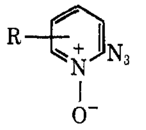
# Communications

See Editorial, *J. Org. Chem.*, **37**, No. 24, 4A (1972)

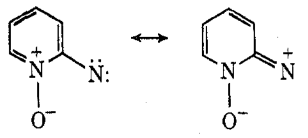
## *N*-Hydroxypyrroles and Related Compounds

*Summary:* 2-Azidopyridine 1-oxides and 2-azidopyrazine 1-oxide undergo thermal decomposition accompanied by ring contraction to give 2-cyanopyrroles or 1-hydroxy-2-pyrrolones, and 2-cyano-1-hydroxyimidazole, respectively.

*Sir:* While the thermal and photochemical decomposition of 3- and 4-azidopyridine 1-oxides have been studied,[1,2] the chemistry of 2-azidopyridine 1-oxide (**1a**) has received little attention.[3] In principle, the nitrene derived from **1a** could either behave as a 1,4 dipole (**2**) or undergo ring contraction as do some other cyclic azides.[4] We have now prepared a series of 2-azidopyridine 1-oxides (**1**) and studied their thermal decomposition. To date we have not found any 1,4-dipolar behavior but have observed ring contraction leading to the desirable but otherwise unavailable 2-cyano-*N*-hydroxypyrroles (**3**). We report on the generality and possible mechanism of this reaction.



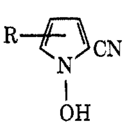
**1a**, R = H
**b**, R = 4-$CH_3$
**c**, R = 5-$CH_3$
**d**, R = 6-$CH_3$
**e**, R = 5-Cl



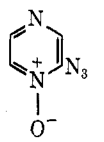
**2**

Direct oxidation to 2-aminopyridine 1-oxides by a modification of Pentimalli's procedure[5] was followed by diazotization of the hydrochlorides and treatment with sodium azide to give **1a–e** (60–80%). The structure of the azides were confirmed by their spectral properties and by microanalysis. 2-Azidopyrazine 1-oxide (**4**, 25%, mp 86–88° dec) was prepared analogously.

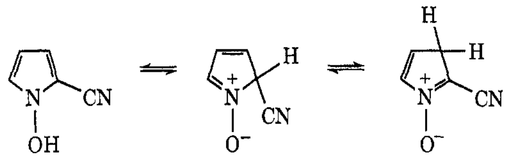
Thermolysis of **1** to give **3** in good yield occurred smoothly at 90° in benzene solution. This temperature is appreciably lower than that at which aryl azides usually decompose (>*ca.* 120°) and this suggests that an arylnitrene is not an intermediate but that nitrogen elimination is concerted with ring opening. Thus, thermolysis of **1a** (mp 84°) gave **3** (R = H), 90%, bp 80° (0.5 mm), M+ calcd *m/e* 108.0324, found 108.0326. Compounds **3** could exist in a number of tautomeric modifications, *e.g.*



**3**



**4**

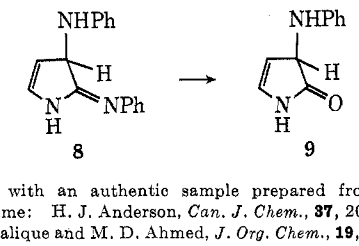


A B C

Only the *N*-hydroxy form (A) was observed as indicated by the ir and nmr spectra of **3**. The following, *e.g.*, were found for **3a** (R = H): ir (film) 3400–2800 (v br, NOH), 2225 $cm^{-1}$ (C≡N); nmr ($CDCl_3$) $\delta$ 7.56 (1 H, s, NOH, exchanges with $D_2O$), 6.90 (1 H, d of d, $J_{4,5} = 2.5$, $J_{3,5} = 1.5$ Hz, $H_5$), 6.55 (1 H, d of d, $J_{3,4} = 3.5$, $J_{3,5} = 1.5$ Hz, $H_3$), 5.96 (1 H, d of d, $J_{4,5} = 2.5$, $J_{3,4} = 3.5$ Hz, $H_4$). **3a** gave an *O*-*p*-toluenesulfonate, mp 79.5–80.5° dec, and *O*-*p*-nitrobenzyl derivative, mp 69–70° dec, and an *O*-benzoate, mp 77–79° dec, all of which exhibited the expected spectral features for O-substituted derivatives. The other compounds **3** behaved similarly.

When the thermolysis of **1a** was carried out in MeOH at 95°, 2-cyanopyrrole (**5**, 6%)[6] and 3-methoxy-2,3-dihydro-2-pyrrolone (**6**, 26%, mp 52–53°) were obtained. The cyanopyrrole (**5**) may result from the deoxygenation of **3a** in boiling methanol, which reaction was found to occur. The structure of the pyrrolone (**6**) followed from its spectral properties: ir (KBr) 3260 (NH), 1690 (amide C=O), 1103 $cm^{-1}$ (C—OMe); nmr ($CDCl_3$) $\delta$ 7.78 (1 H, s, NH, exchanges with $D_2O$), 6.84 (1 H, d of d, $J_{1,5} = 1.0$, $J_{4,5} = 3.5$ Hz, $H_5$), 6.08 (1 H, d of d, $J_{4,5} = 3.5$, $J_{1,4} = 0.5$ Hz, $H_4$), 5.42 (1 H, s, $H_3$), 3.24 (3 H, s, $OCH_3$); mass spectrum *m/e* 113 ($M^+$), 82 ($M^+ - OCH_3$), 31 ($OCH_3^+$). It was confirmed by its hydrolysis to $\alpha$-methoxysuccinic acid (**7**), mp 107–109°.[7]

Similarly, thermolysis of **1a** in aniline gave **5** (22%), 2-aminopyridine 1-oxide (21%),[8] and 3-anilino-2,3-dihydro-2-pyrrolone *N*-phenylimine (**8**, 26%, mp 137–139° dec).[9] Hydrolysis of the latter under very mild conditions gave the pyrrolone **9**, mp 89°. The other



**8** **9**

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[1] T. Okamoto and S. Hayashi, *Yakugaku Zasshi*, **86**, 776 (1966); *Chem. Abstr.*, **65**, 20116 (1966).

[2] S. Kamiya, *Chem. Pharm. Bull.* (*Tokyo*), **10**, 471 (1962).

[3] Attempts to purify crude 2-azidopyridine 1-oxide led to its decomposition: J. H. Boyer, R. Borgers, and L. T. Wolford, *J. Amer. Chem. Soc.*, **79**, 687 (1957).

[4] R. A. Abramovitch and E. P. Kyba, in "The Chemistry of the Azido Group," S. Patai, Ed., Interscience, London, 1971, pp 273, 278.

[5] L. Pentimalli, *Gazzetta*, **94**, 458 (1964).

[6] Identical with an authentic sample prepared from pyrrole-2-carboxaldehyde oxime: H. J. Anderson, *Can. J. Chem.*, **37**, 2053 (1959).

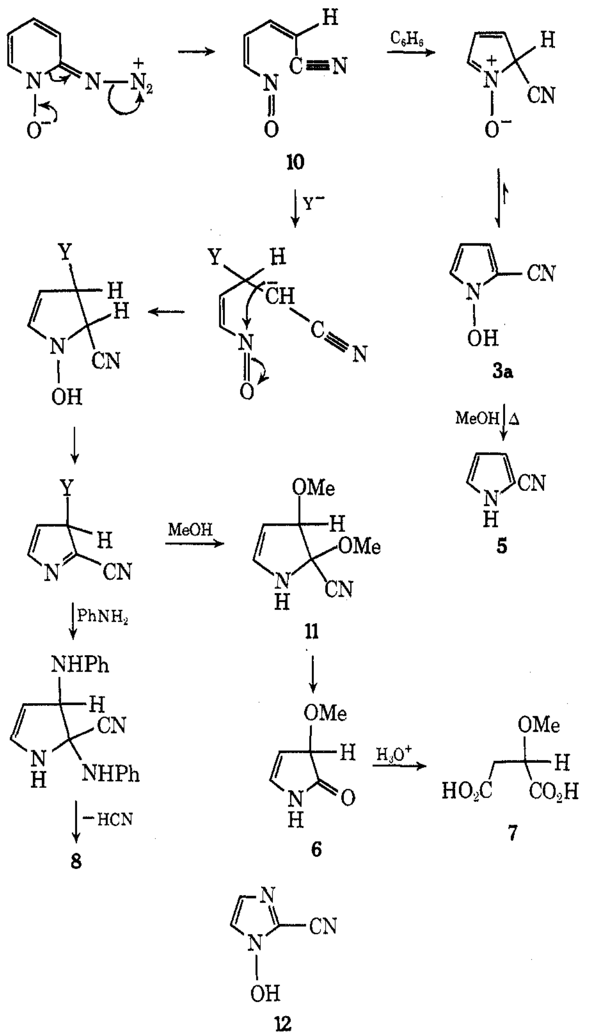
[7] M. A. Khalique and M. D. Ahmed, *J. Org. Chem.*, **19**, 1523 (1954).

[8] Formally, this is the product of hydrogen abstraction by 1-oxido-2-pyridylnitrene from solvent; it could also arise by reduction of the azide function by aniline.

[9] Spectral and microanalytical data consistent with all of the proposed structures were obtained.

azides **1b–e** gave similar products on thermolysis in nucleophilic solvents.

A plausible mechanism which would account for the formation of products **3**, **6**, and **8** involves a nitrogen elimination concerted with ring opening to give the unsaturated nitrile (**10**). This can either undergo electrocyclic ring closure and tautomerization to give **3** or a Michael addition of solvent followed by cyclization and dehydration to **6** or **8**. Mechanistic analogy for **11** → **6** exists.[10]



The potential generality of this ring contraction is indicated by the production of 2-cyano-*N*-hydroxyimidazole (**12**) [83%; mp 169–170° dec; ir (KBr) 2400 (NOH), 2225 cm$^{-1}$ (C≡N); mass spectrum *m/e* 109 (M$^+$), 92 (M$^+$ − OH)] by the thermolysis of **4** in benzene.

Extensions to fused systems and to the azidopyrimidine 1-oxides are now under investigation.

**Acknowledgments.**—This work was carried out with the support of an NIH grant (GM 16626) for which we are grateful.

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[10] S. M. McElvain and R. L. Clarke, *J. Amer. Chem. Soc.*, **69**, 2657, 2661 (1947); S. M. McElvain and C. L. Stevens, *ibid.*, **69**, 2663 (1947); R. Roger and D. Neilson, *Chem. Rev.*, **61**, 192 (1961).

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## Stearoyl Methanesulfonate. A Mixed Anhydride from an Isopropenyl Ester

*Summary:* Isopropenyl stearate and methanesulfonic acid react at ambient temperatures in methylene chloride to give the mixed anhydride stearoyl methanesulfonate, a powerful stearoylating agent.

*Sir:* Mixed carboxylic-oxy acid anhydrides have been regarded as highly effective acylating agents. They have been prepared by the reaction of a silver sulfonate with an acid chloride,[1] a sulfonic acid with a ketene,[2] a sulfonic acid with an acid chloride,[3] or a sulfonic acid with a carboxylic anhydride[3] or from a lithium carboxylate and the sulfur trioxide-*N*,*N*-dimethylformamide complex.[4]

Nevertheless, little attention has been given to the facile synthesis of these acylating agents from sulfonic acids and isopropenyl esters. An early report[5] on the reactions of isopropenyl acetate (IPA) acknowledged that IPA reacts with carboxylic acids in the presence of a catalytic amount of sulfuric acid to give mixed carboxylic anhydrides. Another group studied the kinetics of various acid-catalyzed IPA reactions and concluded that the active intermediates are mixed acetic–sulfonic or acetic–sulfuric anhydrides.[6] Isopropenyl esters now may be prepared easily by reaction of a carboxylic acid with propyne in the presence of zinc oxide or the zinc carboxylate,[7] and this opens a new synthetic pathway to the once difficult to obtain mixed anhydrides.

We have isolated the mixed anhydride stearoyl methanesulfonate from the reaction mixture of equimolar amounts of isopropenyl stearate and anhydrous methanesulfonic acid in methylene chloride. Although attempts to recrystallize the white solid led to disproportionation, ir analysis and potentiometric titration demonstrated that the initial product was reasonably pure mixed anhydride. Ir absorptions (in a Nujol mull) occur at 1805 and 1185 cm$^{-1}$ and are typical[1c] for mixed carboxylic–sulfonic anhydrides. Ir analysis also showed that the material was essentially free of stearic acid, stearic anhydride, and isopropenyl stearate. A weighed sample of product was hydrolyzed in a known amount of dilute aqueous sodium hydroxide, and the resulting solution was back-titrated with 0.1 *N* hydrochloric acid. Two potentiometric end points were observed, one corresponding to double the amount of sodium hydroxide of the other; one end point was in the pH 5 region (methanesulfonic acid) and the other at pH 9 (stearic acid). The equivalent weight of the mixed anhydride calculated from the titration was within 3% of the theoretical value. The stearic acid that resulted from the hydrolysis and subsequent acidification was isolated in 93% yield and identified by its melting point and its ir spectrum. Quenching of the

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[1] (a) F. Effenberger and G. Epple, *Angew. Chem., Int. Ed. Engl.*, **11**, 299 (1972). (b) A. Baroni, *Atti Acad. Lincei*, **17**, 1081 (1933). (c) C. G. Overberger and E. Sarlo, *J. Amer. Chem. Soc.*, **85**, 2446 (1963).

[2] G. A. Olah and S. J. Kuhn, *J. Org. Chem.*, **27**, 2667 (1962).

[3] M. H. Karger and Y. Mazur, *J. Amer. Chem. Soc.*, **90**, 3878 (1968).

[4] W. L. Garbrecht, *J. Org. Chem.*, **24**, 368 (1959).

[5] H. J. Hagemeyer, Jr., and D. C. Hull, *Ind. Eng. Chem.*, **41**, 2920 (1949).

[6] E. A. Jeffery and D. P. N. Satchell, *J. Chem. Soc.*, 1876, 1887, 1906 (1962).

[7] E. S. Rothman and S. Serota, *J. Amer. Oil Chem. Soc.*, **48**, 373 (1971).