after 2 hours from start of reaction] × 100

[0028]

[Example 1]

A CuO-ZnO catalyst (Zn/Cu molar ratio: 0.35, sodium content: 0.03% by mass) was sieved so as to have a particle size of 0.5 mm to 1.7 mm. Then, 2 g of the CuO-ZnO catalyst sieved was mixed with copper granules (0.8 mm to 2 mm), so that a total amount of a resultant mixture was 3 mL. The mixture was charged into a monotubular fixed bed reactor (inner diameter: 12 mm) made of stainless steel. Subsequently, hydrogen (7 NmL/min) and argon (133 NmL/min) were caused to flow in the reactor, and a temperature of a catalyst layer was increased to 150°C. After that, temperature of the catalyst layer was increased at a rate of 1°C/min from 150°C to 300°C, and then was kept at 300°C for 2 hours.

[0029]

A mixed gas composed of carbon dioxide (24% by volume), hydrogen (72% by volume), and nitrogen (4% by volume) was supplied, into the reactor, at a temperature of 240°C, at a gauge pressure of 0.80 MPa-G, and at a flow rate of 250 NmL/min. Simultaneously, gasified water was supplied into the reactor at a flow rate of 0.01 g/min. The water vapor pressure at an inlet of the reactor at that time was calculated to be 47 kPa. Methanol could be thus obtained.

described above, in Comparative Example 2, the activity was low, and a significant decrease of the conversion was observed after 15 hours had elapsed from the start of supply of the raw material gas.

[0034]

[Example 3]

A CuO-ZnO catalyst (Zn/Cu molar ratio: 0.35, sodium content: 0.03% by mass) was sieved so as to have a particle size of 0.5 mm to 1.7 mm. Then, 2 g of the CuO-ZnO catalyst sieved was mixed with copper granules (0.8 mm to 2 mm), so that a total amount of a resultant mixture was 3 mL. The mixture was charged into a monotubular fixed bed reactor (inner diameter: 12 mm) made of stainless steel. Subsequently, hydrogen (7 NmL/min) and argon (133 NmL/min) were caused to flow in the reactor, and a temperature of a catalyst layer was increased to 150°C. After that, temperature was increased at a rate of 1°C/min from 150°C to 300°C, and then was kept at 300°C for 2 hours.

[0035]

A mixed gas composed of carbon dioxide (24% by volume), hydrogen (72% by volume), and nitrogen (4% by volume) was supplied, into the reactor, at a temperature of 240°C, at a gauge pressure of 0.80 MPa-G, and at a flow rate of 250 NmL/min. Simultaneously, 7 NmL/min of hydrogen gas was bubbled in water having a temperature of 25°C. A

[0039]

Hydrogen (7 NmL/min) and argon (133 NmL/min) were caused to flow in the reactor, and a temperature of a catalyst layer was increased to 150°C. After that, temperature was increased at a rate of 1°C/min from 150°C to 300°C, and then was kept at 300°C for 2 hours.

[0040]

A mixed gas composed of carbon dioxide (24% by volume), hydrogen (72% by volume), and nitrogen (4% by volume) was supplied, into the reactor, at a temperature of 240°C, at a cooling water temperature of 10°C, at a gauge pressure of 0.90 MPa-G, and at a flow rate of 50 NmL/min. Simultaneously, gasified water was supplied into the reactor at a flow rate of 0.01 g/min. The water vapor pressure at an inlet of the reactor at that time was calculated to be 196 kPa. Methanol could be thus obtained.

[0041]

The conversion of carbon dioxide which was a raw material was 43.6% after 2 hours from the start of contact of the raw material gas with the catalyst. The conversion of the carbon dioxide which was a raw material was 43.8% after 15 hours from the start of the contact of the raw material gas with the catalyst. Thus, the activity retention was 100%. As described above, in Example 5, the conversion hardly decreased even after 15 hours had elapsed from the start of

supply of the raw material gas.

[0042]

[Example 6]

Employed was the reactor employed in Example 5. A CuO-ZnO catalyst (Zn/Cu molar ratio: 0.35, sodium content: 0.03% by mass) was sieved so as to have a particle size of 0.5 mm to 1.7 mm. Then, 1.6 g of the CuO-ZnO catalyst sieved was mixed with copper granules (0.8 mm to 2 mm), so that a total amount of a resultant mixture was 18 mL. The mixture thus obtained was charged into a space between the main body of the reactor and the inner cylinder of the reactor.

[0043]

Hydrogen (7 NmL/min) and argon (133 NmL/min) were caused to flow in the reactor, and a temperature of a catalyst layer was increased to 150°C. After that, temperature was increased at a rate of 1°C/min from 150°C to 300°C, and then was kept at 300°C for 2 hours.

[0044]

A mixed gas composed of carbon dioxide (12% by volume), carbon monoxide (16% by volume), hydrogen (68% by volume), and nitrogen (4% by volume) was supplied, into the reactor, at a temperature of 240°C, at a cooling water temperature of 10°C, at a gauge pressure of 0.90 MPa-G, and at a flow rate of 50 NmL/min. Simultaneously, 7 NmL/min of hydrogen gas was bubbled in water having a temperature of

Claims

Claim 1

A method for producing methanol, the method comprising the step of bringing a raw material gas into contact with a catalyst to obtain methanol, the raw material gas containing carbon oxide, hydrogen, and water,

the catalyst containing

(i) copper and zinc at a molar ratio of the zinc relative to the copper (Zn/Cu) of 0.3 to 0.45, and

(ii) an alkali metal in an amount of 0.001% by mass to 0.05% by mass.

Claim 2

The method for producing methanol according to claim 1, wherein the alkali metal is sodium.

Claim 3

The method for producing methanol according to claim 2, wherein the catalyst contains sodium in an amount of 0.01% by mass to 0.05% by mass.