Claims

1. Method for producing 2-hydroxy-4-(methylthio)butyronitrile, in which 3-methylmercaptopropionaldehyde is reacted with hydrogen cyanide in the presence of a base as catalyst in a main reaction zone to form the nitrile and residual amounts of gaseous hydrogen cyanide which leave the main reaction zone are absorbed in an absorption and post-reaction zone comprising a device for contacting a gas with a liquid and containing a mixture of 3-methylmercaptopropionaldehyde and catalyst and optionally 2-hydroxy-4-(methylthio)butyronitrile and are further reacted, ~~:~~wherein

~~2. Method according to claim 1, characterized in that~~ the mixture contained in the absorption and post-reaction zone originates at least partially from the main reaction zone and wherein the molar ratio of prussic acid to 3-(methylthio) propanal is 0.99 to 1.01.

~~3.~~2. Method according to claim 1, characterized in that the main reaction zone contains a stirred reactor or loop reactor.

~~4.~~3. Method according to claim ~~3~~2, characterized in that the main reaction zone additionally contains a jet pump.

~~5.~~ 4.Method according to any one of claims 1 to ~~4~~3, characterized in that the device for contacting a gas with a liquid is a column, in particular a tray column, a packed-bed column, a bubble-column reactor, a droplet column or optionally a reactor having a mechanically agitated container, a submerged jet reactor or a jet pump.

6.5. Method according to any one of claims 1 to 54, characterized in that the absorption and post-reaction zones are part of a loop reactor.

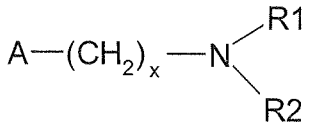
7.6. Method according to any one of claims 1 to 65, characterized in that substantially gaseous hydrogen cyanide is introduced into the main reaction zone, preferably a hydrogen-cyanide-containing product gas from a plant for producing hydrogen cyanide.

8.7. Method according to claim 76, characterized in that the hydrogen cyanide content of the gas used is 1 to 99% by weight, preferably 5 to 75% by weight, particularly preferably 6-22% by weight.

9.8. Method according to any one of claims 1 to 87, characterized in that the catalyst used is low-molecular-weight or heterogeneous amines, solutions of inorganic bases, or mixtures of acids and low-molecular-weight amines.

10.9. Method according to claim 98, characterized in that the low-molecular-weight amines are tri-(C_1-C_{12}-alkyl)amines, preferably triethylamine or triisopropanolamine, dialkylaralkylamines, preferably dimethylbenzylamine, dialkylarylamines, preferably N,N-dimethylaniline, heterocyclic amines, preferably nicotinamide, imidazole, benzimidazole, 2-fluoropyridine, 4-dimethylaminopyridine, picoline or pyrazine.

11.10. Method according to claim 98, characterized in that heterogeneous amines of the general formula



formula I

or polyvinylpyridine are used, wherein

R_1 and R_2 are hydrogen, alkyl having chain lengths between C_1 and C_{12}, aryl or heteroaryl;
R_1 can be different from R_2
X is a number between 0 and 6, and
A is a natural or synthetic resin, preferably a polystyrene.

~~12.~~11. Method according to claim ~~11~~10, characterized in that the catalyst according to formula I is a polymer-bound base selected from the group of homologous dialkylaminoalkylpolystyrenes or dialkylaminomacroreticular resins.

~~13.~~12. Method according to claim ~~12~~11, characterized in that the catalyst according to formula I is diethylaminoethylpolystyrene, diethylaminomethylpolystyrene, dimethylaminomethylpolystyrene, diethylaminomethylmacroreticular resin or dimethylaminoethylpolystyrene.

~~14.~~13. Method according to claim ~~9~~8, characterized in that the inorganic base used is alkali metal hydroxide, preferably NaOH or KOH, alkali metal cyanide, preferably NaCN or KCN, alkali metal carbonate, preferably Na_2CO_3 or K_2CO_3, or alkali metal hydrogencarbonate, preferably $NaHCO_3$ or $KHCO_3$, alone or in mixed form.

~~15.~~14. Method according to claim ~~9~~8, characterized in that the acid used in the mixtures of acids and low-molecular-weight amines is organic acids, preferably short-chain fatty acids, in particular acetic acid, formic acid, citric acid, or organic sulfonic acids, preferably trifluoromethanesulfonic acid or mineral acids, preferably sulfuric acid or phosphoric acid.

~~16.~~15. Method according to any one of claims 1 to ~~15~~14, characterized in that a pH of 4.5 to 6.0 is set, preferably 5.0-5.5, measured using a pH electrode at 23°C and a water content of 2 to 14% by weight in the main reaction zone and the absorption and post-reaction zone.

~~17.~~16. Method according to any one of claims 1 to ~~16~~15, characterized in that the main reaction zone is operated at a temperature of 20°C to 80°C, preferably 30°C to 70°C, particularly preferably 35°C to 65°C.

~~18.~~17. Method according to any one of claims 1 to ~~17~~16, characterized in that the absorption and post-reaction zone is operated at a temperature of 0°C to 30°C, preferably 4°C to 15°C.

~~19.~~18. Method according to any one of claims 1 to ~~18~~17, characterized in that a further post-reaction zone is operated at a temperature of 20°C to 80°C, preferably 40°C to 70°C, particularly preferably 45°C to 65°C, upstream of the MMP-cyanohydrin product discharge site for completing the reaction of HCN and MMP to form the MMP-cyanohydrin.

~~20.~~19. Method according to any one of claims 1 to ~~19~~18, characterized in that an absolute pressure of 0.9 to 5 bar, preferably 1.0 to 3 bar, particularly preferably 1 to 1.5 bar, is employed.

~~21. Method according to any one of claims 1 to 20, characterized in that the molar ratio of prussic acid to 3-(methylthio)propanal is 0.98 to 1.03, preferably 0.99 to 1.01.~~

~~22.~~20. Method according to any one of claims 1 to ~~21~~19, characterized in that a weight ratio of catalyst to 3-(methylthio)propanal of 0.00005 to 0.002, preferably 0.0001 to 0.001, is used.

~~23.~~21. Method according to any of claims 1 to ~~22~~20, characterized in that the method is carried out batchwise, semicontinuously, or continuously.

~~24.~~22. Use of a reaction product containing MMP-cyanohydrin produced according to any one of claims 1 to ~~23~~21 for producing D,L-methionine or 2-hydroxy-4-methylthiobutyric acid.