Claims

1. Continuous process for the synthesis of compounds comprising at least one amine functional group by hydrogenation of a compound comprising at least one nitrile functional group, characterized in that it consists in:

- ❖ feeding a gas comprising hydrogen and a nitrile compound to a reactor of plug-flow type in which circulates a reaction medium comprising suspended particles of catalyst based on Raney metal, an inorganic base and water,
- ❖ withdrawing, at the outlet of the plug-flow reactor, a portion of the reaction medium comprising the amine compound after separation of the catalyst and recycling the other portion to the plug-flow reactor,
- ❖ recycling the separated catalyst to the plug-flow reactor,
- ❖ feeding a stream of fresh catalyst to the plug-flow reactor,

and in that the flow rates for feeding nitrile compounds and/or catalyst to the plug-flow reactor are controlled in order to maintain a ratio P of the number of moles of nitrile compounds fed per unit of time to the flow rate by weight of catalyst in the plug-flow reactor of between 0.02 and 0.15 mol of nitrile compounds per kg of catalyst for a catalyst exhibiting an initial activity of between 15×10^{-5} and 35×10^{-5} mol of H_2/g of catalyst/s.

2. Process according to Claim 1, characterized in that the reaction medium comprises a solvent.

3. Process according to Claim 2, characterized in that the solvent is the amine produced by the hydrogenation reaction.

4. Process according to one of Claims 1 to 3, characterized in that the nitrile compound is adiponitrile, the amine synthesized being hexamethylenediamine.

5. Process according to one of the preceding claims, characterized in that it comprises, at the outlet of the plug-flow reactor, a region for decantation of the catalyst particles, the supernatant phase being recycled to the plug-flow reactor via a first external loop comprising a withdrawal of the medium comprising the amine, the decanted phase being recycled to the plug-flow reactor via a second external loop.

6. Process according to Claim 5, characterized in that it comprises withdrawing spent catalyst from the second external loop and feeding fresh catalyst at the inlet of the plug-flow reactor or to the second external loop.

7. Process according to Claim 6, characterized in that the fresh catalyst is composed of virgin catalyst, regenerated catalyst or a mixture of these.

8. Process according to one of Claims 5 to 7, characterized in that it comprises a determination of the concentration of catalyst in the second external loop in order to calculate the total weight of catalyst in the plug-flow reactor.

9. Process according to one of the preceding claims, characterized in that the catalyst is based on Raney nickel or Raney cobalt.

10. Process according to Claim 9, characterized in that the catalyst comprises a promoter chosen from the elements belonging to Groups IIB and IVB to VIIB of the Periodic Table of the Elements and their combinations.

11. Process according to one of the preceding claims, characterized in that the inorganic base is chosen from the group consisting of LiOH, NaOH, KOH, RbOH, CsOH and their mixtures.

12. Process according to Claim 11, characterized in that the inorganic base is chosen from the group consisting of KOH and NaOH and their mixtures.

13. Process according to one of the preceding claims, characterized in that the reaction temperature is between 50°C and 150°C and the hydrogen pressure is between 0.1 MPa and 10 MPa.

Claims

1. A continuous process for the synthesis of compounds containing at least one amine functional group by hydrogenation of compounds containing at least one nitrile functional group, comprising:

feeding a gas which comprises hydrogen and a nitrile compound to a plug-flow reactor in which circulates a reaction medium comprising suspended particles of catalyst based on Raney metal, an inorganic base and water;

withdrawing, at the outlet of the plug-flow reactor, a portion of the reaction medium comprising the amine compound after separation of the catalyst and recycling the other portion to the plug-flow reactor;

recycling the separated catalyst to the plug-flow reactor;

feeding a stream of fresh catalyst to the plug-flow reactor;

and further wherein the flow rates for feeding nitrile compounds and/or catalyst to the plug-flow reactor are controlled as to maintain a ratio P of the number of moles of nitrile compounds fed per unit of time to the flow rate by weight of catalyst in the plug-flow reactor of from 0.02 to 0.15 mol of nitrile compounds per kg of catalyst for a catalyst exhibiting an initial activity of from 15×10^{-5} to 35×10^{-5} mol of H_2/g of catalyst.

2. The continuous process as defined by claim 1, wherein the reaction medium comprises a solvent.

3. The continuous process as defined by claim 2, wherein the solvent comprises the amine produced by the hydrogenation reaction.

4. The continuous process as defined by claim 1, wherein the nitrile compound is adiponitrile and the amine synthesized is hexamethylenediamine.

5. The continuous process as defined by claim 1, whereat the outlet of the plug-flow reactor is a region for decantation of the catalyst particles, the supernatant phase being recycled to the plug-flow reactor via a first external loop comprising a withdrawal of the medium comprising the amine, the decanted phase being recycled to the plug-flow reactor via a second external loop.

6. The continuous process as defined by claim 5, comprising withdrawing spent catalyst from the second external loop and feeding fresh catalyst at the inlet of the plug-flow reactor or to the second external loop.

7. The continuous process as defined by claim 6, wherein the fresh catalyst comprises virgin catalyst, regenerated catalyst or mixture thereof.

8. The continuous process as defined by claim 5, comprising a determination of the concentration of catalyst in the second external loop in order to calculate the total weight of catalyst in the plug-flow reactor.

9. The continuous process as defined by claim 1, wherein the catalyst is based on Raney nickel or Raney cobalt.

10. The continuous process as defined by claim 9, wherein the catalyst comprises a promoter selected from the elements of Groups IIB and IVB to VIIB of the Periodic Table of the Elements and combinations thereof.

11. The continuous process as defined by claim 1, wherein the inorganic base is selected from the group consisting of LiOH, NaOH, KOH, RbOH, CsOH and mixture thereof.

12. The continuous process as defined by claim 11, wherein the inorganic base is selected from the group consisting of KOH and NaOH and mixture thereof.

13. The continuous process as defined by claim 11, wherein the amount of base in the reaction medium ranges from 0.1 mol of base per kg of catalyst to 2 mol of base per kg of catalyst.

14. The continuous process as defined by claim 1, wherein the reaction temperature ranges from 50° C. to 150° C. and the hydrogen pressure ranges from 0.1 MPa to 10 MPa.