[CONTRIBUTION FROM THE CHEMISTRY LABORATORY OF THE UNIVERSITY OF MICHIGAN]

Nitration of Ethyl Hydantoate and of the Methylamide of Hydantoic Acid[1]

BY W. E. BACHMANN AND CHARLES E. MAXWELL III[2]

As part of a study of the preparation of nitramines the methylamide of hydantoic acid (II), prepared from ethyl hydantoate (I) and methylamine, was treated with 98% nitric acid. The product was a mononitro derivative. Of the three possible positions, NH_2, NH, $NHCH_3$, available for reaction, the NH_2 group was attacked with the formation of IV. The presence of an NO_2NH group was indicated by the acidic properties of the compound, which is able to liberate carbon dioxide from sodium bicarbonate. That the NO_2 group was not on the methylamide nitrogen was shown by the formation of IV by the action of methylamine on the nitro derivative (III) obtained by nitration of ethyl hydantoate. The absence of an NO_2 group on the central nitrogen atom was shown by the reaction of III with aniline to give ethyl δ-phenylhydantoate, C_6H_5NH-$CONHCH_2COOC_2H_5$.

$$\begin{tikzcd}
H_2N\text{—}CONHCH_2COOC_2H_5 \arrow[r] \arrow[d, "\text{I}"] & H_2N\text{—}CONHCH_2CONHCH_3 \arrow[d, "\text{II}"] \\
O_2N\text{—}NHCONHCH_2COOC_2H_5 \arrow[r] & O_2N\text{—}NHCONHCH_2CONHCH_3 \\
\text{III} & \text{IV}
\end{tikzcd}$$

Experimental

Nitration of Ethyl Hydantoate.—The procedure for preparing ethyl hydantoate was similar to that of Harries and Weiss.[3] A warm (45–50°) solution of 16.2 g. of potassium cyanate in 21.6 cc. of water was added in one portion to a solution of 27.8 g. of glycine ethyl ester hydrochloride in 16 cc. of water. The resulting clear solution, now at 85°, was warmed on a steam-bath for fifteen minutes and then chilled to 0°. The colorless crystals of ethyl hydantoate were collected on a filter and washed with a little water and alcohol; yield 26.9 g. (93%); m. p. 137–138° (reported,[3] 135°).

After the slow addition of 4.32 g. of ethyl hydantoate to 15 cc. of colorless 98% nitric acid at 0°, the mixture was kept at 0° for fifteen minutes and then poured into cracked ice. On addition of 60–70° petroleum ether to a hot solution of the dried product in acetone, the **ethyl δ-nitrohydantoate (III)** crystallized in colorless needles; yield 2.54 g.; m. p. 103–105°. From chloroform–petroleum ether the nitro derivative crystallized in colorless cubes; m. p. 113–114.5°. A mixture of the dimorphic forms melted at 113–114.5°. The higher-melting cubes can be converted into the lower-melting needles by recrystallization from acetone–petroleum ether. The nitro compound forms water-soluble salts with sodium bicarbonate and with aqueous ammonia; acidification of the solutions of the salts regenerates the nitro compound unchanged.

Anal. Calcd. for $C_5H_9N_3O_5$: C, 31.4; H, 4.7. Found: C, 30.7; H, 4.9.

Methylamide of Hydantoic Acid (II).—A solution of 7.3 g. of ethyl hydantoate in 50 cc. of 33% aqueous methylamine was allowed to stand for sixteen hours. The residue remaining after evaporation crystallized from alcohol in colorless prisms; the first crop (4.27 g., m. p. 176–177°) and second crop (0.72 g.) were combined and recrystallized, m. p. 180–180.5°.

Anal. Calcd. for $C_4H_9N_3O_2$: N, 32.0. Found: N, 31.8.

Methylamide of δ-Nitrohydantoic Acid (IV). (a) **By Nitration of the Methylamide.**—The amide (1.31 g.) was added slowly to 4.3 cc. of 98% nitric acid with cooling in the course of fifteen minutes. A clear solution resulted when the mixture was poured into water; slow evaporation of the aqueous solution yielded 0.5 g. of colorless plates, m. p. 158–158.5°, after recrystallization from alcohol.

Anal. Calcd. for $C_4H_8N_4O_4$: C, 27.3; H, 4.6; N, 31.8. Found: C, 27.4; H, 4.3; N, 31.9.

(b) **From Methylamine and Ethyl δ-Nitrohydantoate.**—A solution of 3.82 g. of the nitro derivative in 20 cc. of 33% aqueous methylamine was allowed to stand for sixteen hours and then concentrated on a steam-bath to about 10 cc. After making the cooled solution acid to congo red with concentrated hydrochloric acid, the product (3.4 g.) was collected. After recrystallization from alcohol the compound melted at 159–160°, alone and when mixed with the product in (a).

Reaction of Ethyl δ-Nitrohydantoate with Aniline.—A mixture of 3.82 g. of the nitro derivative and 3.72 g. of aniline in 25 cc. of water was refluxed for one-half hour. On acidification of the cooled mixture with hydrochloric acid the insoluble liquid crystallized. After recrystallization from alcohol, the ethyl δ-phenylhydantoate melted at 109.5–110° alone and when mixed with an authentic specimen that had been prepared from the ethyl ester of glycine and phenyl isocyanate.[4]

Summary

Ethyl hydantoate and the methylamide of hydantoic acid yield nitramines when treated with 98% nitric acid. In both compounds nitration takes place at the NH_2 group.

ANN ARBOR, MICH. RECEIVED JANUARY 13, 1950

---

(1) This investigation was carried out under a contract recommended by the NDRC between the OSRD and the Regents of the University of Michigan, 1941.

(2) Chas. Pfizer and Co., Inc., Brooklyn, N. Y.

(3) Harries and Weiss, *Ber.*, **33**, 3418 (1900).

(4) Bailey, *Am. Chem. J.*, **28**, 394 (1902).