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CYCLIC AMINIMIDES CONTAINING THE PYRAZOLONE SKELETON

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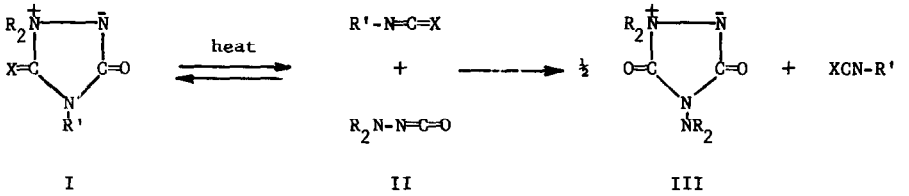
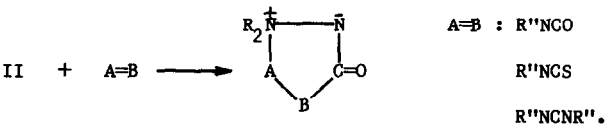
Cyclic aminimides of the type I dissociate upon heating, especially easily if the substituent in position 4 is bulky[1]. The transient N,N-dialkylaminoisocyanates can be captured if two conditions are met : 1) The isocyanate R'NCO must add to the R_2N-NCO more slowly than the competing capture reagent (or the R'NCO must be removed, e.g. by distillation), and 2) the capture reagent must be able to compete with the dimerization of R_2N-NCO, which gives III.



I II III

R : Me, Et.

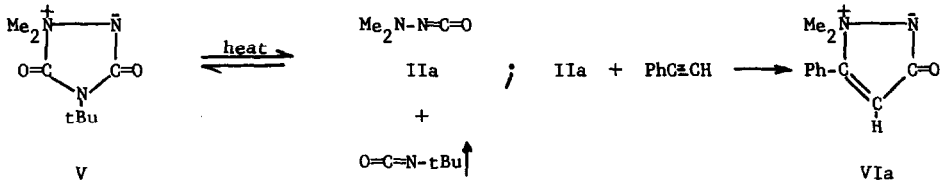
X : O, S, R"N.



IV

We have found that many acetylenes compete effectively with the dimerization of R_2N-NCO and yield 4,5-disubstituted 1,1-dialkylpyrazolin-3-on-1,2-aminimides VI. Heating 1,1-dimethyl-4-tert.-butyl-1,2,4-triazolidin-3,5-dion-1,2-aminimide (V)[1] (400 mg) with phenylacetylene (1.2g) in 5g of tetrachloroethylene to 110° for two hrs gave a 83% yield of 1,1-dimethyl-5-phenyl-pyrazolin-3-on-1,2-aminimide[2] (VIa), mp 207° (dec), C=O absorption at 1690 cm^{-1} ($CHCl_3$), nmr

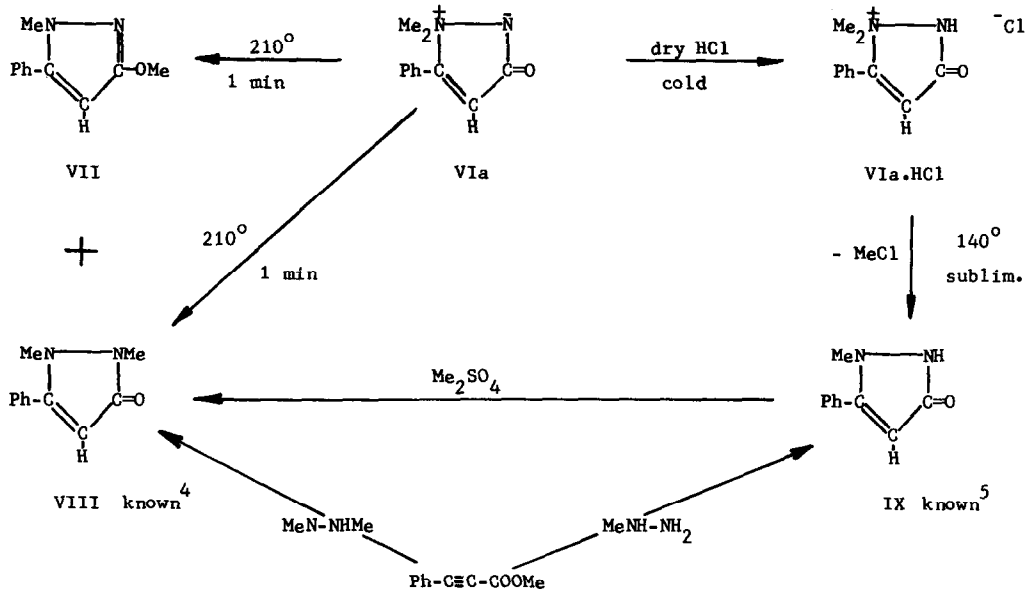
signals at δ3.36 (s, 6H), 6.39 (s, 1H), and 7.52 (m, 5H). The mass spectral parent peak was also the base peak (which presumably is due to the substance rearranging in the spectrometer to the very stable VII and perhaps VIII, see Scheme A). Other prominent peaks corresponded to the loss of H, CO, HNCO, MeNCO, Ph, PhCN, PhC≡CH, and Me_2N-NCO. The latter two fragments, the starting materials, appear in the mass spectra of all the dialkylaminoisocyanate adducts we have investigated, be the addend an acetylene or a heterocumulene (R-NCO, R-NCS, RN=C=NR). Phenylacetylene adds to Me_2N-NCO relatively slowly (see below), which imposes restrictions on the reaction conditions. Tetrachloroethylene is the solvent of choice. At 110° it dissolves the precursor V slowly during the progress of the reaction, especially when large crystals of V are used. The concentration of Me_2N-NCO in the solution is thus kept low and its dimerization is retarded, allowing the phenylacetylene to compete effectively. The aminimide VIa gradually precipitates during the reaction period. When poorly crystallized V is used, the yields drop drastically.



V VIa

A priori, the phenyl group in the adduct could occupy the 4- or the 5-position. Only one isomer was isolated, and its structure VIa follows from the conversions shown in Scheme A, and also from the catalytic hydrogenation of VIa. This gives Me_2N-CHPh-CH_2-$CONH_2$ by cleavage of the N-N bond. Hofmann elimination of the quaternized material leads to trans cinnamamide, proving the sequence of atoms in VIa[3]. The structures of other aminimides, such as VIb, were established by analogous conversions and syntheses of the corresponding 1-alkyl and 1,2-dialkylpyrazolinones. Symmetrically substituted acetylenes give aminimides without structural ambiguity on positions 4 and 5. Those which we prepared (such as X) were identified as five-membered cyclic aminimides by the strong analogies in their spectra and reactions to those of adducts of chemically proven structures. The structures of a number of adducts from unsymmetrically substituted acetylenes have yet to be established. Having prepared them allows us, however, to report a qualitative order of reactivities of acetylenes towards Me_2N-NCO. The more and the stronger electron-withdrawing substituents are attached to the acetylene, the greater is its reactivity. The qualitative

Scheme A



The (known) compounds VIII and IX were prepared as shown and their properties were compared with those of the compounds obtained from VIa

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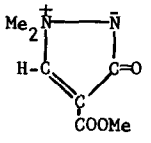
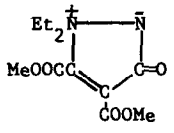
sequence is : MeOOC-C≡C-COOMe ≫ HC≡C-COOMe > Ph-C≡C-COOMe ≥ Ph-C≡C-CO-Me ≥ 2-pyridyl-C≡CH > Ph-C≡CH > Ph-C≡C-Me ≥ Et-C≡C-C≡C-Et. Dialkylmonoacetylenes proved too unreactive in our hands, instead of adducts the dimers III of R_2N-NCO were formed. A few typical acetylene - dialkylaminoisocyanate adducts are the following : The methyl propiolate adduct VIb, mp 192-3° (dec), 1,1-dimehyl-4-methoxycarbonylpyrazolin-3-on-1,2-aminimide[2], obtained in 67% yield. Ir absorptions at 3080, 1740, and 1660 cm^{-1} (Nujol), nmr signals at δ3.39 (s, 6H), 3.87 (s, 3H), and 8.53 (s, 1H). The mass spectrum had a strong (45%) parent peak, showed dissociation into the starting materials, and prominent peaks indicating the loss of H, CO, MeO, CO_2, MeNCO (presumably due to a 1,2-methyl shift before fragmentation), HNCO, NCO, and Me_2N_2. The latter is a very common fragment in the mass spectra of all our adducts from Me_2NCO. It might well rise from a 1,2-methyl shift prior to fragmentation, then loss of MeN=NMe.



VIb



X

The adduct from Et_2N-NCO and dimethyl acetylenedicarboxylate, X, 1,1-diethyl-4,5-bis(methoxycarbonyl)pyrazolin-3-on-1,2-aminimide[2] was obtained in 76% yield. Its ir spectrum showed absorptions at 1755, 1730, and 1683 cm^{-1} ($CHCl_3$). The nmr signals were found at δ1.16 (t, 6H), 3.96 (s, 6H), and 3.7 - 4.2 (m, 4H). The mass spectrum shows a strong (23%) peak for MeOOC-C≡C-COOMe, but not for Et_2N-NCO, which seems to decompose. Other mass spectral peaks correspond to the stepwise loss of the substituents on the ring, down to unsubstituted pyrazolone, m/e = 82 (34%).

Pyrolysis of the aminimides with a pyrazolone skeleton leads predominantely to 3-alkoxypyrazoles (such as VII), which predominate over the 1,2-dialkylpyrazolinones (such as VIII) by factors between 3 and 8. The mechanisms of their formation (N vs. O rearrangement terminus) are still under investigation. The structure assignments, however, are safe : That for VIII follows from Scheme A, and that for VII is based on its ir, nmr, and mass spectra and its being different (nmr) from the known[6] 5-methoxy-1-methyl-3-phenylpyrazole. The latter could have been formed from VIa by subsequent 1,2- and 1,5-methyl shifts. Comparatively few 3-alkoxypyrazoles are known[7], and the thermolysis of our aminimides might be a convenient preparative method.

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References and Notes

1) W.J.S. Lockley, V.T. Ramakrishnan, and W. Lwowski, Tetrahedron Letters, 2621 (1974).

2) The new compounds gave satisfactory elemental analyses for C, H, and N.

3) We are indebted to Mr. S. Vincenti for carrying out the hydrogenations.

4) A. Michaelis, W. Rassman, and H. Dorn, Liebigs Ann. 352, 152 (1907).

5) C.A. Rojan, Chem.Ber. 55, 2959 (1929).

6) R.G. Micetich, Canad.Chem.J. 48, 2006 (1970).

7) Cf. "Pyrazoles, Pyrazolines, Pyrazolidines, Indazoles, and Condensed Rings", R.H. Wiley, ed. Interscience Publishers, New York 1967, especially the tables of compounds therein.