CLAIMS

[Claim 1] A process for producing acetic acid comprising:

a reaction step for allowing methanol to continuously react with carbon monoxide in the presence of a catalyst system containing a metal catalyst, a metal halide, and methyl iodide in a carbonylation reactor,

a flash evaporation step for separating a reaction mixture into a volatile phase (2A) containing produced acetic acid and methyl iodide and a less-volatile phase (2B) containing the metal catalyst and the metal halide,

a distillation step for separating the volatile phase (2A) into an overhead (3A) containing methyl iodide and by-product acetaldehyde, and a stream (3B) containing acetic acid, and

a step for condensing a gaseous phase, containing at least acetaldehyde, resulting from at least one step of these steps,

wherein the gaseous phase is condensed by a plurality of condensers to form condensates sequentially lower in temperature, and acetaldehyde is separated from a condensate or condensates enriched in acetaldehyde,

wherein a condensate in a first condenser has a temperature of not higher than 110°C, and a condensate in at least one of a second and subsequent condensers has a temperature of not higher than a condensation temperature of acetaldehyde.

[Claim 2] A process according to claim 1, wherein the gaseous phase, containing at least methyl iodide and acetaldehyde, resulting from at least one step of the flash evaporation step and the distillation step is condensed by the plurality of condensers.

[Claim 3] A process according to claim 1 or 2, wherein at least one gaseous phase selected from the group consisting of the overhead (3A) and the volatile phase (2A) is subjected to the plurality of condensers and cooled to form condensates and noncondensed gaseous components, wherein the condensates have a lower temperature and a higher acetaldehyde concentration sequentially in the downstream direction, and acetaldehyde is separated from a condensate or condensates highly enriched in acetaldehyde.

[Claim 4] A process according to any one of claims 1 to 3, wherein the gaseous phase is condensed by the plurality of condensers, and a condensate enriched in acetaldehyde from at least one of a second and subsequent condensers are

stored in a hold tank, and acetaldehyde is separated from the stored condensate.

[Claim 5] A process according to any one of claims 1 to 4, the gaseous phase is condensed by the plurality of condensers, a condensate from at least a first condenser is stored in a decanter, a condensate enriched in acetaldehyde from at least one of a second and subsequent condensers is stored in a hold tank, the condensate in the decanter and the condensate in the hold tank are combined and distilled for separating an overhead containing acetaldehyde.

[Claim 6] A process according to any one of claims 1 to 5, wherein the volatile phase (2A) is distilled by a first distillation column to form a first overhead, the overhead as the gaseous phase is condensed by the plurality of condensers, and
(i) a condensate enriched in acetaldehyde from at least one of a second and subsequent condensers is distilled by a second distillation column,
(ii) a condensate from at least one of a second and subsequent condensers is stored in a hold tank, and the stored condensate is distilled by a second distillation column, or
(iii) a condensate from at least a first condenser is stored in a decanter, a condensate from at least one of a second and subsequent condensers is stored in a hold tank, the condensate in the decanter and the condensate in the hold tank are combined and distilled by a second distillation column,
for separating a second overhead enriched in acetaldehyde.

[Claim 7] A process according to claim 5 or 6, wherein the condensate in the decanter and the condensate in the hold tank are combined in a weight ratio of 0/100 to 95/5 as the former/the latter and distilled by a second distillation column.

[Claim 8] A process according to claim 6 or 7, wherein the second overhead is subjected to extraction with water to form an aqueous phase containing acetaldehyde and an organic phase containing methyl iodide, and the organic phase is recycled to the reactor.

[Claim 9] A process according to any one of claims 1 to 8, wherein the volatile phase (2A) as the gaseous phase is condensed by the plurality of condensers, a condensate from at least one of a second and subsequent condensers is

distilled by a first distillation column and/or a second distillation column to form a first overhead and/or a second overhead.

[Claim 10] A process according to any one of claims 1 to 9, wherein the gaseous phase is condensed by 2 to 5 condensers arranged at least in series.

[Claim 11] A process according to any one of claims 1 to 10, wherein a condensate from at least one of a second and subsequent condensers among the plurality of condensers is distilled for separating an overhead containing acetaldehyde.

[Claim 12] A process according to any one of claims 1 to 11, wherein the gaseous phase is cooled by a first condenser to form a first condensate and a first noncondensed gaseous component, the first noncondensed gaseous component is cooled by a second condenser of which a cooling temperature is lower than that of the first condenser to form a second condensate having a temperature lower than that of the first condensate and a second noncondensed gaseous component, and acetaldehyde is separated from at least the second condensate.

[Claim 13] A process according to any one of claims 1 to 12, wherein, further, an offgas (5A), containing at least methyl iodide and acetaldehyde, resulting from at least one step of the reaction step, the flash evaporation step, a storage step, and at least one distillation step is allowed to contact with an absorption solvent, the resulting solvent is stripped to form a gaseous phase containing at least methyl iodide and acetaldehyde, and acetaldehyde is separated from the gaseous phase.

[Claim 14] A process according to any one of claims 1 to 13, wherein a condensate in at least one of a second and subsequent condensers has a temperature of not higher than 50°C.

[Claim 15] A process according to any one of claims 1 to 14, wherein a condensate in at least one of a second and subsequent condensers has a temperature of -15°C to 50°C.

[Claim 16] A process according to any one of claims 1 to 15, wherein a condensate in a first condenser has a temperature of not higher than 110°C, and

a condensate in at least one of a second and subsequent condensers has a temperature of not higher than 45°C.

[Claim 17] A process according to any one of claims 1 to 16, wherein a condensate in at least one of a second and subsequent condensers is lower than a boiling point of acetaldehyde.

[Claim 18] A process according to any one of claims 1 to 17, wherein a condensate in a first condenser has a temperature T1 of 20 to 110°C, and a temperature difference Δ(T1-T2) is 1 to 60°C, in which T2 means a temperature of a condensate in at least one of a second and subsequent condensers.

[Claim 19] A method for separating or removing acetaldehyde, comprising:

distilling a mixture containing acetic acid, methyl acetate, methyl iodide, methanol, water and acetaldehyde to form a gaseous phase containing at least methyl iodide and acetaldehyde and a liquid phase containing at least water and methanol, and

condensing the gaseous phase to separate acetaldehyde from the gaseous phase,

wherein the gaseous phase is condensed by a plurality of condensers to form condensates sequentially lower in temperature, and acetaldehyde is separated from a condensate or condensates enriched in acetaldehyde,

wherein a condensate in a first condenser has a temperature of not higher than 110°C, and a condensate in at least one of a second and subsequent condensers has a temperature of not higher than a condensation temperature of acetaldehyde.

[Claim 20] A method according to claim 19, wherein a condensate in at least one of a second and subsequent condensers has a temperature of not higher than 50°C.

[Claim 21] A method according to claim 19 or 20, wherein a condensate in at least one of a second and subsequent condensers has a temperature of -15°C to 50°C.

[Claim 22] A method according to any one of claims 19 to 21, wherein a condensate in a first condenser has a temperature of not higher than 110°C, and a condensate in at least one of a second and subsequent condensers has a

temperature of not higher than 45°C.

[Claim 23] A method according to any one of claims 19 to 22, wherein a condensate in at least one of a second and subsequent condensers is lower than a boiling point of acetaldehyde.

[Claim 24] A method according to any one of claims 19 to 23, wherein a condensate in a first condenser has a temperature T1 of 20 to 110°C, and a temperature difference Δ(T1-T2) is 1 to 60°C in which T2 means a temperature of a condensate in at least one of a second and subsequent condensers.

[Claim 25] A method according to any one of claims 19 to 24, wherein a condensate in a first condenser has a temperature of 20 to 110°C, and a condensate in at least one of a second and subsequent condensers has a temperature of -5°C to 30°C.

[Claim 26] A method according to any one of claims 19 to 25, wherein a condensate from at least one of a second and subsequent condensers is distilled to form an overhead containing acetaldehyde, and the overhead is subjected to extraction with water to form an aqueous phase containing acetaldehyde and an organic phase.