Claims

1. A process for producing acetic acid, comprising:

(1) allowing methanol to carbonylation react with carbon monoxide in the presence of a catalyst system, acetic acid, methyl acetate, and water, wherein the catalyst system comprises a metal catalyst, an ionic metal iodide, and methyl iodide;

(2) separating the reaction mixture into a volatile phase and a less-volatile phase;

(3) distilling the volatile phase to form a first overhead and an acetic acid stream, wherein the first overhead is rich in at least one lower boiling component selected from the group consisting of methyl iodide and acetaldehyde, and the acetic acid stream is rich in acetic acid; and

at least one section selected from the group consisting of the following sections (4), (9), and (15):

(4) a purification section for obtaining purified acetic acid from the acetic acid stream;

(9) a separation section for separating at least acetaldehyde from the first overhead; and

(15) an off-gas treatment section for absorption-treating an off-gas from the process with an absorption solvent and forming a carbon monoxide-rich stream and an acetic acid-rich stream;

wherein a concentration of oxygen is controlled in at least one selected from the group consisting of the following (a) and (b):

(a) the concentration of oxygen in a gaseous phase of the process is controlled to less than 7% by volume,

(b) the concentration of oxygen in a liquid phase of the process is controlled to less than 7×10^{-5} g/g.

2. The process according to claim 1, wherein the concentration of oxygen is controlled in at least one selected from the group consisting of the following (a) and (b):

(a) the concentration of oxygen in a gaseous phase of the process is controlled to less than 5% by volume,

(b) the concentration of oxygen in a liquid phase of the process is controlled to 2×10^{-5} g/g or less.

3. The process according to claim 1 or 2, wherein the gaseous phase of the process contains at least one member selected from the group consisting of methyl iodide and hydrogen iodide.

4. The process according to any one of claims 1 to 3, wherein the gaseous phase of the process further contains at least one member selected from the group consisting of acetic acid, methyl acetate, methanol, water,

acetaldehyde, a by-product derived from acetaldehyde, and a dialkyl ether; the by-product contains at least one member selected from the group consisting of an alkyl iodide with 2 or more carbon atoms, an alkanal with 4 or more carbon atoms, an alkanecarboxylic acid with 3 or more carbon atoms, an alkane, and a ketone; and the dialkyl ether contains at least dimethyl ether.

5. The process according to any one of claims 1 to 4, wherein, in at least one process stream selected from the group consisting of a stream of a process unit and a stream of a process line, the concentration of oxygen is controlled in at least one selected from the group consisting of the following (a-1) and (b-1):

(a-1) the concentration of oxygen in the gaseous phase is controlled to 5% by volume or less,

(b-1) the concentration of oxygen in the liquid phase is controlled to 2×10^{-5} g/g or less.

6. The process according to any one of claims 1 to 5, wherein, in at least one process stream selected from the group consisting of a stream of a process unit and a stream of a process line, a ratio of oxygen relative to carbon monoxide in each of the gaseous phase and the liquid phase is 2% by volume or less.

7. The process according to any one of claims 1 to 6, wherein, in at least one process stream selected from the group consisting of a stream of a process unit and a stream of a process line, a ratio of oxygen relative to carbon monoxide in each of the gaseous phase and the liquid phase is 1% by volume or less.

8. The process according to any one of claims 1 to 7, wherein at least one component selected from the group consisting of an oxygen-containing gas, an oxygen-containing compound, and an oxygen generator is introduced to the process; and in at least one process stream selected from the group consisting of a stream of a process unit and a stream of a process line, the concentration of oxygen in the gaseous phase is controlled to 1 ppt by volume or more, and/or the concentration of oxygen in the liquid phase is controlled to 0.1×10^{-9} g/g or more.

9. The process according to any one of claims 1 to 8, wherein the concentration of oxygen in the gaseous phase is controlled to 1 ppb by volume or more.

10. The process according to any one of claims 1 to 9, wherein a concentration of oxygen in at least one process stream selected from the group consisting of the gaseous phase and the liquid phase is controlled to 0.25 mol or

less relative to 1 mol of a total amount of hydrogen iodide and methyl iodide.

11. The process according to any one of claims 1 to 10, wherein the purification section (4) comprises at least (5) a dehydration step among the following steps (5) to (8):

(5) dehydrating the acetic acid stream;

(6) removing a higher boiling component from the acetic acid stream;

(7) further purification-distilling an acetic acid stream from the step (6); and

(8) ion-exchange separating an iodine compound from an acetic acid stream from the step (7).

12. The process according to any one of claims 1 to 11, wherein the separation section (9) comprises at least steps (10) to (13) among the following steps (10) to (14):

(10) condensing the first overhead to form two liquid phases with an upper phase and a lower phase;

(11) forming a fifth overhead from the upper phase, the lower phase, or both, wherein the fifth overhead is rich in acetaldehyde and methyl iodide;

(12) extracting acetaldehyde from the fifth overhead to form an extract and a raffinate, wherein the extract is rich in acetaldehyde and the raffinate is rich in methyl iodide;

(13) separating an aldehyde from the extract, the raffinate, or both; and

(14) separating an alkane from the upper phase, the lower phase, or both.

13. The process according to any one of claims 1 to 12, wherein the off-gas treatment section (15) comprises at least one absorption step selected from the group consisting of steps (16) and (17) among the following steps (16) to (18):

(16) absorbing the off-gas to an absorption solvent at a high pressure;

(17) absorbing the off-gas to an absorption solvent at a low pressure; and

(18) diffusing a gaseous component absorbed in the absorption steps (16) and (17).

14. The process according to any one of claims 1 to 13, wherein the gaseous phase of the process comprises an off-gas from the process.

15. The process according to any one of claims 1 to 14, wherein the purified acetic acid as product acetic acid has a concentration of iodine of 10 ppb by weight or less.