It is an object of the present invention to provide shaped catalyst bodies which do not have the aforementioned drawbacks of catalyst tablets and catalyst extrudates, thus having a substantially higher pore volume and a significantly lower bulk density in conjunction with at least comparable stability and activity in comparison to conventional, tableted catalysts.

This object is achieved in accordance with the invention by using, when processing powder catalyst material into extrudates, specific binders which lead to stable shaped catalyst bodies. Through the processing of the powder catalyst material into extrudates using binders which lead to stable shaped bodies and at the same time generate a high pore volume, it has been possible to produce shaped catalyst bodies which, for comparable stability, have a substantially higher pore volume than the conventional, tableted catalysts.

Summary of the disclosure

The disclosure relates to a shaped catalyst body in extruded form, comprising Cu in an amount in the range of 20 - 43 wt%, preferably in the range of 25 - 42 wt%, Al in an amount in the range of 20 - 40 wt%, preferably in the range of 25 - 34 wt%, and Mn in an amount in the range of 1 - 10 wt%, preferably in the range of 2 - 8 wt%, more preferably in the range of 3 - 6 wt%, based on the total weight of the shaped catalyst body in extruded form,

wherein the shaped catalyst body has a pore volume in the range from 250 to 700 mm^3/g, preferably in the range from 400 to 650 mm^3/g, more preferably in the range from 450 to 600 mm^3/g, determined by mercury intrusion to DIN 66133, a monomodal pore radius distribution and wherein 50% or more, preferably 70% or more, more preferably 80% or more of the pore volume is formed by pores having a pore radius in the range from 7 to 40 nm, the pore radius distribution and the pore volume being determined by mercury intrusion to DIN 66133.

The disclosure further relates to a process for producing Cu-, Al-, and Mn-containing shaped catalyst bodies (shaped Cu-Al-Mn catalyst bodies) in extruded form, the process comprising the following steps:

(a) combining (i) at least one aqueous solution of copper compounds, aluminum compounds, manganese compounds, and optionally transition metal compounds and (ii) at least one aqueous carbonate-containing solution to form a precipitate, isolating the precipitate, optionally washing the isolated precipitate, and drying the isolated precipitate to give a dried precipitate,

(b) mixing the dry precipitate obtained in step (a) with an aluminum-containing binder selected from the group consisting of boehmite and pseudoboehmite,

(c) extruding the mixture obtained in step (b), to give an extrudate, and

(d) calcining the extrudate obtained in step (c), at a temperature in the range from 300 to 750°C, preferably in the range from 600°C to 750°C, more particularly at about 750°C, to give an extruded shaped body.

The disclosure further relates to the use of Cu-Al-Mn catalysts of the disclosure for hydrogenating organic compounds, more particularly compounds which contain a carbonyl function.

Detailed description of the invention

The extruded shaped catalyst bodies of the invention comprise copper in an amount in the range of 20 - 43 wt%, preferably in the range of 25 - 42 wt%, more preferably in the range of 30 - 35 wt%, based on the

CLAIMS

1. A shaped catalyst body in extruded form, comprising Cu in an amount in the range of 20 - 43 wt%, preferably in the range of 25 - 42 wt%, Al in an amount in the range of 20 - 40 wt%, preferably in the range of 25 - 34 wt%, and Mn in an amount in the range of 1 - 10 wt%, preferably in the range of 2 - 8 wt%, more preferably in the range of 3 - 6 wt%, based on the total weight of the shaped catalyst body in extruded form,

wherein the shaped catalyst body has a pore volume in the range from 250 to 700 mm^3/g, preferably in the range from 400 to 650 mm^3/g, more preferably in the range from 450 to 600 mm^3/g, determined by mercury intrusion to DIN 66133, a monomodal pore radius distribution and wherein 50% or more, preferably 70% or more, more preferably 80% or more of the pore volume is formed by pores having a pore radius in the range from 7 to 40 nm, the pore radius distribution and the pore volume being determined by mercury intrusion to DIN 66133.

2. The shaped catalyst body as claimed in claim 1, having a bulk density in the range from 300 to 800 g/L, preferably in the range from 400 to 700 g/L, and more preferably in the range from 450 to 650 g/L, determined to DIN ISO 903.

3. The shaped catalyst body as claimed in claim 1 or 2, comprising at least one further metal selected from the group consisting of alkali metal, alkaline earth metal, rare earths, Fe, Ni, Cr, Co, Zn, and Zr.

4. The shaped catalyst body as claimed in any of claims 1 to 3, wherein the shaped body has a side crushing strength, based on the length of the extrudates, in the range from 5 to 40 N/mm, preferably in the range from 10 to 30 N/mm, the side crushing strength being determined to DIN EN 1094-5.

5. The shaped catalyst body as claimed in any of claims 1 to 4, wherein the shaped body has a diameter in the range from 1 to 6 mm, preferably in the range from 1.5 to 3.5 mm.

6. The shaped catalyst body as claimed in any of claims 1 to 5, wherein the shaped body has grooves in longitudinal direction having a depth in the range from 0.3 mm to 0.9 mm, preferably of about 0.7 mm, and a width in the range from 1.0 to 1.5 mm, preferably of about 1.2 mm.

7. The shaped catalyst body as claimed in any of claims 1 to 6, wherein the shaped catalyst body in reduced form has a Cu metal surface, based on the amount of Cu in the shaped catalyst body, in the range from 20 m^2/gCu to 60 m^2/gCu, preferably in the range from 25 m^2/gCu to 50 m^2/gCu, more preferably in the range from 30 m^2/gCu to 45 m^2/gCu, determined by N_2O pulse chemisorption.

8. A process for producing an extruded shaped catalyst body, comprising the following steps:

(a) combining (i) at least one aqueous solution of copper compounds, aluminum compounds, manganese compounds, and optionally transition metal compounds and (ii) at least one aqueous carbonate-containing solution to form a precipitate, isolating the precipitate, optionally washing the

isolated precipitate, and drying the isolated precipitate to give a dried precipitate,

(b) mixing the dry precipitate obtained in step (a) with an aluminum-containing binder selected from the group consisting of boehmite and pseudoboehmite,

(c) extruding the mixture obtained in step (b), to give an extrudate, and

(d) calcining the extrudate obtained in step (c), at a temperature in the range from 300 to 750°C, preferably in the range from 600°C to 750°C, more particularly at about 750°C, to give an extruded shaped catalyst body.

9. The process as claimed in claim 8, wherein step (b) comprises:

(b1) calcining dried precipitate obtained in step (a) at a temperature in the range from 250°C to 900°C, preferably at a temperature in the range from 300°C to 750°C, more preferably in the range from 600°C to 750°C, to give a calcined precipitate,

(b2) mixing dried precipitate obtained in step (a) with calcined precipitate obtained in step (b1) in a weight ratio of dried precipitate to calcined precipitate in the range from 2:98 to 98:2, preferably in the range from 10:90 to 90:10, more preferably in the range from 15:85 to 85:15, and very preferably in the range from 20:80 to 50:50, to give a mixture, and

(b3) mixing the mixture obtained in step (b2) with an aluminum-containing binder selected from the group consisting of boehmite and pseudoboehmite.

10. The process as claimed in claim 8 or 9, wherein the aluminum-containing binder is peptized by addition of an acid, preferably an organic acid, the peptizing taking place preferably before or during step (b).

11. The process as claimed in claim 10, wherein the organic acid is selected from acetic acid and citric acid.

12. The process as claimed in any of claims 8 to 11, wherein the mixture obtained from step (b) or step (b3) is admixed, prior to extrusion, with a lubricant in an amount in the range from 0.1 to 5 wt%, based on the total weight of the material to be extruded.

13. The process as claimed in any of claims 8 to 12, wherein the binder has a pore volume in the range of 300 - 700 mm^3/g, preferably in the range of 400 - 600 mm^3/g, and more preferably in the range of 450 - 550 mm^3/g, the pore volume being determined by mercury intrusion to DIN 66133.

14. The process as claimed in any of claims 8 to 13, wherein the binder has a particle size D_{50} in the range from 10 to 40 µm, preferably in the range from 15 to 35 µm, and more preferably in the range from 20 to 30 µm, determined by the laser diffraction method to DIN ISO 13320.

15. The process as claimed in any of claims 8 to 14, comprising the following step:

(e) reducing the extruded shaped catalyst body obtained in step (d) to give a reduced shaped catalyst body.

16. A shaped catalyst body obtainable by a process as claimed in any of claims 8 to 15.

17. The use of a shaped catalyst body as claimed in any of claims 1 to 7 and 16 for hydrogenating carbonyl compounds.