Claims

[Claim 1]

A hydrogenation treatment catalyst for hydrocarbon oil comprising:

(1) a carrier being an inorganic composite oxide carrier that contains aluminum in an amount of 80 to 98 parts by mass in terms of alumina relative to 100 parts by mass of the carrier,

the carrier being such that the crystallite diameter of a pseudo-boehmite of alumina to be the main component in a precursor is 15 or more and 40 or less Å as obtained from the half-value width of the XRD diffraction spectral (020) peak thereof,

the carrier being such that the ratio of the absorbance of the spectral peak Sb in a wavelength range of 3770 to 3774 cm^{-1} corresponding to a basic OH group therein to the absorbance of the spectral peak Sa in a wavelength range of 3674 to 3678 cm^{-1} corresponding to an acidic OH group, as measured with a transmission Fourier transform IR spectrophotometer, the ratio of Sb/Sa is in a range of 0.20 to 0.45, and

the carrier being such that, when the diffraction peak area showing an aluminum crystal structure attributed to a boehmite (020) plane measured in the XRD diffraction

spectrum thereof is referred to as P1 and the diffraction peak area showing the aluminum crystal structure of a γ-alumina (440) plane is referred to as P2, the ratio of P2 to the total value of P1 and P2, P2/(P1 + P2) is 0.9 or more,

(2) a first metal component of at least one of molybdenum and tungsten, and a second metal component of at least one of cobalt and nickel are loaded on the carrier,

(3) the content of the first metal component is 15 to 27 parts by mass in terms of oxide relative to 100 parts by mass of the catalyst, and the content of the second metal component is 2 to 7 parts by mass in terms of oxide relative to 100 parts by mass of the catalyst,

(4) the specific surface area of the catalyst is 180 to 320 m^2/g, and the mean pore diameter of the catalyst, as measured according to a mercury intrusion method, is 50 to 110 Å,

(5) the ignition loss is 5.0% by mass or less,

(6) the amount of carbon derived from an organic acid is 2.0 parts by mass or less on an elemental basis relative to 100 parts by mass of the catalyst, and

(7) the adsorption amount of nitrogen monoxide on a sulfurized catalyst is 8.0 ml/g or more.

[Claim 2]

The hydrogenation treatment catalyst for hydrocarbon oil according to claim 1, wherein:

a. in the case of the carrier containing phosphorus, a

content of phosphorus is not larger than 5.0 parts by mass in terms of phosphoric acid relative to 100 parts by mass of the carrier,

b. in the case of the carrier containing silicon, a content of silicon is not larger than 3.0 parts by mass in terms of silica relative to 100 parts by mass of the carrier,

c. in the case of the carrier containing titanium, a content of titanium is not larger than 18.0 parts by mass–in terms of titania relative to 100 parts by mass of the carrier, and

d. in the case of the carrier containing zirconium, a content of zirconium is not larger than 9.0 parts by mass in terms of zirconium oxide relative to 100 parts by mass of the carrier.

[Claim 3]

A method for producing a hydrogenation treatment catalyst for hydrocarbon oil stated in claim 1, the method comprising:

(1) a step of preparing the inorganic composite oxide carrier,

(2) a step of preparing an impregnating liquid that contains a first metal component of at least one of molybdenum and tungsten, a second metal component of at least one of cobalt and nickel, and an organic acid, and making the first metal component and the second metal component loaded on the

inorganic composite oxide carrier, and

(3) a step of heat-treating the inorganic composite oxide carrier on which the first metal component and the second metal component have been loaded, as obtained in the previous step (2), at a temperature of 100 to 600°C to produce a hydrogenation treatment catalyst.

[Claim 4]

The method for producing a hydrogenation treatment catalyst for hydrocarbon oil according to claim 3, wherein the step (1) for preparing the inorganic composite oxide carrier comprises:

(1-1) a slurry preparing step of mixing

<a> an aqueous solution of a basic aluminum salt,

<b> an aqueous solution of an acidic aluminum salt, and

<c> a salt of an inorganic ingredient except aluminum, phosphoric acid, or phosphorous acid,

to prepare a composite metal hydrate slurry,

(1-2) a first aging step of aging the composite metal hydrate slurry,

(1-3) then a step of washing the composite metal hydrate slurry,

(1-4) thereafter, a second aging step of aging the composite metal hydrate slurry,

(1-5) subsequently, a kneading/concentrating step of

kneading and concentrating the composite metal hydrate slurry,

(1-6) a step of shaping the concentrated product obtained by concentrating the composite metal hydrate slurry, and

(1-7) a step of drying and calcining the shaped product, and wherein:

a first organic compound is added in the second aging step of the above (1-4).

[Claim 5]

The method for producing a hydrogenation treatment catalyst for hydrocarbon oil according to claim 4, wherein the aqueous solution of a basic aluminum salt in the slurry preparing step of the above (1-1) contains a carboxylate.

[Claim 6]

The method for producing a hydrogenation treatment catalyst for hydrocarbon oil according to claim 4, wherein the first organic compound is added in an amount of 0.5 to 4.0 parts by mass relative to 100 parts by mass of the inorganic composite oxide.

[Claim 7]

The method for producing a hydrogenation treatment catalyst for hydrocarbon oil according to claim 4, wherein in the kneading/concentrating step of the above (1-5), a second organic compound is added.

[Claim 8]

The method for producing a hydrogenation treatment

catalyst for hydrocarbon oil according to claim 7, wherein the second organic compound is added in an amount of 0.5 to 4.0 parts by mass relative to 100 parts by mass of the inorganic composite oxide.

[Claim 9]

The method for producing a hydrogenation treatment catalyst for hydrocarbon oil according to claim 4, wherein the inorganic composite oxide concentration in the slurry in the second aging step of the above (1-4) is less than 20%, and the inorganic composite oxide concentration in the slurry in the kneading/concentrating step of the above (1-5) is 20% or more.

[Claim 10]

The method for producing a hydrogenation treatment catalyst for hydrocarbon oil according to claim 4, wherein the first organic compound is at least one selected from citric acid, malic acid, tartaric acid, gluconic acid, acetic acid, ethylenediaminetetraacetic acid (EDTA), diethylenetriaminepentaacetic acid (DTPA), and saccharides (monoses, polyoses, etc.).

[Claim 11]

The method for producing a hydrogenation treatment catalyst for hydrocarbon oil according to claim 7, wherein the second organic compound is at least one selected from citric acid, malic acid, tartaric acid, gluconic acid, acetic acid, ethylenediaminetetraacetic acid (EDTA),

diethylenetriaminepentaacetic acid (DTPA), and saccharides (monoses, polyoses, etc.).

[Claim 12]

A hydrogenation treatment method for hydrocarbon oil comprising hydrogenating a hydrocarbon oil in the presence of a hydrogenation treatment catalyst stated in claim 1 under the conditions of a hydrogen partial pressure of 3 to 8 MPa, a temperature of 260 to 420°C and a liquid hourly space velocity of 0.3 to 5 hr^{-1}.