CLAIMS

1. A method for producing acetic acid, comprising at least one step selected from

a carbonylation reaction step that satisfies the following operating conditions (i) and

an evaporation step or a distillation step that satisfies the following operating conditions (ii) in an acetic acid production process:

(i) operating conditions involving a hydrogen partial pressure of more than 1 kPa and less than 500 kPa (absolute pressure), a carbon dioxide partial pressure of not less than 2 kPa and less than 70 kPa (absolute pressure), and an operating temperature of more than 175°C and not more than 250°C; and

(ii) operating conditions involving a hydrogen partial pressure of not less than 0 kPa and not more than 5 kPa (absolute pressure), a carbon dioxide partial pressure of not less than 0 kPa and less than 20 kPa (absolute pressure), and an operating temperature of more than 100°C and not more than 250°C, wherein

the acetic acid production process has at least one distillation step,

a column top fraction of a distillation column in the at least one distillation step is recycled to the carbonylation reaction step that satisfies the operating conditions (i), the evaporation step that satisfies the operating conditions (ii), and/or the distillation step that satisfies the operating conditions (ii) positioned upstream from the distillation step associated with the distillation column, and

the carbonylation reaction step that satisfies the operating conditions (i) or the evaporation step or the distillation step that satisfies the operating conditions (ii) decomposes formic acid in the column top fraction.

2. The method for producing acetic acid according to claim 1, wherein the operating conditions (ii) involve a hydrogen partial pressure of not more than 1 kPa (absolute pressure) and a carbon dioxide partial pressure of less than 2 kPa (absolute pressure).

3. The method for producing acetic acid according to claim 1, wherein the method has the carbonylation reaction step that satisfies the operating conditions (i).

4. The method for producing acetic acid according to claim 3, wherein a reaction mixture liquid in the carbonylation reaction step has an acetic acid concentration of not less than 30% by mass and a formic acid concentration of not more than 102 ppm by mass.

5. The method for producing acetic acid according to claim 3, wherein a reaction mixture liquid in the reaction step has an acetic acid concentration of 50 to 90% by mass, a metal catalyst concentration (in terms of the metal) of 200 to 10000 ppm by mass, a methyl iodide concentration of 1 to 20% by mass, an ionic iodide concentration of 1 to 25% by mass, a water concentration of 0.1 to 15% by mass, a methyl acetate concentration of 0.1 to 30% by mass, and a formic acid concentration of not more than 102 ppm by mass.

6. The method for producing acetic acid according to claim 1, wherein the method has the evaporation step or the distillation step that satisfies the operating conditions (ii).

7. The method for producing acetic acid according to claim 6, wherein a charging mixture for an evaporator in the evaporation step has an acetic acid concentration of 50 to 90% by mass, a metal catalyst concentration (in terms of the metal) of 200 to 10000 ppm by mass, a methyl iodide concentration of 1 to 20% by mass, an ionic iodide concentration of 1 to 25% by mass, a water concentration of 0.1 to 15% by mass, a methyl acetate concentration of 0.1 to 30% by mass, and a formic acid concentration of not more than 10000 ppm by mass.

8. The method for producing acetic acid according to claim 6, wherein a charging mixture for a distillation column in the distillation step that satisfies the operating conditions (ii) has an acetic acid concentration of not less than 30% by mass and a formic acid concentration of not less than 5 ppm by mass.

9. The method for producing acetic acid according to claim 6, wherein a charging mixture for a distillation column in the distillation step that satisfies the operating conditions (ii) has an acetic acid concentration of 40 to 85% by mass, a methyl iodide concentration of 2 to 50% by mass, a water concentration of 0.2 to 20% by mass, a methyl acetate concentration of 0.2 to 50% by mass, and a formic acid concentration of 5 to 10000 ppm by mass.

10. The method for producing acetic acid according to claim 6, wherein a charging mixture for a distillation column in the distillation step that satisfies the operating conditions (ii) has an acetic acid concentration of 80 to 99.9% by mass, a methyl iodide concentration of 0.01 to 16% by mass, a water concentration of 0.05 to 18% by mass, a methyl acetate concentration of 0.01 to 16% by mass, and a formic acid concentration of 5 to 10000 ppm by mass.

11. The method for producing acetic acid according to claim 6, wherein a charging mixture for a distillation column in the distillation step that satisfies the operating conditions (ii) has an acetic acid concentration of 99.1 to 99.999% by mass and a formic acid concentration of 5 to 9000 ppm by mass.

12. The method for producing acetic acid according to claim 1,

wherein the acetic acid production process has the carbonylation reaction step of reacting methanol with carbon monoxide to produce acetic acid, the evaporation step of separating the reaction mixture obtained in the carbonylation reaction step into a vapor stream and a residual liquid stream, and a lower boiling point component removal step of separating the vapor stream by distillation into an overhead stream rich in lower boiling point component and a first acetic acid stream rich in acetic acid, or

wherein the acetic acid production process further has at least one of the following steps (a) - (d) in addition to the carbonylation reaction step, the evaporation step, and the lower boiling point component removal step:

(a) a dehydration step of separating the first acetic acid stream by distillation into an overhead stream rich in water and a second acetic acid stream more enriched with acetic acid than the first acetic acid stream,

(b) a higher boiling point component removal step of separating the first acetic acid stream or the second acetic acid stream by distillation into a bottom stream rich in higher boiling point component and a third acetic acid stream more enriched with acetic acid than the acetic acid stream before the distillation,

(c) an adsorptive removal step of treating the first acetic acid stream, the second acetic acid stream, or the third acetic acid stream with an ion exchange resin to obtain a fourth acetic acid stream, and

(d) a product step of distilling the first acetic acid stream, the second acetic acid stream, the third acetic acid stream or the fourth acetic acid stream to obtain a fifth acetic acid stream more enriched with acetic acid than the acetic acid stream before the distillation.

13. The method for producing acetic acid according to claim 12, wherein at least one step selected from the evaporation step, the lower boiling point component removal step, the dehydration step, the higher boiling point component removal step, and the product step satisfies the operating conditions (ii).

14. The method for producing acetic acid according to claim 1, wherein a retention time in the step that satisfies the operating conditions (i) or the step that satisfies the operating conditions (ii) is not less than 1 minute.

15. The method for producing acetic acid according to claim 1, wherein a process solution having a formic acid concentration of not less than 10 ppm by mass is recycled to a step that satisfies operating conditions involving a hydrogen partial pressure of less than 500 kPa (absolute pressure), a carbon dioxide partial pressure of less than 70 kPa (absolute pressure), and an operating temperature of more than 100°C.

16. The method for producing acetic acid according to claim 1, wherein the column top fraction to be recycled is a column top fraction of a distillation column that a charging mixture for the distillation column has an acetic acid concentration of 80 to 99.999% by mass.

17. The method for producing acetic acid according to claim 1, wherein the operating conditions (i) involves a hydrogen partial pressure of not less than 1 and less than 500 kPa (absolute pressure), and the operating conditions (ii) involves a carbon dioxide partial pressure of less than 12 kPa (absolute pressure) and an operating temperature of 106°C to 250°C.

18. The method for producing acetic acid according to claim 1, wherein a retention time in the step that satisfies the operating conditions (i) or the step that satisfies the operating conditions (ii) is not less than 1 minute and not more than 2 hours.

19. The method for producing acetic acid according to claim 1, wherein the method has a distillation step that satisfies the operating conditions (ii), and a charging mixture for a distillation column in the distillation step that satisfies the operating condition (ii) has a formic acid concentration of 5 to 1000 ppm by mass.