set forth in claim 1, wherein the lowering of the solubility of the dissolved gas in the step (c) is carried out by mixing a water soluble organic material

into the acrylic acid-based monomer aqueous solution containing the surfactant and/or the dispersing agent.

Claim 4

The process as set forth in any one of claims 1 to 3, wherein the step (c) is carried out before the step (a).

Claim 5

A process for production of water-absorbable polyacrylic acid resin powder, comprising:

(a) polymerizing an acrylic acid-based monomer aqueous solution containing bubbles, and

(b) drying a hydrogel crosslinked polymer thus obtained in the step of polymerizing,

the process further comprising:

(d) heating the acrylic acid-based monomer aqueous solution in the presence of a surfactant and/or a dispersing agent.

Claim 6

A process for production of water-absorbable polyacrylic acid resin powder, comprising:

(a) polymerizing an acrylic acid-based monomer aqueous solution containing bubbles, and

(b) drying a hydrogel crosslinked polymer thus obtained

in the step of polymerizing,

the process further comprising:

(e) mixing a water soluble organic material into the acrylic acid-based monomer aqueous solution in the presence of a surfactant and/or a dispersing agent.

Claim 7

A process as set forth in any one of claims 1 to 6, comprising adding the surfactant and/or the dispersing agent into the acrylic acid-based monomer aqueous solution before the step (a).

Claim 8

The process as set forth in claim 3 or 6, wherein the water soluble organic material is acrylic acid.

Claim 9

The process as set forth in any one of claims 1 to 4, wherein the step (c) is carried out substantially at atmospheric pressure.

Claim 10

The process as set forth in claim 1 or 4, comprising mixing inert gas into the acrylic acid-based monomer aqueous solution before or after the step (c).

Claim 11

The process as set forth in any one of claims 1 to 4, wherein the polymerization in the step (a) starts within 300 seconds from an end of the step (c).

Claim 12

The process as set forth in claim 2 or 5, wherein the heating of the acrylic acid-based monomer aqueous solution causes a temperature increase of 5 °C or higher.

Claim 13

The process as set forth in claim 2, 5, or 12, wherein the acrylic acid-based monomer aqueous solution reaches a temperature in a range of 40 °C to 100 °C after the heating.

Claim 14

The process as set forth in claim 2, 5, 12, or 13, wherein the heating is carried out by using neutralization heat of acrylic acid in the acrylic acid-based monomer aqueous solution containing the surfactant.

Claim 15

The process as set forth in claim 2, 5, 12, or 13, wherein the heating is carried out by heating the acrylic

acid-based monomer aqueous solution.

Claim 16

The process as set forth in any one of claims 1 to 15, wherein the surfactant is a nonionic surfactant or a silicone surfactant.

Claim 17

The process as set forth in any one of claims 1 to 16, wherein the dispersing agent is a water-soluble polymer.

Claim 18

The process as set forth in any one of claims 1 to 17, wherein a maximum reaching temperature in the polymerization is 100 °C or higher.

Claim 19

The process as set forth in any one of claims 1 to 18, wherein the monomer aqueous solution has an acrylic acid-based monomer content of 40 wt% or more in the step (a).

Claim 20

The process as set forth in any one of claims 1 to 19, further comprising surface crosslinking the water-absorbable polyacrylic acid resin powder after the step (b).

Claim 21

The process as set forth in any one of claims 1 to 20, wherein the monomer aqueous solution contains a methoxy phenol as a polymerization retarder by 10 ppm to 200 ppm.

Claim 22

The process as set forth in any one of claims 1 to 21, wherein the step (a) is carried out by continuous kneader polymerization and gel grinding is carried out during the polymerization and if necessary after the polymerization.

Claim 23

The process as set forth in any one of claims 1 to 21, wherein the step (a) is carried out by continuous belt polymerization and gel grinding is carried out after the polymerization.

Claim 24

The process as set forth in any one of claims 1 to 23, further comprising:

(f) classifying after the step (b),

fine powder collected in the step (f) being reused to be reused in the step (b) or a step before the step (b).

Claim 25

The process as set forth in any one of claims 1 to 24, wherein the acrylic acid-based monomer aqueous solution contains the surfactant and/or the dispersing agent in such an amount that water-absorbable resin produced from the acrylic acid-based monomer aqueous solution will have a surface tension of 60 [mN/m] or more.

Claim 26

The process as set forth in any one of claims 1 to 25, comprising, after the step (b):

(g) surface crosslinking the water-absorbable polyacrylic acid resin powder having been subjected to the step (b); and

(h) further coating a surface of the water-absorbable polyacrylic acid resin powder with a/the surfactant,

the step (g) and step (h) being carried out at the same time or separately.

Claim 27

The process as set forth in any one of claims 1 to 26, wherein the water-absorbable polyacrylic acid resin powder produced by the process has a saline flow conductivity of 20 [$\times 10^{-7} \cdot cm^3 \cdot sec \cdot g^{-1}$] or greater, and a water absorbing rate (FSR) of 0.25 [g/g/sec] or greater.

Claim 28

The process as set forth as set forth in any one of claims 1 to 27, wherein a volume of the monomer aqueous solution after the step (c) is 1.01 to 1.1 times greater than that before the step (c).

Claim 29

The process as set forth in claims 1 to 28, wherein the bubbles has a volume average particle diameter of 50 μm or less.

Claim 30

The process as set forth in any one of claims 1 to 29, comprising, before or after the step (c), the step (d), or the step (e):

(i) introducing gas.

Claim 31

The process as set forth in any one of claims 1 to 30, comprising:

(j) performing gel grinding during or after the polymerization, the gel grinding being such that it is performed with gel grinding energy (GGE) of 18 to 60 [J/g] and/or the gel grinding increases a weight average molecular

weight of water soluble content by 10,000 to 500,000 [Da].

Claim 32

Water-absorbable resin powder being water-absorbable polyacrylic acid resin powder in which particles having a particle diameter of 850 μm to 150 μm accounts for 95 wt% or more, and having an internal cell rate of 2.8 % to 6.6 %, the internal cell rate being defined by the following equation:

(internal cell rate [%] = {(Real Density [g/cm^3]) - (Apparent Density [g/cm^3])}/(Real Density [g/cm^3]) × 100

Claim 33

Water-absorbable resin powder being water-absorbable polyacrylic acid resin powder comprising a surfactant and/or a dispersing agent inside thereof, wherein:

the water-absorbable resin powder has a surface tension of 60 [mN/m] or greater, and a particle surface being coated with a/the surfactant.

Claim 34

The water-absorbable resin powder as set forth in claim 32 or 33, wherein a saline flow conductivity thereof is 20 [× 10^{-7} · cm^3 · sec · g^{-1}] or greater, and a water absorbing rate (FSR) thereof is 0.25 [g/g/sec] or greater.

Claim 35

The water-absorbable resin powder as set forth in any one of claims 32 to 34, wherein an absorbency without pressure (CRC) thereof is 25 [g/g] or more, and an absorbency against pressure (AAP) under load of 50 [g/cm^2] thereof is 15 [g/g] or more.

Claim 36

The water-absorbable resin powder as set forth in any one of claims 32 to 35, wherein an absorbency without pressure (CRC) thereof is 25 [g/g] or more, and a saline flow conductivity thereof is 20 [$\times 10^{-7} \cdot cm^3 \cdot sec \cdot g^{-1}$] or greater.

Claim 37

The water-absorbable resin powder as set forth in any one of claims 32 to 36, further comprising:

one or more kinds of permeability improving agents selected from the group consisting of multivalent metal cations, polyamine polymers and water insoluble fine particles.

Claim 38

The water-absorbable resin powder as set forth in claim 32, further comprising a surfactant.

Claim 39

The water-absorbable resin powder as set forth in any one of claims 32 to 38, further comprising p-methoxy phenol by 5 ppm to 60 ppm.

Claim 40

The water-absorbable resin powder as set forth in any one of claims 32 to 39, further comprising one or more kinds of additives selected from the group consisting of chelating agents, α-hydroxy carboxylic acids, and inorganic or organic reducing agents.

Claim 41

The water-absorbable resin powder as set forth in any one of claims 32 to 40, wherein

a water absorbing rate index there of is 90 or more, water absorbing rate index being defined by the following equation:

(Water Absorbing Rate Index) = (FSR [g/g/sec]) × (Bulk Specific Gravity [g/cm^3]) × (Weight Average Particle Diameter [μm]),

where FSR is a water absorbing rate for saline so as to

swell 20-fold, and

a bulk specific gravity thereof is in a range of 0.6 to 0.8 [g/cm^3].

Claim 42

The water-absorbable resin powder as set forth in any one of claims 32 to 41, wherein a surface tension thereof is 60 [mN/m] or greater.

Claim 43

The water-absorbable resin powder as set forth in any one of claims 32 to 42, wherein a bulk specific gravity thereof is in a range of 0.58 to 0.80 [g/cm^3].

Claims

1. A process for production of water-absorbable polyacrylic acid resin powder, comprising:

(a) polymerizing an acrylic acid-based monomer aqueous solution containing bubbles; and

(b) drying a hydrogel crosslinked polymer thus obtained in the step (a),

the process further comprising:

(c) lowering solubility of dissolved gas in a monomer aqueous solution in the presence of a surfactant and/or a dispersing agent, so as to generate the bubbles in the acrylic acid-based monomer aqueous solution; and

(d) surface crosslinking the water-absorbable polyacrylic acid resin powder after the step (b),

an internal crosslinking agent being used during the polymerization,

the step (a) being carried out at a polymerization starting temperature of not lower than 30°C, and

the water-absorbable polyacrylic acid resin powder produced by the process having a saline flow conductivity of 20 [$\times 10^{-7} \cdot cm^3 \cdot sec \cdot g^{-1}$] or greater, and a water absorbing rate (FSR) of 0.25 [g/g/sec] or greater.

2. The process as set forth in claim 1, wherein the

lowering of the solubility of the dissolved gas in the step (c) is carried out by heating the acrylic acid-based monomer aqueous solution containing the surfactant and/or the dispersing agent.

3. The process as set forth in claim 1 or 2, wherein the step (c) is carried out before the step (a).

4. The process as set forth in any one of claims 1 through 3, comprising adding the surfactant and/or the dispersing agent into the acrylic acid-based monomer aqueous solution before the step (a).

5. The process as set forth in any one of claims 1 through 4, wherein the surfactant is a nonionic surfactant or a silicone surfactant.

6. The process as set forth in any one of claims 1 through 5, wherein the dispersing agent is a water-soluble polymer.

7. The process as set forth in any one of claims 1 through 6, wherein a maximum reaching temperature in the polymerization is 100 °C or higher.

8. The process as set forth in any one of claims 1 to 7, wherein the monomer aqueous solution has an acrylic acid-based monomer

content of 40 wt% or more in the step (a).

9. The process as set forth in any one of claims 1 through 8, wherein the monomer aqueous solution contains a methoxy phenol as a polymerization retarder by 10 ppm to 200 ppm.

10. The process as set forth in any one of claims 1 through 9, wherein the step (a) is carried out by continuous kneader polymerization, and gel grinding is carried out during the polymerization and if necessary after the polymerization.

11. The process as set forth in any one of claims 1 through 9, wherein the step (a) is carried out by continuous belt polymerization, and gel grinding is carried out after the polymerization.

12. The process as set forth in any one of claims 1 through 11, further comprising:

(e) classifying after the step (b),

fine powder collected in the step (e) being reused in the step (b) or a step before the step (b).

13. The process as set forth in any one of claims 1 through 12, wherein the acrylic acid-based monomer aqueous solution contains the surfactant and/or the dispersing agent in such an amount that water-absorbable resin produced from the acrylic acid-based

monomer aqueous solution will have a surface tension of 60 [mN/m] or more.

14. The process as set forth in any one of claims 1 through 13, comprising, after the step (b):

(f) further coating a surface of the water-absorbable polyacrylic acid resin powder with the surfactant,

the step (d) and the step (f) being carried out at the same time or separately.

15. The process as set forth in any one of claims 1 through 14, wherein a volume of the monomer aqueous solution after the step (c) is 1.01 to 1.1 times greater than that before the step (c).

16. The process as set forth in any one of claims 1 through 15, wherein the bubbles have a volume average particle diameter of 50 μm or less.

17. The process as set forth in any one of claims 1 through 16, comprising, before or after a step of mixing a water-soluble organic material into the acrylic acid-based monomer aqueous solution, the heating the acrylic acid-based monomer aqueous solution, or the step (c):

(g) introducing gas.

18. The process as set forth in any one of claims 1 through 17, comprising:

(h) performing gel grinding during or after the polymerization, the gel grinding being such that it is performed with gel grinding energy (GGE) of 18 to 60 [J/g] and/or the gel grinding increases a weight average molecular weight of water soluble content by 10,000 to 500,000 [Da].