CLAIMS

1. A catalyst comprising at least molybdenum having a composition represented by the following formula, for use in production of an α,β-unsaturated aldehyde and/or an α,β-unsaturated carboxylic acid from an alkene, an alcohol, or an ether, wherein a COD (chemical oxygen demand) of the catalyst is greater than 300 ppm and less than 2,000 ppm.

$$Mo_{a1}Bi_{b1}Fe_{c1}M_{d1}X_{e1}Y_{f1}Si_{g1}(NH_4)_{h1}O_{i1}$$

(wherein in formula above, Mo, Bi, Fe, Si, NH_4, and O each represent molybdenum, bismuth, iron, silicon, an ammonium root, 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 zinc, chromium, lead, manganese, calcium, magnesium, niobium, silver, barium, tin, tantalum, tungsten, antimony, phosphorus, boron, sulfur, selenium, tellurium, cerium and titanium; Y represents at least one element selected from the group consisting of lithium, sodium, potassium, rubidium, cesium, and thallium; a1, b1, c1, d1, e1, f1, g1, h1, and i1 each represent a molar ratio of each component, and when a1 = 12, b1 = 0.01 to 3, c1 = 0 to 8, d1 = 0 to 12, e1 = 0 to 8, f1 = 0.001 to 2, g1 = 0 to 20, h1 = 0 to 30, and i1 is a molar ratio of oxygen required to satisfy a valence of the each component.)

2. A catalyst comprising at least molybdenum having a composition represented by the following formula, wherein a COD (chemical oxygen demand) of the catalyst is greater than 300 ppm and less than 11,000 ppm.

$$P_{a2}Mo_{b2}V_{c2}Cu_{d2}A_{e2}E_{f2}G_{g2}(NH_4)_{h2}O_{i2}$$

(wherein in formula above, P, Mo, V, Cu, NH_4, and O each represent phosphorus, molybdenum, vanadium, copper, an ammonium root, and oxygen; A represents at least one element selected from the group consisting of antimony, bismuth, arsenic, germanium, zirconium, tellurium, silver, selenium, silicon, tungsten and boron; E represents at least one element selected from the group consisting of iron, zinc, chromium, magnesium, calcium, strontium, tantalum, cobalt, nickel, manganese, barium, titanium, tin, lead, niobium, indium, sulfur, palladium, gallium, cerium, and lanthanum; G represents at least one element selected from the group consisting of lithium, sodium, rubidium, potassium, cesium and thallium; a2, b2, c2, d2, e2, f2, g2, h2 and i2 each represent a molar ratio of each component, and when b2 = 12, a2 = 0.5 to 3, c2 = 0.01 to 3, d2 = 0.01 to 2, e2 = 0 to 3, f2 = 0 to 3, g2 = 0 to 5, h2 = 0 to 30, and i2 is a molar ratio

of oxygen required to satisfy a valence of the each component.)

3. The catalyst according to claim 1, wherein a value obtained by dividing the COD value (ppm) by a value of specific surface area S (m^2/g) of the catalyst (COD/S) is greater than 43 $\mu g/m^2$ and 3600 $\mu g/m^2$ or less.

4. The catalyst according to claim 2, wherein a value obtained by dividing the COD value (ppm) by a value of specific surface area S (m^2/g) of the catalyst (COD/S) is greater than 43 $\mu g/m^2$ and 3600 $\mu g/m^2$ or less.

5. The catalyst according to claim 1 or 3, wherein the COD is from 400 to 1,500 ppm.

6. The catalyst according to any one of claims 1, 3 and 5, wherein a value obtained by dividing the COD value (ppm) by a value of specific surface area S (m^2/g) of the catalyst (COD/S) is from 45 to 500 $\mu g/m^2$.

7. The catalyst according to claim 2 or 4, for use in production of an α,β-unsaturated carboxylic acid from an α,β-unsaturated aldehyde.

8. The catalyst according to any one of claims 2, 4, and 7, wherein the COD is 2,500 ppm or greater and less than 11,000 ppm.

9. The catalyst according to any one of claims 2, 4, 7 and 8, wherein the COD is from 2,600 to 10,000 ppm.

10. The catalyst according to any one of claims 2, 4, and 7 to 9, wherein a value obtained by dividing the COD value (ppm) by a value of specific surface area S (m^2/g) of the catalyst (COD/S) is from 100 to 3,000 $\mu g/m^2$.

11. A method of producing a catalyst according to any one of claims 1, 3, 5 and 6, comprising at least molybdenum, wherein the method comprises the following steps (i) to (v):
(i) mixing at least a molybdenum raw material with a solvent to obtain a slurry (liquid

A);
(ii) stirring the liquid A at a temperature of 1 to 30°C lower than the boiling point of the solvent for 20 to 90 minutes to obtain a slurry (liquid B);
(iii) stirring the liquid B at a temperature of 2°C or higher than the temperature in the step (ii) for 10 minutes to 10 hours to obtain a slurry (liquid C);
(iv) drying the liquid C to obtain a dried product; and
(v) calcining the dried product to obtain a catalyst.

12. The method of producing the catalyst according to claim 11, wherein 50% by mass or more of the total solvent is water in the step (i).

13. The method of producing the catalyst according to claim 11 or 12, wherein the temperature in the step (iii) is 1 to 20°C higher than the boiling point of the solvent.

14. The method of producing a catalyst according to any one of claims 11 to 13, comprising stirring the liquid B for 90 minutes to 10 hours to obtain the liquid C in the step (iii).

15. The method of producing a catalyst according to any one of claims 11 to 14, comprising calcining the dried product under oxygen-containing gas distribution in the step (v).

16. A method of producing a catalyst according to any one of claims 2, 4, and 7 to 10, comprising at least molybdenum, wherein the method comprises the following steps (i) to (v):
(i) mixing at least a molybdenum raw material with a solvent to obtain a slurry (liquid A);
(ii) stirring the liquid A at a temperature of 1 to 30°C lower than the boiling point of the solvent for 20 to 90 minutes to obtain a slurry (liquid B);
(iii) stirring the liquid B at a temperature of 2°C or higher than the temperature in the step (ii) for 10 minutes to 10 hours to obtain a slurry (liquid C);
(iv) drying the liquid C to obtain a dried product; and
(v) calcining the dried product to obtain a catalyst.

17. The method of producing the catalyst according to claim 16, wherein 50% by

mass or more of the total solvent is water in the step (i).

18. The method of producing the catalyst according to claim 16 or 17, wherein the temperature in the step (iii) is 1 to 20°C higher than the boiling point of the solvent.

19. The method of producing a catalyst according to any one of claims 16 to 18, comprising stirring the liquid B for 90 minutes to 10 hours to obtain the liquid C in the step (iii).

20. The method of producing a catalyst according to any one of claims 16 to 19, comprising calcining the dried product under oxygen-containing gas distribution in the step (v).

21. The method of producing a catalyst according to any one of claims 16 to 20, comprising producing a catalyst used when an α,β-unsaturated carboxylic acid is produced from an α,β-unsaturated aldehyde.

22. A method of producing an α,β-unsaturated aldehyde and/or an α,β-unsaturated carboxylic acid, comprising producing the α,β-unsaturated aldehyde and/or the α,β-unsaturated carboxylic acid from an alkene, an alcohol or an ether by using the catalyst according to any one of claims 1, 3, 5, and 6.

23. A method of producing an α,β-unsaturated aldehyde and/or an α,β-unsaturated carboxylic acid, comprising producing the α,β-unsaturated aldehyde and/or the α,β-unsaturated carboxylic acid from an alkene, an alcohol or an ether by using a catalyst produced by the production method according to any one of claims 11 to 15.

24. A method of producing an α,β-unsaturated carboxylic acid, comprising producing the α,β-unsaturated carboxylic acid from an α,β-unsaturated aldehyde by using the catalyst according to any one of claims 2, 4, and 7 to 10.

25. A method of producing an α,β-unsaturated carboxylic acid, comprising producing the α,β-unsaturated carboxylic acid from an α,β-unsaturated aldehyde by using a catalyst produced by the production method according to any one of claims 16 to 21.

26. A method of producing an α,β-unsaturated carboxylic acid, comprising producing the α,β-unsaturated carboxylic acid from an α,β-unsaturated aldehyde produced by the production method according to claim 22 or 23.

27. A method of producing an α,β-unsaturated carboxylic acid ester, comprising producing the α,β-unsaturated carboxylic acid ester from an α,β-unsaturated carboxylic acid produced by the production method according to any one of claims 22 to 26.