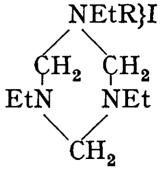
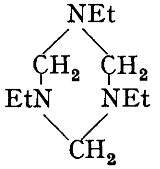
366. *The Cyclic Methyleneimines. Part II. Hydrolysis of Quaternary Compounds and Preparation of Aliphatic Secondary Amines.*

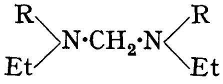
By Raymond Blundell and John Graymore.

NN'N''-Trimethyltrimethylenetriamine combines readily with *n*-alkyl iodides to give quaternary compounds, although where the reaction is slow the product is admixed with di-iodides of the base. Secondary amines may be prepared in moderate yield from the quaternary compounds by a modification of the method previously used. Ethyl, butyl, and propyl chlorides do not appear to form quaternary compounds with the base.

In Part I (J., 1938, 1311) it was shown that *NN'N''*-triethyltrimethylenetriamine forms quaternary derivatives (I) which are readily hydrolysed in aqueous solution to give, after addition of alkali, a mixture of the original cyclic methyleneimine (II) and the condensation product of a secondary amine with formaldehyde (III).


(I.)


(II.)


(III.)

The method is not of general application, because (*a*) in some cases the boiling points of the two products of hydrolysis lie too close for separation to be readily effected and (*b*) trimethyltrimethylenetriamine forms a troublesome addition compound with sodium iodide which separates in the presence of sodium hydroxide. In the present experiments, which are concerned with the trimethyl base, the formaldehyde was driven off subsequent to hydrolysis and the resultant methylamine separated from the secondary amine by means of the insolubility of its hydrochloride in chloroform.

Although *n*-alkyl iodides react readily in the cold with the cyclic base, the rate of formation of the quaternary compounds diminishes with increasing molecular weight. Ethyl iodide combines immediately with great vigour, and if the mixture gets warm the only solid product isolated is the di-iodide of the cyclic methyleneimine (I, R = I); under such conditions the quaternary derivative decomposes. *n*-Butyl iodide reacts very slowly with no apparent development of heat, the iodine content of the product indicating that the quaternary derivative is in all probability admixed with the di-iodide of the base. Thus it appears that the base, like trimethylamine, promotes the separation of iodine from the alkyl halide. *iso*Propyl iodide, not unexpectedly, gave a very small yield; attempts to improve it by refluxing on the water-bath produced oils with a high iodine content. This is without doubt due to the formation of di- and tetra-iodides. Ethyl, *n*-propyl and *n*-butyl chlorides do not combine. Secondary amines could be obtained in moderate yield from the ethiodide, the propiodide and the butiodide.

EXPERIMENTAL.

NN'N''-Trimethyltrimethylenetriamine was prepared by condensation of methylamine (33%) with formaldehyde (40%). The alkyl iodides were redistilled from phosphoric oxide and stored over mercury until required. Further quantities of the base were prepared from the methylamine hydrochloride recovered in the initial experiments.

NN'N''-*Trimethyltrimethylenetriamine Ethiodide*.—To 10 c.c. (9 g.) of the base, dried and redistilled from barium oxide and cooled in ice–salt, ethyl iodide (6 c.c.) was gradually added. After 12 hours, a portion of the solid white product was washed with dry ether and dried between porous sheets, giving a white crystalline *ethiodide*, m. p. 72° (decomp.) (Found: I, 44·3. $C_8H_{20}N_3I$ requires I, 44·6%).

Hydrolysis of the ethiodide. A solution of the remainder of the ethiodide in hydrochloric acid was separated from unchanged iodide, steam-distilled to remove formaldehyde, evaporated to small bulk on the water-bath, and distilled after addition of sodium hydroxide. The distillate was collected in hydrochloric acid, and the solution evaporated on the water-bath to incipient crystallisation; after rapid cooling, the crystals were removed and washed with warm chloroform, and the undissolved methylamine hydrochloride filtered off. The original mother-liquor, evaporated further, was thus gradually separated into a chloroform solution and a residue of methylamine hydrochloride (10 g.), m. p. and mixed m. p. 226°. The chloroform extract, evaporated on the water-bath, gave a deliquescent solid melting indefinitely at 120°. Purification was effected by conversion into the nitrosoamine, which after decomposition yielded methylethylamine hydrochloride (3·5 g.), m. p. 124° (Found: Cl, 37·1. Calc. for C_3H_9N,HCl: Cl, 37·2%).

NN'N''-*Trimethyltrimethylenetriamine* n-*Propiodide*.—The base (19—20 g.) was cooled in ice-water, and *n*-propyl iodide (25 g.) added during 1 hour. The mixture was kept for 2 days in the dark, the n-*propiodide* separating in small white needles. A portion, washed with dry ether and rapidly dried, had m. p. 105° (decomp.) after sintering at 100° (Found: I, 42·5. $C_9H_{22}N_3I$ requires I, 42·5%).

Hydrolysis. This was carried out, and the mixed amines collected and separated, as in the previous experiment. The yield of methylamine hydrochloride was 20 g. The chloroform solution was evaporated, water added to the residue, and the solution boiled to remove the last trace of chloroform (this was essential if the presence of *iso*cyanide in the final product was to be avoided). The aqueous solution was evaporated on the water-bath, the residual deliquescent mass treated with an excess of concentrated sodium hydroxide solution with cooling, and the secondary amine distilled into a receiver containing anhydrous barium oxide; after several hours, distillation gave methyl-*n*-propylamine (8 g.), b. p. 62—65°, which was identified by its hydrochloride, m. p. 140° (Found: Cl, 32·3. Calc. for $C_4H_{11}N,HCl$: Cl, 32·4%). The base reacted with a saturated alcoholic solution of 2 : 4-dinitrochlorobenzene to give 2 : 4-*dinitrophenylmethyl*-n-*propylamine* in orange needles, m. p. 72—73° (Found: N, 17·3. $C_{10}H_{13}O_4N_3$ requires N, 17·6%).

Methylenebismethyl-n-*propylamine*.—Formaldehyde (3 c.c. of 40%) was added to methyl-*n*-propylamine hydrochloride (5 g.) dissolved in water, and the mixture made alkaline by the gradual addition of aqueous sodium hydroxide. On addition of solid sodium hydroxide with cooling, an oily layer separated, which was extracted with ether, dried over barium oxide, and distilled, giving *methylenebismethyl*-n-*propylamine* (3 c.c.), b. p. 170—171°, $d_{4^\circ}^{19^\circ}$ 0·795 (Found: N, 17·8; *M*, by vapour density, 146. $C_9H_{22}N_2$ requires N, 17·7%; *M*, 158). Hydrolysis with dilute hydrochloric acid gave formaldehyde and methyl-*n*-propylamine hydrochloride, m. p. 140° (2 : 4-dinitrophenylmethyl-*n*-propylamine, m. p. and mixed m. p. 72—73°).

NN'N''-*Trimethyltrimethylenetriamine–sodium iodide*, obtained in white needles by the addition of a saturated aqueous solution of sodium iodide to the base, was soluble in water and separated on the addition of concentrated sodium hydroxide solution (Found: I, 45·5. $C_6H_{15}N_3,NaI$ requires I, 45·5%).

NN'N''-*Trimethyltrimethylenetriamine* n-*Butiodide*.—The base (22 c.c.) was added to redistilled *n*-butyl iodide (18 c.c.). Crystals began to separate after a few hours. A portion of the n-*butiodide* was extracted, washed with dry ether, and dried; m. p. 123—125° (decomp.) (Found:

I, 41·6. $C_{10}H_{24}N_3I$ requires I, 40·6%). Samples taken at later intervals showed increased iodine content. After being kept in the dark for 3 days, the mixture became practically solid.

Hydrolysis. (*a*) A solution of the solid in water was acidified with hydrochloric acid and evaporated on the water-bath with frequent addition of water. Oily drops separated as water was added in the early stages. The last traces of formaldehyde were removed very slowly. Methylamine hydrochloride (21—22 g.) was separated from the mixed hydrochlorides as before.. Evaporation of the chloroform solution yielded crude methyl-*n*-butylamine hydrochloride (13 g.), m. p. 165—173°. The hydrochloride was decomposed with concentrated sodium hydroxide solution, and the base distilled on to barium oxide and redistilled, giving a liquid (9 c.c.), b. p. 86—97°. This was shown to be a mixture of methyl-*n*-butylamine with some dimethyl-*n*-butylamine by conversion of the former into its nitrosoamine, b. p. 195—198° (Found : N, 24·3. Calc. for $C_5H_{12}ON_2$: N, 24·1%), and distillation of the residue from sodium hydroxide into hydrochloric acid. Evaporation yielded a small quantity of solid, m. p. 183—185° (Found : Cl, 25·5. $C_6H_{15}N,HCl$ requires Cl, 25·8%). The base obtained from this *hydrochloride* and concentrated sodium hydroxide solution was distilled into an alcoholic solution of picric acid; *dimethyl*-n-*butylamine picrate* separated in needles, m. p. 99·5—100·5° (Found : N, 17·1. $C_6H_{15}N,C_6H_3O_7N_3$ requires N, 17·0%).

(*b*) The method was similar to (*a*) save that the quaternary iodide was dissolved in excess of hydrochloric acid and steam-distilled to remove formaldehyde (about 5 hrs.). Separation gave a pure sample of *methyl*-n-*butylamine hydrochloride*, m. p. 171° (Found : Cl, 28·5. $C_5H_{13}N,HCl$ requires Cl, 28·7%). Methyl-*n*-butylamine, b. p. 90—92°, was recovered by addition of sodium hydroxide, distillation on to barium oxide, and redistillation. Yield, 7 c.c. (approx. 40%). When a slight excess of this base was added to an aqueous alcoholic solution of 2 : 4-dinitrochlorobenzene, and the solution allowed to evaporate, golden needles of 2 : 4-*dinitrophenylmethyl*-n-*butylamine*, m. p. 81°, separated slowly (Found : N, 16·7. $C_{11}H_{15}O_4N_3$ requires N, 16·6%).

NN′N″-*Trimethyltrimethylenetriamine di-iodide* was obtained by addition of the base in chloroform to iodine in chloroform until the colour of the latter was discharged. The di-iodide was deposited in white crystals on the addition of ethyl acetate; m. p. 162° (Found : I, 66·1. $C_6H_{15}N_3I_2$ requires I, 66·3%).

n-Butyl chloride and *n*-propyl chloride did not give any quaternary derivative.

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