in the step (i) is 5% by mol or more.

[6]: The method for producing methacrolein and/or methacrylic acid according to any of [1] to [5], wherein a mixed gas obtained by mixing water with the isobutylene-containing gas 2 and gasifying the resulting mixture is fed to the oxidation catalyst layer in the step (ii).

[7]: The method for producing methacrolein and/or methacrylic acid according to any of [1] to [6], wherein dehydration reaction of isobutanol is performed at 260 to 380°C in the step (i).

[8]: The method for producing methacrolein and/or methacrylic acid according to any of [1] to [7], wherein the conversion rate of isobutanol in the step (i) is 95% or more.

[9]: The method for producing methacrolein and/or methacrylic acid according to any of [1] to [8], wherein oxidation reaction of isobutylene is performed at 200 to 400°C in the step (ii).

[10]: A method for producing methacrylic acid, including oxidizing methacrolein produced by the method according to any [1] to [9], to produce methacrylic acid.

[11]: A method for producing methacrylic acid ester, including esterifying methacrylic acid produced by the method according to any [1] to [10], to produce methacrylic acid ester.

EFFECTS OF THE INVENTION

[0010]

According to the present invention, methacrolein and/or methacrylic acid can be produced at high selectivity with suppressed generation of a by-product in a method for producing methacrolein and/or methacrylic acid from isobutanol.

MODE FOR CARRYING OUT THE INVENTION

[0011]

Hereinafter, embodiments according to the present

mol or less, especially preferably 0.1% by mol or less, most preferably 0.01% by mol or less.

The lower limit of the content rate of isobutanol in the isobutanol-containing gas is preferably 5% by mol or more. Thus, the selectivity of isobutylene can be enhanced and the reactor 1 can be reduced in size, and therefore the facility cost and the energy cost can be reduced. The lower limit of the content rate of isobutanol is more preferably 10% by mol or more, further preferably 15% by mol or more, particularly preferably 20% by mol or more, especially preferably 30% by mol or more, most preferably 40% by mol or more. The upper limit of the content rate of isobutanol is not particularly limited, and can be, for example, 99.99% by mol or less.

The content rate of isobutanol in the isobutanol-containing gas can be adjusted with water vapor. The content rate of water vapor in the isobutanol-containing gas is preferably 0.01 to 80% by mol. Thus, the selectivity of isobutylene in step (i) is enhanced and the selectivity of methacrolein and methacrylic acid in step (ii) described below is enhanced. The upper limit of the content rate of water vapor is more preferably 80% by mol or less, further preferably 70% by mol or less, particularly preferably 60% by mol or less, especially preferably 50% by mol or less, most preferably 40% by mol or less.

[0025]

The isobutanol-containing gas may contain an inert gas having no influence on dehydration reaction. Examples of the inert gas include nitrogen, helium, neon, krypton, xenon, radon, argon, methane, ethane, propane, butane, isobutane, carbon monoxide, carbon dioxide, nitrogen monoxide, nitrogen dioxide, nitrous oxide, dinitrogen trioxide, dinitrogen tetraoxide and dinitrogen pentoxide.

[0026]

The oxidation catalyst here used can be a known catalyst, a catalyst containing at least molybdenum and bismuth is preferably used, and a catalyst having a composition represented by the following formula (1) is more preferably used.

$$Mo_{12}Bi_{a1}Fe_{a2}M_{a3}X_{a4}Y_{a5}Z_{a6}O_{a7} \quad (1)$$

In the formula (1), Mo, Bi, Fe and O respectively represent molybdenum, bismuth, iron, and oxygen. M represents at least one element selected from the group consisting of cobalt and nickel. X represents at least one element selected from the group consisting of chromium, lead, manganese, calcium, magnesium, niobium, silver, barium, tin, tantalum, and zinc. Y represents at least one element selected from the group consisting of phosphorus, boron, sulfur, selenium, tellurium, cerium, tungsten, antimony, and titanium. Z represents at least one element selected from the group consisting of lithium, sodium, potassium, rubidium, cesium and thallium. a1 to a7 each represent the atomic ratio of each element, a1 = 0.01 to 3, a2 = 0.01 to 5, a3 = 1 to 12, a4 = 0 to 8, a5 = 0 to 5, and a6 = 0.001 to 2 are satisfied, and a7 represents the atomic ratio of oxygen necessary for satisfying the atomic valence of each element described above.

The atomic ratio of each element is a value determined by analyzing each component in the catalyst dissolved in hydrochloric acid with ICP emission spectroscopy. ICP emission spectrometric analysis can be performed with, for example, Optima 8300 ICP-OES Spectrometer (product name, manufactured by Perkin Elmer).

The oxidation catalyst layer may be an undiluted layer of only the oxidation catalyst, or may be a diluted layer further including an inert carrier. The dehydration catalyst layer may be a single layer, or a mixed layer including a plurality of layers.