CLAIMS

1. A process for producing (meth)acrylic acid, comprising the steps of:

supplying a cooling medium to a crystallizer from a heat source device, thereby crystallizing (meth)acrylic acid from a crude (meth)acrylic acid solution; and

discharging the cooling medium from the crystallizer and returning the cooling medium to the heat source device;

wherein:

temperature of the cooling medium returned to the heat source device is maintained constant by a first adjustment operation or a second adjustment operation;

the first adjustment operation is performed by feeding at least a part of the cooling medium to be returned to the heat source device from the crystallizer into an upper part of a first buffer tank and discharging the cooling medium from a lower part of the first buffer tank to return to the heat source device; and

the second adjustment operation is performed by feeding at least a part of the cooling medium to be supplied to the crystallizer from the heat source device and/or the cooling medium to be returned to the heat source device from the crystallizer into the lower part of the first buffer tank and discharging the cooling medium from the upper part of the first buffer tank to return to the heat source device.

2. A process for producing (meth)acrylic acid, comprising the steps of:

supplying a heating medium to a crystallizer from a heat source device, thereby melting crystallized (meth)acrylic acid; and

discharging the heating medium from the crystallizer and returning the heating medium to the heat source device;

wherein:

temperature of the heating medium returned to the heat source device is maintained constant by a third adjustment operation or a fourth adjustment operation;

the third adjustment operation is performed by feeding at least a part of the heating medium to be returned to the heat source device from the crystallizer into an

lower part of a second buffer tank and discharging the heating medium from an upper part of the second buffer tank to return to the heat source device; and

the fourth adjustment operation is performed by feeding at least a part of the heating medium to be supplied to the crystallizer from the heat source device and/or the heating medium to be returned to the heat source device from the crystallizer into the upper part of the second buffer tank and discharging the heating medium from the lower part of the second buffer tank to return to the heat source device.

3. A process for producing (meth)acrylic acid, comprising the steps of:

supplying a cooling medium to a crystallizer from a heat source device, thereby crystallizing (meth)acrylic acid from a crude (meth)acrylic acid solution;

discharging the cooling medium from the crystallizer and returning the cooling medium to the heat source device;

supplying a heating medium to the crystallizer from a heat source device, thereby melting the (meth)acrylic acid; and

discharging the heating medium from the crystallizer and returning the heating medium to the heat source device;

wherein:

temperature of the cooling medium returned to the heat source device is maintained constant by a first adjustment operation or a second adjustment operation;

temperature of the heating medium returned to the heat source device is maintained constant by a third adjustment operation or a fourth adjustment operation;

the first adjustment operation is performed by feeding at least a part of the cooling medium to be returned to the heat source device from the crystallizer into an upper part of a first buffer tank and discharging the cooling medium from a lower part of the first buffer tank to return to the heat source device;

the second adjustment operation is performed by feeding at least a part of the cooling medium to be supplied to the crystallizer from the heat source device and/or the cooling medium to be returned to the heat source device from the crystallizer into the lower part of the first buffer tank and discharging the cooling medium from the upper

part of the first buffer tank to return to the heat source device;

the third adjustment operation is performed by feeding at least a part of the heating medium to be returned to the heat source device from the crystallizer into an lower part of a second buffer tank and discharging the heating medium from an upper part of the second buffer tank to return to the heat source device; and

the fourth adjustment operation is performed by feeding at least a part of the heating medium to be supplied to the crystallizer from the heat source device and/or the heating medium to be returned to the heat source device from the crystallizer into the upper part of the second buffer tank and discharging the heating medium from the lower part of the second buffer tank to return to the heat source device.

4. A process for producing (meth)acrylic acid, comprising the steps of:

supplying a cooling medium to a first crystallizer from a heat source device, thereby crystallizing (meth)acrylic acid from a crude (meth)acrylic acid solution;

discharging the cooling medium from the first crystallizer and returning the cooling medium to the heat source device;

supplying a heating medium to a second crystallizer from the heat source device, thereby melting crystallized (meth)acrylic acid; and

discharging the heating medium from the second crystallizer and returning the heating medium to the heat source device;

wherein:

the heat source device is a refrigerator;

temperature of the cooling medium returned to the heat source device is maintained constant by a first adjustment operation or a second adjustment operation;

temperature of the heating medium returned to the heat source device is maintained constant by a third adjustment operation or a fourth adjustment operation;

the first adjustment operation is performed by feeding at least a part of the cooling medium to be returned to the heat source device from the first crystallizer into an upper part of a first buffer tank and discharging the cooling medium from a lower part of the first buffer tank to return to the heat source device;

the second adjustment operation is performed by feeding at least a part of the cooling medium to be supplied to the first crystallizer from the heat source device and/or the cooling medium to be returned to the heat source device from the first crystallizer into the lower part of the first buffer tank and discharging the cooling medium from the upper part of the first buffer tank to return to the heat source device;

the third adjustment operation is performed by feeding at least a part of the heating medium to be returned to the heat source device from the second crystallizer into an lower part of a second buffer tank and discharging the heating medium from an upper part of the second buffer tank to return to the heat source device; and

the fourth adjustment operation is performed by feeding at least a part of the heating medium to be supplied to the second crystallizer from the heat source device and/or the heating medium to be returned to the heat source device from the second crystallizer into the upper part of the second buffer tank and discharging the heating medium from the lower part of the second buffer tank to return to the heat source device.

5. The process for producing (meth)acrylic acid according to claim 4, wherein

a part or all of the cooling medium discharged from the first crystallizer is utilized as a source of the heating medium, and

a part or all of the heating medium discharged from the second crystallizer is utilized as a source of the cooling medium.

6. The process for producing (meth)acrylic acid according to claim 5, wherein

the cooling medium discharged from the first crystallizer is utilized as the source of the heating medium when temperature of the cooling medium discharged from the first crystallizer is higher than that of the heating medium discharged from the second crystallizer; and

the heating medium discharged from the second crystallizer is utilized as the

source of the cooling medium when temperature of the heating medium discharged from the second crystallizer is lower than that of the cooling medium discharged from the first crystallizer.

7. The process for producing (meth)acrylic acid according to claim 5, wherein

the cooling medium discharged from the first crystallizer is utilized as the source of the heating medium when temperature of the cooling medium discharged from the first crystallizer is higher than a predetermined temperature between temperature of the cooling medium supplied from the heat source device and temperature of the heating medium supplied from the heat source device; and

the heating medium discharged from the second crystallizer is utilized as the source of the cooling medium when temperature of the heating medium discharged from the second crystallizer is lower than the predetermined temperature between temperature of the cooling medium supplied from the heat source device and temperature of the heating medium supplied from the heat source device.

8. The process for producing (meth)acrylic acid according to ~~any one of~~ claims ~~1 to 7~~ 3, wherein

the first buffer tank retains a certain amount of the cooling medium,

the second buffer tank retains a certain amount of the heating medium, and

each of the cooling medium retained in the first buffer tank and the heating medium retained in the second buffer tank has a temperature gradient such that an upper part is high-temperature and a lower part is low-temperature.

9. The process for producing (meth)acrylic acid according to claim 8, wherein

temperature of the cooling medium returned to the heat source device is adjusted depending on temperatures of the upper part and the lower part of the cooling medium retained in the first buffer tank, and

temperature of the heating medium returned to the heat source device is adjusted depending on temperatures of the upper part and the lower part of the heating medium retained in the second buffer tank.

10. The process for producing (meth)acrylic acid according to ~~any one of~~ claim~~s 1 to 9~~ 3, wherein

the first buffer tank is provided with openings at an upper part and a lower part thereof, through which the cooling medium passes, wherein distance between the opening at the upper part and the opening at the lower part of the first buffer tank is equal to or more than a maximum cross-section length of the first buffer tank, and

the second buffer tank is provided with openings at an upper part and a lower part thereof, through which the heating medium passes, wherein distance between the opening at the upper part and the opening at the lower part of the second buffer tank is equal to or more than a maximum cross-section length of the second buffer tank.

11. The process for producing (meth)acrylic acid according to ~~any one of~~ claim~~s~~ 1 ~~to 10~~, further comprising the steps of:

dehydrating glycerin or 2-methylglycerin to convert to (meth)acrolein; and

oxidizing the (meth)acrolein to convert to (meth)acrylic acid, thereby obtaining the crude (meth)acrylic acid solution.

12. The process for producing (meth)acrylic acid according to ~~any one of~~ claims 1 ~~to 10~~, further comprising the step of:

dehydrating hydroxypropionic acid or 2-methyl-3-hydroxypropionic acid to convert to (meth)acrylic acid, thereby obtaining the crude (meth)acrylic acid solution.

13. A process for producing a hydrophilic resin, comprising the step of:

polymerizing a monomeric component(s) including the (meth)acrylic acid obtained by the producing process according to ~~any one of~~ claims 1 ~~to 12~~.

14. A process for producing an absorbent resin, comprising the step of:

polymerizing a monomeric component(s) including the (meth)acrylic acid obtained by the producing process according to ~~any one of~~ claims 1 ~~to 12~~.

15. The process for producing (meth)acrylic acid according to claim 1, wherein

the first buffer tank retains a certain amount of cooling medium, and

the cooling medium retained in the first buffer tank has a temperature gradient such that an upper part is high-temperature and a lower part is low-temperature.

16. The process for producing (meth)acrylic acid according to claim 15, wherein

temperature of the cooling medium returned to the heat source device is adjusted depending on temperatures of the upper part and the lower part of the cooling medium retained in the first buffer tank.

17. The process for producing (meth)acrylic acid according to claim 1, wherein

the first buffer tank is provided with openings at an upper part and a lower part thereof, through which the cooling medium passes, wherein distance between the opening at the upper part and the opening at the lower part of the first buffer tank is equal to or more than a maximum cross-section length of the first buffer tank.

18. The process for producing (meth)acrylic acid according to claim 2, wherein

the second buffer tank retains a certain amount of the heating medium, and

the heating medium retained in the second buffer tank has a temperature gradient such that an upper part is high-temperature and a lower part is low-temperture.

19. The process for producing (meth)acrylic acid according to claim 18,

wherein

temperature of the heating medium returned to the heat source device is adjusted depending on temperatures of the upper part and the lower part of the heating medium retained in the second buffer tank.

20. The process for producing (meth)acrylic acid according to claim 2, wherein

the second buffer tank is provided with openings at an upper part and a lower part thereof, through which the heating medium passes, wherein distance between the opening at the upper part and the opening at the lower part of the second buffer tank is equal to or more than a maximum cross-section length of the second buffer tank.

~~15. A crystallization system, comprising:~~

~~a crystallizer provided with a heat-transfer surface and having a medium-present part and a crystal-present part partitioned by the heat-transfer surface;~~

~~a heat-source device provided with a cooling medium-supply port connected to an inlet of the medium-present part, and a cooling medium-return port connected to an outlet of the medium-present part; and~~

~~a first buffer tank provided with an upper opening connected to the outlet of the medium-present part and the cooling medium-return port, and a lower opening connected to the cooling medium-supply port and/or the outlet of the medium-present part and the cooling medium-return port.~~

~~16. A crystallization system, comprising:~~

~~a crystallizer provided with a heat-transfer surface and having a medium-present part and a crystal-present part partitioned by the heat-transfer surface;~~

~~a heat-source device provided with a heating medium-supply port connected to an inlet of the medium-present part, and a heating medium-return port connected to an outlet of the medium-present part; and~~

~~a second buffer tank provided with an upper opening connected to the heating~~

~~medium-supply port and/or the outlet of the medium-present part and the heating medium-return port, and a lower opening connected to the outlet of the medium-present part and the heating medium-return port.~~

~~17. A crystallization system, comprising:~~

~~a crystallizer provided with a heat-transfer surface and having a medium-present part and a crystal-present part partitioned by the heat-transfer surface;~~

~~a first heat source device provided with a cooling medium-supply port connected to an inlet of the medium-present part, and a cooling medium-return port connected to an outlet of the medium-present part;~~

~~a second heat source device provided with a heating medium-supply port connected to the inlet of the medium-present part, and a heating medium-return port connected to the outlet of the medium-present part;~~

~~a first buffer tank provided with an upper opening connected to the outlet of the medium-present part and the cooling medium-return port, and a lower opening connected to the cooling medium-supply port and/or the outlet of the medium-present part and the cooling medium-return port; and~~

~~a second buffer tank provided with an upper opening connected to the heating medium-supply port and/or the outlet of the medium-present part and the heating medium-return port, and a lower opening connected to the outlet of the medium-present part and the heating medium-return port.~~

~~18. A crystallization system, comprising:~~

~~a first crystallizer provided with a first heat-transfer surface and having a first medium-present part and a first crystal-present part partitioned by the first heat-transfer surface;~~

~~a second crystallizer provided with a second heat-transfer surface and having a second medium-present part and a second crystal-present part partitioned by the second heat-transfer surface;~~

~~a refrigerator provided with a cooling medium-supply port connected to an~~

~~inlet of the first medium-present part, a cooling medium-return port connected to an outlet of the first medium-present part, a heating medium-supply port connected to an inlet of the second medium-present part, and a heating medium-return port connected to an outlet of the second medium-present part;~~

~~a first buffer tank provided with an upper opening connected to the outlet of the first medium-present part and the cooling medium-return port, and a lower opening connected to the cooling medium-supply port and/or the outlet of the first medium-present part and the cooling medium-return port; and~~

~~a second buffer tank provided with an upper opening connected to the heating medium-supply port and/or the outlet of the second medium-present part and the heating medium-return port, and a lower opening connected to the outlet of the second medium-present part and the heating medium-return port.~~

~~19. The crystallization system according to any one of claims 15 to 18, wherein~~

~~distance between the upper opening and the lower opening is equal to or more than a maximum cross-section length in the first buffer tank and the second buffer tank.~~