CLAIMS

1. An apparatus for water treatment, comprising:

a membrane separator for solids-liquid separation; and

a particle fractionator which has at least two exits of a fractionated solid-liquid mixture produced therein,

wherein a liquor containing particles of different sizes including submicron particles having a particle size range of 0.03 to 0.4 μm is fed to the particle fractionator before a membrane separation by the membrane separator, and

wherein a first fraction of the fractionated solid-liquid mixture is supplied to the membrane separator from one exit of the at least two exits of the particle fractionator, the first fraction being less than the liquor in terms of content of the submicron particles.

2. An apparatus for water treatment, comprising:

a membrane separator for solids-liquid separation;

a first particle fractionator which has at least two exits of a first fractionated solid-liquid mixture produced therein; and

a second particle fractionator which has at least two exits of a second fractioned solid-liquid mixture produced therein,

wherein a liquor containing particles of different sizes including submicron particles having a particle size range of 0.03 to 0.4 μm is fed to the first particle fractionator before a membrane separation by the membrane separator,

wherein a first fraction of the first fractionated solid-liquid mixture from the first particle fractionator is supplied to the membrane separator from one exit of the at least two exits of the first particle fractionator, the first fraction of the first fractioned solid-liquid mixture being less than the

liquor in terms of content of the submicron particles,

wherein a second fraction of the first fractionated solid-liquid mixture from another exit of the at least two exits of the first particle fractionator is fed to the second particle fractionator, and

wherein a first fraction of the second fractionated solid-liquid mixture from one exit of the at least two exits of the second particle fractionator is supplied to the membrane separator, the first fraction of the second fractionated solid-liquid mixture being less than the second fraction of the first fractionated solid-liquid mixture in terms of content of the submicron particles.

3. An apparatus for water treatment, comprising:

a membrane separator for solids-liquid separation;

a reactor for pretreatment before a membrane separation by the membrane separator; and

a particle fractionator which has at least two exits of a fractionated solid-liquid mixture,

wherein a liquor containing particles of different sizes including submicron particles having a particle size range of 0.03 to 0.4 μm is fed to the particle fractionator before the membrane separation, and

wherein a first fraction of the fractionated solid-liquid mixture is supplied to the membrane separator or the reactor for pretreatment from one exit of the at least two exits of the particle fractionator, the first fraction being less than the liquor in terms of content of the submicron particles.

4. An apparatus for water treatment, comprising:

a membrane separator for solids-liquid separation;

a reactor for pretreatment before a membrane separation by the membrane separator;

a first particle fractionator which has at least two exits of a first fractionated solid-liquid mixture produced therein; and

a second particle fractionator which has at least two exits of a second fractioned solid-liquid mixture produced therein,

wherein a liquor containing particles of different sizes including submicron particles having a particle size range of 0.03 to 0.4 μm is fed to the first particle fractionator before the membrane separation by the membrane separator,

wherein a first fraction of the first fractionated solid-liquid mixture from the first particle fractionator is supplied to the membrane separator or the reactor for pretreatment from one exit of the at least two exits of the first particle fractionator, the first fraction of the first fractioned solid-liquid mixture being less than the liquor in terms of content of the submicron particles,

wherein a second fraction of the first fractionated solid-liquid mixture from another exit of the at least two exits of the first particle fractionator is fed to the second particle fractionator, and

wherein a first fraction of the second fractionated solid-liquid mixture from one exit of the at least two exits of the second particle fractionator is supplied to the membrane separator or the reactor for pretreatment, the first fraction of the second fractionated solid-liquid mixture being less than the second fraction of the first fractionated solid-liquid mixture in terms of content of the submicron particles.

5. The apparatus of any one of claims 1-4, wherein the particle fractionator comprises at least one hydrocyclone.

6. The apparatus of claim 3 or 4, wherein the reactor for pretreatment before the membrane separation includes a biological process.

7. The apparatus of any one of claims 3-5, wherein the reactor for pretreatment before the membrane separation includes a physical-chemical process like coagulation.

8. A method for water treatment, comprising the steps of:

a membrane separation step for solid-liquid separation using a membrane separator; and

a fractionation step using a particle fractionator which has at least two exits of a fractionated solid-liquid mixture produced therein,

wherein a liquor containing particles of different sizes including submicron particles having a particle size range of 0.03 to 0.4 μm is fed to the fractionation step before the membrane separation step by a membrane in the membrane separator, and

wherein a first fraction of the fractionated solid-liquid mixture is supplied to the membrane separator, the first fraction being less than the liquor in terms of content of the submicron particles.

9. A method for water treatment, comprising the steps of:

a membrane separation step for solids-liquid separation using a membrane separator;

a first fractionation step using a first particle fractionator, the first particle fractionator having at least two exits of a first fractionated solid-liquid mixture produced therein; and

a second fractionation step using a second particle fractionator, the second particle fractionator having at least two exits of a second fractionated solid-liquid mixture produced therein,

wherein a liquor containing particles of different sizes including submicron particles having a particle size range of 0.03 to 0.4 μm is fed to

the first fraction step before the membrane separation step,

wherein a first fraction of the first fractionated solid-liquid mixture from the first particle fractionator is supplied to the membrane separation step from one exit of the at least two exits of the first particle fractionator, the first fraction of the first fractionated solid-liquid mixture being less than the liquor in terms of content of the submicron particles,

wherein a second fraction of the first fractionated solid-liquid mixture from another exits of the at least two exits of the first particle fractionator is fed to the second particle fractionator, and

wherein a first fraction of the second fractionated solid-liquid mixture from one exit of the at least two exits of the second particle fractionator is supplied to the membrane step, the first fraction of the second fractionated solid-liquid mixture being less than the second fraction of the first fractionated solid-liquid mixture in terms of content of the submicron particles.

10. A method for water treatment, comprising the steps of:

a membrane separation step for solids-liquid separation using a membrane separator;

a pretreatment step before the membrane separation step; and

a fractionation step using a particle fractionator which has at least two exits of a fractionated solid-liquid mixture produced therein,

wherein a liquor containing particles of different sizes including submicron particles having a particle size range of 0.03 to 0.4 μm is fed to the fractionation step before the membrane separation step, and

wherein a first fraction of the fractionated solid-liquid mixture from one exit of the at least two the exits of the particle fractionator in the fraction step is supplied to the membrane separation step or the pretreatment step, the first fraction being less than the liquor in terms of

content of the submicron particles.

11. A method for water treatment, comprising the steps of:

a membrane separation step for solids-liquid separation,

a pretreatment step before the membrane separation step, and

a first fractionation step using a first particle fractionator, the first particle fractionator having at least two exits of a first fractionated solid-liquid mixture produced therein, and

a second fractionation step using a second particle fractionator, the second particle fractionator having at least two exits of a second fractionated solid-liquid mixture produced therein,

wherein a liquor containing particles of different sizes including submicron particles having a particle size range of 0.03 to 0.4 μm is fed to the first particle fractionator before the membrane separation step,

wherein a first fraction of the first fractionated solid-liquid mixture from the first particle fractionator is supplied to the membrane separation step or pretreatment step from one exit of the at least two exits of the first particle fractionator, the first fraction being less than the liquor in terms of content of the submicron particles,

wherein a second fraction of the first fractionated solid-liquid mixture from anther exit of the at least two exits of the first particle fractionator is fed to the second particle fractionator, and

wherein a first fraction of the second fractionated solid-liquid mixture from one exit of the at least two exits of the second particle fractionator is supplied to the membrane separation step or the pretreatment step, the first fraction of the second fractionated solid-liquid mixture being less than the second fraction of the first fractionated solid-liquid mixture in terms of content of the submicron particles.

12. The method of claim 10 or 11, wherein the pretreatment step before the membrane separation step includes a biological process.

13. The method of any one of claims 10 or 11, wherein the pretreatment step before the membrane separation step includes a physical-chemical process like coagulation.

14. The method of any one of claims 8-13, wherein the particle fractionator comprises at least one hydrocyclone.