SYNTHESIS OF HIGHER ALIPHATIC ALKYLPOLYAMINES

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The widely used antimicrobial preparations, the so-called TEGO-disinfectants, are prepared by the reaction between higher alkylpolyamines and monochloroacetic acid, or its alkali metal salts [1, 2]. The advantages of the preparations of this group over bactericidal preparations of other classes are the broad spectrum of their antimicrobial and fungicidal action, low toxicity to warm-blooded animals, and good detergent properties [3]. It was found that salts of higher alkylpolyamides have strong bactericidal action [4].

Aliphatic alkylpolyamines are obtained by the reaction between alkyl halides and polyamines. The few data [5-7] available on the preparation of the above compounds show that at present there are no methods for the synthesis of these compounds in a high yield. If the reaction is carried out under relatively mild conditions in an organic solvent, the end products can be obtained in a 50% yield only [5]. The synthesis of alkylpolyamines by heating mixtures of alkyl halides with polyamines in a ratio of 1:5 gives a maximal yield of alkylpolyamines of not more than 70% [6, 7]. The low yield of the compounds can probably be explained by the secondary formation of dialkylpolyamines.

We should note that higher alkylpolyamines have high boiling points and are strongly resinified even on distillation *in vacuo*. In industry, Dowtherm and vacuum flash distillation must be used for their isolation. This makes it difficult to organize the industrial production of disinfecting agents based on higher alkylpolyamines.

The aim of the present investigation was to increase the yield of alkylpolyamines and simplify the process for their isolation.

We therefore studied in detail the alkylation of polyamines by higher alkyl halides. We found that together with the preparation of the main product, α,ω-dialkylpolyamines (II) are formed, and resinification takes place.

$$RX + NH_2(CH_2CH_2NH)_nCH_2CH_2NH_2 \longrightarrow \underset{\text{I a–f}}{RNH(CH_2CH_2NH)_nCH_2CH_2NH_2} +$$

$$+ \underset{\text{II a–f}}{RNH(CH_2CH_2NH)_nCH_2CH_2NHR}$$

$X = Cl$, Br; R = aliphatic radical with a normal structure; Ia, IIa: $R = C_{12}H_{25}$, $n = 1$, Ib IIb $R = C_{10}H_{23}—C_{13}H_{27}$, $n = 1$; Ia IIf. $R = C_8H_{17}$, $n = 1$; I d II d $R = C_{12}H_{25}$, $n = 0$; I e IIe: $R = C_{10}H_{21}$, $n = 0$; I f IIf: $R = C_8H_{17}$, $n = 2$.

To suppress the formation of II, the reaction between the components must take place with a large excess of polyamine. This can be achieved, firstly, by slow addition of alkyl halide to the polyamine heated to the required temperature for carrying out the process with constant stirring of the reaction mixture, and, secondly, by increasing the excess of polyamine above the previously proposed 4-molar excess [6]. We found that when higher alkyl chlorides are used as the alkyl halide, the optimal time for their addition to the polyamine is 5 h, and when alkyl bromides are used, 2 h are sufficient at the same reaction temperature. It was shown that the yield of I is maximal when alkyl chlorides are used at an alkyl halide/polyamine ratio of 1:10, and in the case of alkyl bromides, 1:6. To decrease the resinification of the reaction mixture, the alkylation and the removal of unreacted polyamine should be carried out in an atmosphere of an inert gas, which should be bubbled through the liquid layer. When these conditions are maintained, the yield of I can be increased to 93-98.5%.

Because of the formation of small amounts of side products, the purification of the end product is considerably simplified.

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It is known [6] that at a ratio of I/polyamine = 1:4–5, the reaction mixture separates into two layers: upper — I with an admixture of polyamine, lower — polyamine and its hydrochloride, formed in the course of the reaction. According to the method which we developed, the procedure for isolating I from the reaction mixture consists in the following: First, the excess of the relatively low-boiling polyamine is removed by evaporation *in vacuo* to a ratio I/polyamine = 1:4, and after cooling, the lower layer is separated, and residues of polyamine are distilled *in vacuo* from the upper layer. We should note that when ethylenediamine is used, the layers are separated at 1:10 ratio between the components. The distillation of polyamine *in vacuo* from the reaction mixture should be carried out in an inert gas atmosphere. In such a case, the still residue consists of 95-97% of I. The lower layer is treated with alkali to decompose the polyamine hydrochlorides, and the polyamines are distilled. The regenerated polyamines can be used again. Our method for the preparation and isolation of I was successfully approved for the preparation of the disinfecting agent Ampholan on an industrial scale.

EXPERIMENTAL

The purity of the compounds was controlled by chromatography on Silufol-254 plates in an isopropanol—25% aqueous ammonia (6:1) system. To detect the spots, we used a 1% alcoholic solution of ninhydrin.

Dodecylaminoethylamine (Ia). Method A. A 11.8 g portion (0.058 mole) of dodecyl chloride is added dropwise during 5 h with stirring and continuous bubbling of nitrogen to 60 g (0.58 mole) of diethylenetriamine heated to 140°C. The mixture is held for 1 h at 160°C, and then about half of the unreacted diethylenetriamine is distilled *in vacuo* in a nitrogen atmosphere. The remaining reaction mixture separates into two layers. From the upper layer, the residues diethylenetriamine are distilled *in vacuo*. At the end of the distillation, the temperature in the reactor is increased (50° above the boiling point of diethylenetriamine), and the still residue is cooled *in vacuo* in a nitrogen atmosphere, to yield 15.0 g (97.6%) of Ia, bp 178-180°C (3 mm Hg), R_f 0.25. Found, %: C 70.86; H 13.84; N 15.51. $C_{16}H_{37}N_3$. Calculated, %: C 70.78; H 13.73; N 15.49.

Method B. The synthesis is carried out as above, but dodecyl bromide is used as the alkyl halide. The temperature for carrying out the reaction is 140°C, the time of addition of dodecyl bromide 2 h, and the ratio alkyl halide/polyamine is 1:6. Yield, 15.15 g (98.5%) of Ia.

Compounds I_{b-f} are obtained by method A, but the temperature for carrying out the preparation of $I_{d,e}$ is 110-120°C, and I_f 160-180°C.

Compound I_b: yield 97%, bp 185-215°C (5 mm Hg); I_c: yield 98%, bp 190-192°C (10 mm Hg); I_d: yield 97%, mp 36-38°C, bp 132-135°C (12 mm Hg); I_e: yield 93.5%, bp 162-163°C (45 mm Hg); I_f: yield 93%, bp 170-176°C (2 mm Hg). The parameters of compounds I_{c-f} coincide with the literature data [5].

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