Claims

[Claim 1]

A method of producing a catalyst for producing methacrylic acid by oxidizing methacrolein, comprising:

(i) preparing a slurry A1 containing a heteropolyacid containing at least phosphorus and molybdenum or a salt of the heteropolyacid containing at least phosphorus and molybdenum,

(ii) preparing a slurry A2 satisfying the following Formula (I) and Formula (II) using the slurry A1,

(iii) mixing the slurry A2 and a raw material liquid B containing a cationic raw material to prepare a slurry C, wherein the cationic raw material comprises at least one selected from the group consisting of a compound containing an alkali metal and a compound containing an ammonium ion, and

(iv) drying the slurry C,

$$\alpha_{A2} / \alpha_{A1} \leq 0.95 \qquad \text{(I)}$$

$$2 \leq D_{A2} \leq 50 \qquad \text{(II)}$$

wherein, in Formula (I), α_{A1} represents a half-value width (μm) of a particle size distribution of the slurry A1, α_{A2} represents a half-value width (μm) of a particle size distribution of the slurry A2, and in Formula (II), D_{A2} represents a median diameter (μm) of the particle size distribution of the slurry A2.

[Claim 2]

The method of producing a catalyst used for a production of methacrylic acid according to claim 1, which the following Formula (III):

$$2 \leq D_C \leq 50 \qquad \text{(III)}$$

wherein, in Formula (III), D_C represents a median diameter (μm) of the particle size distribution of the slurry C.

[Claim 3]

The method of producing a catalyst used for a production of methacrylic acid according to claim 1 or 2, which the following Formula (IV):

$$0.6 \leq D_{A2} / D_{A1} < 1.0 \qquad \text{(IV)}$$

wherein, in Formula (IV), D_{A1} represents a median diameter (μm) of the particle size distribution of the slurry A1, and D_{A2} represents a median diameter (μm) of the particle size

distribution of the slurry A2.

[Claim 4]

The method of producing a catalyst used for a production of methacrylic acid according to any one of claims 1 to 3, wherein, in the step (ii), the slurry A2 is prepared by supplying the slurry A1 to a pump.

[Claim 5]

The method of producing a catalyst used for a production of methacrylic acid according to claim 4, wherein, when a volume of the slurry A1 prepared in the step (i) is V_{A1}, and a total volume of the slurry A1 supplied to the pump is V_{POMP}, V_{POMP} / V_{A1} at beginning of the mixing with the raw material liquid B in the step (iii) is 0.1 or more.

[Claim 6]

The method of producing a catalyst used for a production of methacrylic acid according to claim 4 or 5, wherein V_{POMP} / V_{A1} at beginning of the mixing with the raw material liquid B in the step (iii) is 1.0 or more and 10.0 or less.

[Claim 7]

The method of producing a catalyst used for a production of methacrylic acid according to any one of claims 4 to 6, wherein V_{POMP} / V_{A1} at beginning of the mixing with the raw material liquid B in step (iii) is larger than 1.0.

[Claim 8]

The process of producing a catalyst used for a production of methacrylic acid according to any one of claims 4 to 7, wherein a supply speed of the slurry A1 to the pump is 1 L/min or more.

[Claim 9]

The method of producing a catalyst used for a production of methacrylic acid according to any one of claims 4 to 8, wherein the pump is a turbo type pump or a reciprocating pump.

[Claim 10]

The method of producing a catalyst used for a production of methacrylic acid according

to any one of claims 4 to 9, wherein, when a tank for preparing the slurry A1 in the step (i) is tank 1, and a tank for mixing the slurry A2 and the raw material liquid B in the step (iii) is a tank 2, the tank 1 and the tank 2 are different tanks.

[Claim 11]

The method of producing a catalyst used for a production of methacrylic acid according to claim 10, wherein the tank 1 and the tank 2 are connected through a pipe.

[Claim 12]

The method of producing a catalyst used for a production of methacrylic acid according to claim 11, wherein the pump is provided in the pipe.

[Claim 13]

The method of producing a catalyst used for a production of methacrylic acid according to any one of claims 1 to 12, wherein the slurry A1 has a viscosity of 1 to 200 cP at 30 °C.

[Claim 14]

The method of producing a catalyst used for a production of methacrylic acid according to any one of claims 1 to 13, wherein a solid content concentration of the slurry A1 is 5 to 60% by mass.

[Claim 15]

The method of producing a catalyst used for a production of methacrylic acid according to any one of claims 1 to 14, wherein the catalyst has a composition represented by the following Formula (V):

$$P_aMo_bV_cCu_dX_eY_fZ_g(NH_4)_hO_i \qquad (V)$$

wherein, in the formula,

P, Mo, V, Cu, NH_4 and O represent phosphorus, molybdenum, vanadium, copper, ammonium and oxygen, respectively;

X represents at least one element selected from the group consisting of silicon, titanium, germanium, arsenic, antimony and bismuth;

Y represents at least one element selected from the group consisting of niobium, tantalum, tungsten, cerium, zirconium, silver, iron, zinc, chromium, magnesium, cobalt, manganese, barium and lanthanum;

Z represents at least one element selected from the group consisting of lithium, sodium, potassium, rubidium and cesium;

a to i represent molar ratios of each component, and

when b is 12, a = 0.5 to 3, c = 0.01 to 3, d = 0.01 to 2, e = 0.1 to 3, f = 0 to 3, g = 0.01 to 3, h = 0 to 20, and i represents a molar ratio of oxygen required to satisfy a valence of each of the components.

[Claim 16]

A method of producing methacrylic acid, comprising oxidizing methacrolein in a presence of the catalyst produced by the method according to any one of claims 1 to 15.

[Claim 17]

A method of producing a methacrylic ester, comprising esterifying the methacrylic acid produced by the method according to claim 16.

[Claim 18]

An apparatus for producing a catalyst used for producing methacrylic acid by oxidizing methacrolein, comprising:

a tank for preparing a slurry A1 containing at least phosphorus and molybdenum, and

a pump configured to provide shearing force for preparing a slurry A2 satisfying the following Formula (I) and Formula (II) using the slurry A1:

$$\alpha_{A2} / \alpha_{A1} \leq 0.95 \quad \text{(I)}$$

$$2 \leq D_{A2} \leq 50 \quad \text{(II)}$$

wherein, in Formula (I), α_{A1} represents a half-value width (μm) of a particle size distribution of the slurry A1, α_{A2} represents a half-value width (μm) of a particle size distribution of the slurry A2, and in Formula (II), D_{A2} represents a median diameter (μm) of the particle size distribution of the slurry A2.

[Claim 19]

The apparatus according to claim 18, comprising tank 1 as the tank for preparing the slurry A1 and tank 2 for mixing the slurry A2 with a raw material liquid B containing a cationic raw material.

[Claim 20]

The apparatus for producing a catalyst used for a production of methacrylic acid according to claim 19, wherein the tank 1 and the tank 2 are connected through a pipe.

[Claim 21]

The apparatus for producing a catalyst used for a production of methacrylic acid according to claim 20, wherein the pump is provided in the pipe.