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Note

Separation of pyrazoles by gas chromatography

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Although there have been reports[1–3] of the use of gas chromatography (GC) for the separation of pyrazoles, no systematic study has yet been presented. We had found earlier[4] that a wide range of imidazoles is separable using OV-17 as liquid phase, provided that the compounds are either N-substituted or can be N-acetylated prior to introduction on to the column. Such polar compounds as the azoles require silanized glass columns packed with a relatively inert support such as Chromosorb W.

EXPERIMENTAL

Chemicals

The pyrazole derivatives were prepared in this laboratory by standard methods and checked for purity by microanalytical and spectrophotometric techniques.

Gas chromatography

GC analysis was performed on a Varian Aerograph Model 1400-10 gas chromatograph equipped with a flame ionisation detector. The glass columns were 2.5 m × 1.5 mm I.D., packed with silanized 100–120 mesh Chromosorb W coated with 12% OV-17 or OV-225. The carrier gas was nitrogen with a flow-rate of 20–25 $cm^3\ min^{-1}$; the inlet temperature was 130–140°; and the detector temperature 300–350°. The column oven was temperature programmed to increase in temperature by 10° min^{-1} from 50°.

RESULTS AND DISCUSSION

We found that, in contrast to the imidazoles, N-unsubstituted pyrazoles are susceptile to direct GC, and no prior acetylation is required. However, in order to separate a wide range of pyrazole derivatives, which in some instances required high temperatures, isothermal operation of the columns proved unsatisfactory. The use of linear temperature-programmed techniques overcame the problem of long retention times, but required the results to be quoted in the form of relative retention indices, I_{py} (relative to pyrazole), and, in addition, linear programmed retention indices, I_p (ref. 5). These are listed in Table I. When using the method for quantitative analysis of mixtures of pyrazoles, the flame ionisation detector requires that response factors relative to pyrazole be calculated (see Table II). Although both N-substituted and

TABLE I

RELATIVE RETENTION INDICES (R_{py}) AND LINEAR PROGRAMMED RETENTION INDICES (I_p) FOR PYRAZOLES

Compound	*OV-17*		*OV-225*	
	R_{py}	I_p	R_{py}	I_p
Alkylpyrazoles				
Pyrazole	1.00	1050	1.00	870
1-Acetyl-3,5-dimethyl-			0.42	775
1-Allyl-	1.00	1050		
1-*t*-Butyl	1.01	1080		
1-Ethyl-	0.83	985		
3-Ethyl-	1.48	1205	1.88	1170
3,4-Dimethyl-	1.61	1270		
3,5-Dimethyl-	1.46	1215	1.68	1130
1-Methyl-	0.69	910		
3-Methyl-	1.25	1155		
4-Methyl-	1.36	1165		
4-Bromopyrazoles				
Unsubstituted	1.94	1400	2.28	1250
1-Acetyl-3,5-dimethyl-			0.93	830
1-*t*-Butyl-	1.78	1315		
1-Ethyl	1.89	1365		
3-Ethyl-	2.23	1515	3.11	1495
3,5-Dimethyl-	2.19	1500	2.75	1412
1-Methyl-	1.08	1070		
3-Methyl-	2.03	1435		
3-Phenyl-	5.65	1800		
4,5-Dibromo-1-methyl-	1.91	1400		
1-Nitropyrazoles				
Unsubstituted	*	*		
4-Bromo-	1.85	1333	1.65	1080
3,5-Dimethyl-			1.83	1145
3-Ethyl-	1.73	1300	2.25	1245
5-Ethyl-	*	*	*	*
3-Methyl-	1.50	1233		
3-Phenyl-	6.80	2100		
3-Methyl-1,4-dinitro	*	*		
3,5-Dimethyl-1,4-dinitro			4.72	2030
C-Nitropyrazoles				
3-Nitro-	2.58	1820	4.40	1835
4-Nitro-	2.44	1730	4.30	1825
1,4-Dimethyl-3,5-dinitro-	2.81	1870		
1,4-Dimethyl-5-nitro-	1.79	1320		
3,5-Dimethyl-4-nitro-	2.80	1840	4.42	1980
3,4-Dinitro-1-methyl-	3.15	2051		
3,4-Dinitro-1-ethyl-	3.35	2100		
1-Ethyl-4-nitro-	2.30	1575		
3-Ethyl-4-nitro-	2.79	1840	4.38	1915
3-Ethyl-5-nitro-	2.85	1885	4.52	2000
1-Methyl-4-nitro-	2.20	1520		
3-Methyl-4-nitro-	2.71	1800		
3-Methyl-5-nitro-	2.78	1832		

TABLE I *(continued)*

Compound	*OV-17*		*OV-225*	
	R_{py}	I_p	R_{py}	I_p
Bromonitropyrazoles				
4-Bromo-3,5-dimethyl-1-nitro-	2.03	1435	2.29	1315
4-Bromo-3,5-dinitro-1-ethyl-	3.13	2070		
4-Bromo-3,5-dinitro-1-methyl-	1.93	1380		
4-Bromo-1-ethyl-3-nitro-	2.60	1725		
4-Bromo-3-ethyl-5-nitro-	3.63	2265	5.42	2270
4-Bromo-3-methyl-1-nitro-	*	*		
4-Bromo-5-methyl-1-nitro-	*	*		
4-Bromo-3-methyl-5-nitro-	3.12	2155		

* Denitration and/or rearrangement takes place on injection.

TABLE II

DETECTOR SENSITIVITY FACTORS (RELATIVE TO PYRAZOLE)

Pyrazole	*Sensitivity factor*	*Pyrazole*	*Sensitivity factor*
Unsubstituted	1.00	3-Ethyl-1-nitro-	1.30
4-Bromo-	6.14	3-Ethyl-4-nitro-	0.60
4-Bromo-3,5-dimethyl-	9.72	3-Ethyl-5-nitro-	6.68
4-Bromo-3-ethyl-	2.83	3-Methyl-	0.88
4-Bromo-3-methyl-	17.65	3-Methyl-1-nitro-	1.29
4-Bromo-3-methyl-5-nitro-	3.12	3-Methyl-4-nitro-	1.68
4-Bromo-1-nitro-	6.30	3-Methyl-5-nitro-	1.73
3,5-Dimethyl-	0.96	3-Nitro-	1.86
3,5-Dimethyl-4-nitro-	1.06	4-Nitro-	1.31
3-Ethyl-	0.83		

N-unsubstituted pyrazoles could be separated on the same columns there were problems experienced with 1-nitropyrazoles which were sometimes susceptible to denitration or rearrangement at the elevated temperatures used.

REFERENCES

1 U. Rydberg and J. C. Buijten, *J. Chromatogr.*, 64 (1972) 170.
2 J. W. A. M. Janssen, H. J. Koeners, C. G. Kruse and C. L. Habraken, *J. Org. Chem.*, 38 (1973) 1777.
3 J. W. A. M. Janssen and C. L. Habraken, *J. Org. Chem.*, 36 (1971) 3081.
4 C. G. Begg and M. R. Grimmett, *J. Chromatogr.*, 73 (1972) 238.
5 H. van den Dool, and P. D. Kratz, *J. Chromatogr.*, 11 (1963) 463.