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## A NEW SYNTHESIS OF 1,5-DIALKYL TETRAZOLES FROM NITRILIUM SALTS AND SODIUM AZIDE

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Numerous investigators have reported the synthesis of various types of 1,5-disubstituted tetrazoles (1). The versatile reaction between arylimide chlorides and hydrazoic acid in chloroform or benzene, first reported by von Braun and Rudolph (2), was extended to the synthesis of 1,5-dialkyl tetrazoles by Harvill et al. (3). Use of sodium azide in this reaction, in order to avoid handling hazardous hydrazoic acid, is restricted by the instability of the dialkyl substituted imide chlorides at the required reaction temperature, especially with small alkyl substituents.

A new synthesis of 1,5-dialkyl tetrazoles was discovered in this laboratory when nitrilium salts and sodium azide were allowed to react in toluene.

Nitrilium salts (4) of the general formula  $\begin{bmatrix} R'-\dot{C}=N-R\leftrightarrow R'-C\equiv N-R \end{bmatrix} X$ (I) can be prepared by the reaction of trialkyloxonium salts with nitriles. These nitrilium salts (I) react with sodium azide to form 1,5-disubstituted tetrazoles (III) according to the following equations:

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$$\begin{bmatrix} \mathbf{R}' - \mathbf{C} = \mathbf{N} - \mathbf{R} \end{bmatrix} BF_{4}^{-} + NaN_{3} \rightarrow \begin{bmatrix} \mathbf{R}' \mathbf{C} = \mathbf{N} - \mathbf{R} \end{bmatrix} N_{3}^{-} + NaBF_{4}$$
(I)
$$K' - \mathbf{C} - \mathbf{N} - \mathbf{R}$$

$$N_{N}^{+} N$$
(III)
(III)

The initial reaction of the nitrilium salt (I) with sodium azide is exothermic and the rate of addition of azide must be controlled. The postulated azide intermediate (II) cyclized in boiling toluene to form III. All attempts to isolate II have been unsuccessful.

1-Ethyl-5-methyl and 1,5-diethyl tetrazole were prepared by this procedure in yields greater than 20%. Yields were increased approximately 10% when activated sodium azide (5) was used. The synthesis of 1-ethyl-5-methyl tetrazole has not been previously reported. Although the synthesis of 1,5-diethyl tetrazole (3) has been mentioned, physical data were not given.

Further research towards extension of the new reaction to aromatic systems and elucidation of the reaction mechanism is now in progress; results will be published in a later paper.

To a suspension of N-ethylacetonitrilium fluoborate (4.29 g., 0.027 mole) in dry toluene (250 ml.) was added in several small portions with stirring, activated sodium azide (2.0 g., 0.031 mole). The mixture was then stirred and heated between 105-110° for 20 hours under nitrogen to give 1-ethyl-5-methyl tetrazole, 0.93 g. (33% yield based on nitrilium salt), b.p. 94-95°, 0.24 mm. The analytical sample was obtained by chromatographing the distillate on a column (2 x 33 cm.) of silica gel (43.90 g.) with 500 ml. of 1:9 methanol-ether as developing solvent.  $N_D^{25^\circ}$ , 1.4593; infrared max. (liquid film) 2990, 2945, 1531, 1412, 1095, 1055, and 1009 cm<sup>-1</sup>, tetrazole ring (6) 1111-1000 cm<sup>-1</sup>; R<sub>f</sub>\* 0.47; Anal. calcd. for C<sub>4</sub>H<sub>8</sub>N<sub>4</sub>: C, 42.84; H, 7.19; N, 49.97. Found: C, 42.82; H, 7.12; N, 49.94.

1,5-Diethyl tetrazole was prepared and isolated in the same manner as 1-ethyl-5-methyl tetrazole. N-ethylpropionitrilium fluoborate (4.29 g., 0.027 mole) gave 1,5-diethyl tetrazole, 1.36 g.; (36% yield, based on nitrilium salt); b.p. 83-85°, 0.12 mm. Analytical sample,  $N_D^{25°}$ , 1.4605; infrared max. (liquid film) 3003, 2950, 1513, 1447, 1418, 1089, and 1064 cm<sup>-1</sup>;  $R_f^*$  0.67; Anal. calcd. for C<sub>5</sub>H<sub>10</sub>N<sub>4</sub>: C, 47.60; H, 7.99; N, 44.41. Found: C, 47.70; H, 7.94; N, 43.80.

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