REACTION OF ISOCYANATES WITH PYRAZOL-5-ONES

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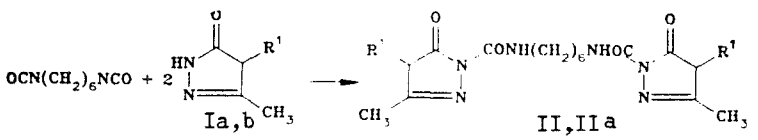
Treatment of mono- and diisocyanates with 3-methyl-4-alkyl(aryl)pyrazol-5-ones by heating in absolute dioxane gives the corresponding 1-carbamoylpyrazol-5-ones. Using PMR spectroscopy it has been shown that they exist in the 5-hydroxypyrazole form in DMSO, dimethylacetamide, chloroform, or acetone solutions.

It has previously been shown [1] that 1-phenyl-3-methylpyrazol-5-one adds via the active 4-methylene group to hexamethylenediisocyanate upon heating in toluene in the presence of sodium. Monoisocyanates react with N-organo-4-hydroxypyrazoles (acetone, triethylamine catalyst, 40°C) to form the corresponding urethanes which have insecticidal and nematodal activity [2]. In a search for novel pesticides we have studied the reaction of isocyanates with a series of 3-methyl-4-organopyrazol-5-ones which have active hydrogen atoms at positions 1 and 4.

It is known that pyrazol-5-ones exist in tautomeric equilibrium with 5-hydroxypyrazoles [3]. Using PMR spectroscopy we have shown that 3-methylpyrazol-5-ones having phenyl, ethyl, isopropyl, or hydrogen at position 4 exist in the 5-hydroxypyrazole form in DMSO at room temperature. A definitive determination of tautomerism in dioxane did not appear possible. To decrease the likelihood of isocyanates reaction with the heterocycles through the hydrogens at position 4 [1] or 5 [2] we have used neither sodium nor urethane forming catalysts.

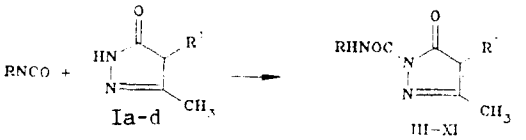
In fact, 3-methyl-4-phenyl(ethyl)pyrazol-5-ones Ia,b add to hexamethylenediisocyanate in refluxing anhydrous dioxane exclusively at position 1.

The difference in structure between II and the adduct reported in [1] results in a significant change in melting point (199-202°C and 104-106°C, respectively). Analogously, the pyrazol-5-ones react with monoisocyanates independently of the nature of the 4-substituent in the heterocycles and the monomer fragment.



I a $R^1=C_6H_5$, b $R^1=C_2H_5$

Trimethylisocyanatosilane reacts with pyrazolones Ic,d under mild conditions to form organosilicon carbamoylpyrazol-5-ones. Without separation these undergo hydrolytic desilylation to give 1-carbamoylpyrazol-5-ones X, XI. It was found that trimethylisocyanatosilane does not react with 3(5)-methylpyrazole Ie or 1-carbamoyl-3(5)-methylpyrazole If upon heating at 100°C even in the presence of dibutyltin laurate or 1,4-diazabicyclo[2,2,2]octane. In the first case this may be explained by steric factor and, in the second, by the lower basicity of the amide group.



Ic $R^1=CH(CH_3)_2$, d $R^1=H$

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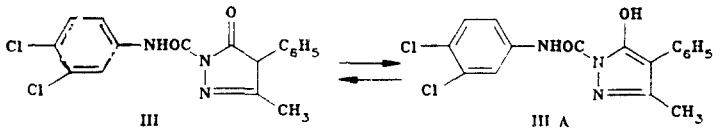
TABLE 1. Physical Constants for Synthesized Compounds

Compound	R	R'	Empirical formula	mp, °C	IR spectrum, cm^{-1}			PMR spectrum, δ, ppm*		Yield, %
					C=O	C=N	NH	CH_3 (s)	R'	
II	–	C_6H_5	$C_{28}H_{32}N_6O_4$	199...202	1695, 1640	1610	3180			90
IIa	–	C_2H_5	$C_{30}H_{32}N_6O_4$	196...199	1700, 1650	1600	3225	2,20	2,16, q CH_2CH_3, 1,05, t, CH_2CH_3	85
III	3,4-$Cl_2C_6H_3$	C_6H_5	$C_{37}H_{13}Cl_2N_3O_2$	209...212	1710, 1650	1620	3245	2,56, 2,45	3,50, s, CH	70
IV	$Cl(CH_2)_6$	C_6H_5	$C_{17}H_{22}ClN_3O_2$	84...86	1710, 1650	1620	3230			98
V	*cyclo*-C_6H_{11}	C_2H_5	$C_{13}H_{21}N_3O_2$	87...90	1690, 1645	1600	3350			94
VI	C_6H_5	C_2H_5	$C_{13}H_{15}N_3O_2$	149	1710, 1630	1600	3370	2,17	2,30, q CH_2CH_3; 1,07, t, CH_2CH_3	83
VII	$Cl(CH_2)_6$	C_2H_5	$C_{13}H_{22}ClN_3O_2$	95	1690, 1655	1600	3260	2,28	2,15, q CH_2CH_3; 1,05, t, CH_2CH_3	45
VIII	3,4-ClC_6H_3	$CH(CH_3)_2$	$C_{14}H_{15}Cl_2N_3O_2$	208	1690, 1650	1620	3350			87
IX	C_6H_5	H	$C_{11}H_{11}N_3O_2$	224	1710, 1635	1605	3200	2,19	5,2, s, CH	90
X	H	$CH(CH_3)_2$	$C_8H_{13}N_3O_2$	135...137	1735, 1715, 1660	1620	3430	2,37	2,72, septet $CH(CH_3)_2$; 1,14, d, $CH(CH_3)_2$	81
XI	H	H	$C_5H_7N_3O_2$	183...185	1760, 1660	1610	3460	2,14	5,10, s CH	60

*For IIA, III, and IIIA, the solvent was N,N-dimethylacetamide, VIA $CDCl_3$, VIIA acetone-D_6, and IXA-XIA DMSO-D_6.

The IR spectrum of the model 1-carbamoyl-3(5)-methylpyrazole If contains intensive absorptions at 1725 (C=O) and 1610 cm^{-1} (C=N) and a number of bands near 3350 cm^{-1} (NH_2) and the spectra of the heterocycles Ia-d (in KBr) have absorptions at 1620-1590 cm^{-1} for the C=O and C=N bonds. Table 1 shows that II-XI have two bands in the region 1710-1650 cm^{-1} which can be assigned to the carbonyl groups of the carbamoyl and pyrazolone groups. This suggests that the adducts are essentially in the carbamoyl pyrazolone form in the solid state. The NH group appears as a weak absorption between 3350-3200 cm^{-1}. In compounds X, XI (R = H) the stretching absorption for the C=O group is shifted to high frequency and that of the NH_2 is characterized by a series of bands (3460-3250 cm^{-1}), the most intense being given in Table 1.

The PMR spectra of IIa, VI, VII, and IX-XI in sufficiently concentration solution show they exist in the 5-hydroxy form (Table 1). An exception is III, which exists as a mixture of two tautomers in the ratio 1:3.



Thus, the spectra of IIA, IIIA, VIA, VIIA, and XIA show the absence of CH proton signals from position 4 of the heterocycle but the spectra of adducts III, IXA, and XI do show signals corresponding to this methine proton. Signals for the NH and OH protons in the spectra of IIa, VII, and XI are not observed, presumably because of rapid proton exchange on the NMR time scale. Compound III shows two signals for the NH protons (9.95 and 11.7 ppm) in the intensity ratio 1:3. In the spectra of X and XI the NH protons give rise to separate doublet signals at 8.00 and 6.96 ppm due to hindered rotation around the N–C bond in the H_2N–C=O fragment.

EXPERIMENTAL

IR spectra were taken on a UR-20 instrument for KBr tablets. PMR spectra were recorded on a Tesla BS-487c (80 MHz) instrument at room temperature with TMS or HMDS internal standard.

Elemental analytical data for C, H, and N agreed with that calculated.

1,6-Bis(1-carbamoyl-3-methyl-4-phenyl-5-oxopyrazolinyl)hexane (II). A solution of hexamethylenediisocyanate (2.4 g, 14 mmoles) in dioxane (10 ml) was added with stirring to a solution of 3-methyl-4-phenylpyrazol-5-one (Ia, 5 g, 28 mmoles) in anhydrous dioxane (40 ml). The product was heated to 100°C for 30 min, cooled, and the precipitate filtered off, washed with hexane, and dried in air to give II (6.7 g) as small, colorless crystals.

Pyrazolones IIa-IX were obtained similarly (Table 1).

1-Carbamoyl-3-methyl-4-isopropylpyrazol-5-one (X). A mixture of dioxane (15 ml), 3-methyl-4-isopropylpyrazol-5-one (Ic, 2 g, 14 mmoles) and trimethylisocyanatosilane (1.6 g, 14 mmoles) was refluxed for 1 h, cooled to 50°C, and water (40 ml) added with stirring. After standing overnight the product was filtered off and recrystallized from isopropanol to give X (2.1 g) as colorless crystals.

1-Carbamoyl-3-methylpyrazol-5-one (XI). A mixture of dioxane (30 ml), 3-methylpyrazol-5-one (Id, 3 g, 30 mmoles) and trimethylisocyanatosilane (3.5 g, 30 mmoles) was refluxed for 1 h, cooled to 50°C, and water (40 ml) added with stirring. After standing overnight the product was filtered off to give XI (2.6 g) as colorless needlelike crystals.

LITERATURE CITED

1. S. Petersen, *Ann. Chemie*, **562**, 205 (1949).
2. German Patent No. 3,114,833, Abstract of Applications, No. 43, Part 1 (1982).
3. T. L. Jacobs, in: *Heterocyclic Compounds*, R. Elderfield (ed.) [Russian translation], Vol. 5, Mir, Moscow (1961), p. 84.