Claims

1. A chemical reaction method that causes a reaction, a product of which contains a component having a boiling point higher than a component of a source material gas, and progress of which in a gaseous phase is restricted by a chemical equilibrium between a source material and the product, to proceed, wherein

a chemical reaction device includes:

a catalyst layer which contains a catalyst that promotes the reaction;

a cooling surface which is provided apart from the catalyst layer with a space between the cooling surface and the catalyst layer, which is maintained at a temperature not higher than a dew point of a reactant gas produced by the reaction, and which extends in a height direction of the chemical reaction device; and

a transmission wall which is provided at a boundary between the catalyst layer and the space and which allows the reactant gas to pass therethrough,

given that a distance between (a) a surface of the catalyst layer which surface is in contact with the transmission wall and (b) the cooling surface is Lx (x = 1, 2, ..., n), and a height of the catalyst layer corresponding to the cooling surface having the distance is Hx (x = 1, 2,

..., n),

a sum total of n heights in relation to the height Hx is not less than 1,000 mm,

a distance Lx is not less than 0.5 mm and not more than 500 mm,

a cumulative value is not less than 500 mm^2, the cumulative value being obtained by cumulatively adding, from one end to the other end of the cooling surface in the height direction, products of the distance Lx and the height Hx, and

the chemical reaction device is used

to cause a chemical reaction to proceed by supplying the source material gas to the catalyst layer, and

to condense, on the cooling surface and in the space, some of a product produced by the chemical reaction.

2. The chemical reaction method according to claim 1, wherein the source material gas contains a carbon oxide and hydrogen, and the product contains methanol.

3. The chemical reaction method according to claim 1 or 2, wherein the cumulative value is not more than 10,000,000 mm^2.

4. A chemical reaction device that causes a reaction, a

product of which contains a component having a boiling point higher than a component of a source material gas, and progress of which in a gaseous phase is restricted by a chemical equilibrium between a source material and the product, to proceed,

said chemical reaction device comprising:

a catalyst layer to which the source material gas is supplied and which contains a catalyst that promotes the reaction;

a cooling surface which is provided apart from the catalyst layer with a space between the cooling surface and the catalyst layer, which is maintained at a temperature not higher than a dew point of the reactant gas that has been produced by the reaction, and which extends in a height direction of the chemical reaction device; and

a transmission wall which is provided at a boundary between the catalyst layer and the space and which allows the reactant gas to pass therethrough,

given that a distance between (a) a surface of the catalyst layer which surface is in contact with the transmission wall and (b) an outer surface of the cooling surface is Lx (x = 1, 2, ..., n), and a height of the catalyst layer corresponding to the outer surface having the distance is Hx (x = 1, 2, ..., n),

a sum total of n heights in relation to the height Hx

is not less than 1,000 mm,

a distance Lx is not less than 0.5 mm and not more than 500 mm,

a cumulative value being not less than 500 mm^2, the cumulative value being obtained by cumulatively adding, from one end to the other end of the cooling surface in the height direction, products of the distance Lx and the height Hx, and

the chemical reaction device condensing some of a product on a surface of the cooling surface and in the space.

5. The chemical reaction device according to claim 4, wherein the source material gas contains a carbon oxide and hydrogen, and the product contains methanol.

6. The chemical reaction device according to claim 4 or 5, wherein the cumulative value is not more than 10,000,000 mm^2.

7. A chemical reaction device according to any one of claims 4 to 6, further comprising a heat transfer surface on an opposite side from the transmission wall with the catalyst interposed between the heat transfer surface and the transmission wall, the heat transfer surface being

maintained at a higher temperature than the cooling surface.

8. The chemical reaction device according to any one of claims 5 to 7, wherein a sum total of n heights in relation to the height of the catalyst layer Hx is not more than 20,000 mm.

9. A chemical reaction device comprising a reaction container including at least one reaction tube that has a multiple structure and that causes a reaction, a product of which contains a component having a boiling point higher than a component of a source material gas, and progress of which in a gaseous phase is restricted by a chemical equilibrium between a source material and the product, to proceed inside the at least one reaction tube,

the at least one reaction tube each including:

an inner cylinder which allows a reactant gas produced by the reaction to pass therethrough;

an outer cylinder inside which the inner cylinder is provided;

a cooling tube which is provided inside the inner cylinder and which extends in a height direction of the chemical reaction device; and

a catalyst layer which is provided between the

inner cylinder and the outer cylinder,

given that a distance between (a) a surface of the catalyst layer which surface is in contact with the inner cylinder and (b) an outer surface of the cooling tube is Lx (x = 1, 2, ..., n), and a height of the catalyst layer corresponding to the outer surface having the distance is Hx (x = 1, 2, ..., n),

a sum total of n heights in relation to the height Hx being not less than 1,000 mm,

the distance Lx being not less than 0.5 mm,

a cumulative value being not less than 500 mm^2, the cumulative value being obtained by cumulatively adding, from one end to the other end of the cooling tube in the height direction, products of the distance Lx and the height Hx,

a temperature of the outer surface of the cooling tube being maintained at a temperature not higher than a dew point of the reactant gas, and

the chemical reaction device condensing some of the product in a space provided between the cooling tube and the inner cylinder.

10. The chemical reaction device according to claim 9, wherein the source material gas contains carbon oxide and hydrogen, and the product contains methanol.

11. The chemical reaction device according to claim 9 or 10, wherein the cumulative value is not more than 10,000,000 mm^2.

12. A chemical reaction device according to claim 9, further comprising a heating medium in a space defined by an inner wall of the reaction container and an outer wall of the reaction tube.

13. The chemical reaction device according to any one of claims 9 to 12, wherein the distance Lx is not more than 500 mm, and the height of the catalyst layer is not more than 20,000 mm.

14. A chemical reaction device comprising a reaction container including at least one reaction tube that has a multiple structure and that causes a reaction, a product of which contains a component having a boiling point higher than a component of a source material gas, and progress of which in a gaseous phase is restricted by a chemical equilibrium between a source material and the product, to proceed inside the at least one reaction tube,

the at least one reaction tube each including:

an inner cylinder which allows a reactant gas

produced by the reaction to pass therethrough;

an outer cylinder inside which the inner cylinder is provided and which extends in a height direction of the chemical reaction device; and

a catalyst layer which is provided inside the inner cylinder,

given that a distance between (a) a surface of the catalyst layer which surface is in contact with the inner cylinder and (b) an inner surface of the outer cylinder is Lx (x = 1, 2, ..., n), and a height of the catalyst layer corresponding to the inner surface having the distance is Hx (x = 1, 2, ..., n),

a sum total of n heights in relation to the height Hx being not less than 1,000 mm,

the distance Lx being not less than 0.5 mm,a cumulative value being not less than 500 mm^2, the cumulative value being obtained by cumulatively adding, from one end to the other end of an inner surface of the outer cylinder in the height direction, products of the distance Lx and the height Hx,

a temperature of the inner surface of the outer cylinder being maintained at a temperature not higher than a dew point of the reactant gas, and

the chemical reaction device condensing some of the product in a space provided between the outer cylinder and

the inner cylinder.

15. The chemical reaction device according to claim 14, wherein the source material gas contains carbon oxide and hydrogen, and the product contains methanol.

16. The chemical reaction device according to claim 14 or 15, wherein the cumulative value is not more than 10,000,000 mm^2.

17. A chemical reaction device according to any one of claims 14 to 16, further comprising a heat source inside the catalyst layer.

18. The chemical reaction device according to any one of claims 14 to 17, wherein the distance Lx is not more than 500 mm, and the height of the catalyst layer is not more than 20,000 mm.

19. A methanol production method that causes a reaction, a product of which contains a component having a boiling point higher than a component of a source material gas, and progress of which in a gaseous phase is restricted by a chemical equilibrium between a source material and the product, to proceed, wherein

a chemical reaction device containing carbon oxide and hydrogen as the source material gas,

the chemical reaction device includes:

a catalyst layer which contains a catalyst for methanol synthesis;

a cooling surface which is provided apart from the catalyst layer with a space between the cooling surface and the catalyst layer, which is maintained at a temperature not higher than a dew point of a reactant gas produced by the reaction, and which extends in a height direction of the chemical reaction device; and

a transmission wall which is provided at a boundary between the catalyst layer and the space and which allows the reactant gas to pass therethrough,

given that a distance between (a) a surface of the catalyst layer which surface is in contact with the transmission wall and (b) the cooling surface is Lx (x = 1, 2, ..., n), and a height of the catalyst layer corresponding to the cooling surface having the distance is Hx (x = 1, 2, ..., n),

a sum total of n heights in relation to the height Hx is not less than 1,000 mm,

a distance Lx is not less than 0.5 mm,

a cumulative value is not less than 500 mm^2, the cumulative value being obtained by cumulatively adding,

from one end to the other end of the cooling surface in the height direction, products of the distance Lx and the height Hx, and

the chemical reaction device is used

to cause a chemical reaction to proceed by supplying the source material gas to the catalyst layer, and

to condense, on the cooling surface and in the space, some of a reactant gas produced by the chemical reaction.