CLAIMS

Claim 1

A method for producing acetic acid,

the method being performed using acetic acid production equipment comprising: a reactor; and a distillation column,

the method comprising the following steps:

a reaction step of subjecting a material mixture comprising methanol and carbon monoxide to a methanol carbonylation reaction in the reactor to form acetic acid;

a low-boiling component removing step of distilling a crude acetic acid stream comprising the acetic acid formed in the reaction step in a low-boiling component removing column to give a first acetic acid stream, the first acetic acid stream being enriched with acetic acid as compared with the crude acetic acid stream; and

a dehydration step of distilling the first acetic acid stream in a dehydration column to give a second acetic acid stream enriched with acetic acid as compared with the first acetic acid stream, and

the method comprising

subjecting an acetic acid solution to an acetic anhydride decreasing treatment comprising at least one of

water concentration increasing and temperature lowering, to bring the acetic acid solution into such a state that the equilibrium concentration of acetic anhydride is lower than the acetic anhydride concentration, wherein

the acetic acid solution comprises acetic acid in a concentration of 90 mass percent or more; acetic anhydride; and water, and the acetic acid solution is in such a state that an equilibrium concentration of acetic anhydride is higher than an acetic anhydride concentration,

wherein the acetic anhydride decreasing treatment is performed to meet at least one of conditions (i) to (iv) as follows:

(i) the acetic anhydride decreasing treatment is performed on an acetic acid solution being distilled in the distillation column;

(ii) the method further comprises distilling the second acetic acid stream in a high-boiling component removing distillation column to obtain a third acetic acid stream enriched with acetic acid as compared with the second acetic acid stream, and the acetic anhydride decreasing treatment is performed on an acetic acid solution passing through a line between the dehydration column and the

high-boiling component removing distillation column;

(iii) the method further comprises passing an acetic acid stream through the interior of an ion exchange resin column packed with an ion exchange resin to adsorb and remove impurities from the acetic acid stream, and the acetic anhydride decreasing treatment is performed on an acetic acid solution passing through an inlet line to the ion exchange resin column and/or on an acetic acid stream passing through an outlet line from the ion exchange resin column; and

(iv) the acetic anhydride decreasing treatment is performed on an acetic acid solution passing through an inlet line to a product tank which stores an acetic acid stream.

Claim 2

The method according to claim 1 for producing acetic acid,

wherein a catalyst capable of functionally promoting acetic anhydride hydrolysis is present in the acetic acid solution during the acetic anhydride decreasing treatment.

Claim 3

The method according to claim 2 for producing acetic acid,

wherein the catalyst comprises at least one substance selected from the group consisting of Broensted acids, Lewis acids, corrodible metals, ion exchange resins, and sulfonic acids.

Claim 4

The method according to claim 2 for producing acetic acid,

wherein the catalyst in the acetic acid solution is present in an amount of 0.01 to 10000 ppm.

Claim 5

The method according to claim 1 for producing acetic acid,

wherein the acetic acid solution to be subjected to the acetic anhydride decreasing treatment is an acetic acid stream having an acetic acid concentration of 99.8% by mass or more passing through a line downstream from the dehydration column in the acetic acid production equipment.

Claim 6

The method according to claim 1 for producing acetic acid,
wherein the water concentration increasing is an increasing within a range up to 2500 ppm.

Claim 7

The method according to claim 1 for producing acetic acid,
wherein the acetic anhydride concentration in the acetic acid solution in such a state that the equilibrium concentration of acetic anhydride is higher than the acetic anhydride concentration is 300 ppm or less.

Claim 8

A method for producing acetic acid,
the method being performed using acetic acid production equipment comprising: a reactor; and a distillation column,
the method comprising the following steps:

a reaction step of subjecting a material mixture comprising methanol and carbon monoxide to a methanol

carbonylation reaction in the reactor to form acetic acid;

a low-boiling component removing step of distilling a crude acetic acid stream comprising the acetic acid formed in the reaction step in a low-boiling component removing column to give a first acetic acid stream, the first acetic acid stream being enriched with acetic acid as compared with the crude acetic acid stream; and

a dehydration step of distilling the first acetic acid stream in a dehydration column to give a second acetic acid stream enriched with acetic acid as compared with the first acetic acid stream, and

the method comprising

subjecting an acetic acid solution to an acetic anhydride decreasing treatment comprising at least one of water concentration increasing and temperature lowering, to further lower the equilibrium concentration of acetic anhydride,

wherein the acetic acid solution comprises acetic acid in a concentration of 90 mass percent or more; acetic anhydride; and water, and the acetic acid solution is in such a state that an equilibrium concentration of acetic anhydride is lower than an acetic anhydride concentration,

wherein the acetic anhydride decreasing treatment is performed to meet at least one of conditions (i) to (iv) as follows:

(i) the acetic anhydride decreasing treatment is performed on an acetic acid solution being distilled in the distillation column;

(ii) the method further comprises distilling the second acetic acid stream in a high-boiling component removing distillation column to obtain a third acetic acid stream enriched with acetic acid as compared with the second acetic acid stream, and the acetic anhydride decreasing treatment is performed on an acetic acid solution passing through a line between the dehydration column and the high-boiling component removing distillation column;

(iii) the method further comprises passing an acetic acid stream through the interior of an ion exchange resin column packed with an ion exchange resin to adsorb and remove impurities from the acetic acid stream, and the acetic anhydride decreasing treatment is performed on an acetic acid solution passing through an inlet line to the ion exchange resin column and/or on an acetic acid stream passing through an outlet line from the ion exchange

resin column; and

(iv) the acetic anhydride decreasing treatment is performed on an acetic acid solution passing through an inlet line to a product tank which stores an acetic acid stream.

Claim 9

The method according to claim 8 for producing acetic acid,

wherein a catalyst capable of functionally promoting acetic anhydride hydrolysis is present in the acetic acid solution during the acetic anhydride decreasing treatment.

Claim 10

The method according to claim 9 for producing acetic acid,

wherein the catalyst comprises at least one substance selected from the group consisting of Broensted acids, Lewis acids, corrodible metals, ion exchange resins, and sulfonic acids.

Claim 11

The method according to claim 9 for producing acetic acid,

wherein the catalyst in the acetic acid solution is present in an amount of 0.01 to 10000 ppm.

Claim 12

The method according to claim 8 for producing acetic acid,

wherein the acetic acid solution to be subjected to the acetic anhydride decreasing treatment is an acetic acid stream having an acetic acid concentration of 99.8% by mass or more passing through a line downstream from the dehydration column in the acetic acid production equipment.

Claim 13

The method according to claim 8 for producing acetic acid,

wherein the water concentration increasing is an increasing within a range up to 2500 ppm.

Claim 14

The method according to claim 8 for producing acetic

acid,

wherein the acetic anhydride concentration in the acetic acid solution in such a state that the equilibrium concentration of acetic anhydride is higher than the acetic anhydride concentration is 300 ppm or less.

Claim 15

A method for producing acetic acid,

the method being performed using acetic acid production equipment comprising: a reactor; and a distillation column,

the method comprising the following steps:

a reaction step of subjecting a material mixture comprising methanol and carbon monoxide to a methanol carbonylation reaction in the reactor to form acetic acid;

a low-boiling component removing step of distilling a crude acetic acid stream comprising the acetic acid formed in the reaction step in a low-boiling component removing column to give a first acetic acid stream, the first acetic acid stream being enriched with acetic acid as compared with the crude acetic acid stream; and

a dehydration step of distilling the first acetic acid stream in a dehydration column to give a second acetic acid

stream enriched with acetic acid as compared with the first acetic acid stream, and

the method comprising

subjecting an acetic acid solution to an acetic anhydride decreasing treatment comprising temperature rising alone or in combination with water concentration increasing, as long as the state being maintained, so as to perform acetic anhydride hydrolysis at a higher reaction rate, wherein the acetic acid solution comprises acetic acid in a concentration of 90 mass percent or more; acetic anhydride; and water, and the acetic acid solution is in such a state that an equilibrium concentration of acetic anhydride is lower than an acetic anhydride concentration,

wherein the acetic anhydride decreasing treatment is performed to meet at least one of conditions (i) to (iv) as follows:

(i) the acetic anhydride decreasing treatment is performed on an acetic acid solution being distilled in the distillation column;

(ii) the method further comprises distilling the second acetic acid stream in a high-boiling component removing distillation column to obtain a third acetic acid stream

enriched with acetic acid as compared with the second acetic acid stream, and the acetic anhydride decreasing treatment is performed on an acetic acid solution passing through a line between the dehydration column and the high-boiling component removing distillation column;

(iii) the method further comprises passing an acetic acid stream through the interior of an ion exchange resin column packed with an ion exchange resin to adsorb and remove impurities from the acetic acid stream and the acetic anhydride decreasing treatment is performed on an acetic acid solution passing through an inlet line to the ion exchange resin column and/or on an acetic acid solution passing through an outlet line from the ion exchange resin column; and

(iv) the acetic anhydride decreasing treatment is performed on an acetic acid solution passing through an inlet line to a product tank which stores an acetic acid stream.

Claim 16

The method according to claim 15 for producing acetic acid,

wherein a catalyst capable of functionally promoting acetic anhydride hydrolysis is present in the acetic acid solution during the acetic anhydride decreasing treatment.

Claim 17

The method according to claim 16 for producing acetic acid,

wherein the catalyst comprises at least one substance selected from the group consisting of Broensted acids, Lewis acids, corrodible metals, ion exchange resins, and sulfonic acids.

Claim 18

The method according to claim 16 for producing acetic acid,

wherein the catalyst in the acetic acid solution is present in an amount of 0.01 to 10000 ppm.

Claim 19

The method according to claim 15 for producing acetic acid,

wherein the acetic acid solution to be subjected to the acetic anhydride decreasing treatment is an acetic acid stream having an acetic acid concentration of 99.8% by mass or more passing through a line downstream from the dehydration column in the acetic acid production equipment.

Claim 20

The method according to claim 15 for producing acetic acid,

wherein the water concentration increasing is an increasing within a range up to 2500 ppm.

Claim 21

The method according to claim 15 for producing acetic acid,

wherein the acetic anhydride concentration in the acetic acid solution in such a state that the equilibrium concentration of acetic anhydride is higher than the acetic anhydride concentration is 300 ppm or less.

Claim 22

The method according to claim 1 for producing acetic

acid,

wherein the acetic acid solution in the acetic anhydride decreasing treatment is controlled to have any one of the following:

a water concentration of 2000 ppm or more and a temperature of 180°C or lower;

a water concentration of 1000 ppm or more and a temperature of 170°C or lower;

a water concentration of 500 ppm or more and a temperature of 120°C or lower;

a water concentration of 200 ppm or more and a temperature of 100°C or lower;

a water concentration of 80 ppm or more and a temperature of 60°C or lower;

a water concentration of 40 ppm or more and a temperature of 50°C or lower; and

a water concentration of 12 ppm or more and a temperature of 30°C or lower.

Claim 23

The method according to claim 8 for producing acetic acid,

wherein the acetic acid solution in the acetic anhydride decreasing treatment is controlled to have any one of the following:

a water concentration of 2000 ppm or more and a temperature of 180°C or lower;

a water concentration of 1000 ppm or more and a temperature of 170°C or lower;

a water concentration of 500 ppm or more and a temperature of 120°C or lower;

a water concentration of 200 ppm or more and a temperature of 100°C or lower;

a water concentration of 80 ppm or more and a temperature of 60°C or lower;

a water concentration of 40 ppm or more and a temperature of 50°C or lower; and

a water concentration of 12 ppm or more and a temperature of 30°C or lower.

Claim 24

The method according to claim 15 for producing acetic acid,

wherein the acetic acid solution in the acetic anhydride decreasing treatment is controlled to have any one of the following:

a water concentration of 2000 ppm or more and a temperature of 180°C or lower;

a water concentration of 1000 ppm or more and a temperature of 170°C or lower;

a water concentration of 500 ppm or more and a temperature of 120°C or lower;

a water concentration of 200 ppm or more and a temperature of 100°C or lower;

a water concentration of 80 ppm or more and a temperature of 60°C or lower;

a water concentration of 40 ppm or more and a temperature of 50°C or lower; and

a water concentration of 12 ppm or more and a temperature of 30°C or lower.

Claim 25

The method according to claim 1 for producing acetic acid,

satisfying at least one of the following conditions:

a) a water concentration in the reaction mixture in the reactor being 0.1 to 15 mass percent of the entire liquid phase in the reaction mixture;

b) an acetic acid concentration in the reaction mixture in the reactor being 50 to 90 mass percent of the entire liquid phase in the reaction mixture; and

c) an acetic anhydride concentration in the reaction mixture in the reactor being 0 to 5000 ppm of the entire liquid phase in the reaction mixture.

Claim 26

The method according to claim 8 for producing acetic acid,

satisfying at least one of the following conditions:

a) a water concentration in the reaction mixture in the reactor being 0.1 to 15 mass percent of the entire liquid phase in the reaction mixture;

b) an acetic acid concentration in the reaction mixture in the reactor being 50 to 90 mass percent of the entire liquid phase in the reaction mixture; and

c) an acetic anhydride concentration in the reaction

mixture in the reactor being 0 to 5000 ppm of the entire liquid phase in the reaction mixture.

Claim 27

The method according to claim 15 for producing acetic acid,

satisfying at least one of the following conditions:

a) a water concentration in the reaction mixture in the reactor being 0.1 to 15 mass percent of the entire liquid phase in the reaction mixture;

b) an acetic acid concentration in the reaction mixture in the reactor being 50 to 90 mass percent of the entire liquid phase in the reaction mixture; and

c) an acetic anhydride concentration in the reaction mixture in the reactor being 0 to 5000 ppm of the entire liquid phase in the reaction mixture.