# CALCULATED REACTIVITY INDICES AND BOND DISTANCES FOR THIENO[2,3-c]PYRIDAZINE

Stewart W. Schneller*

Department of Chemistry, University of South Florida

Tampa, Florida 33620 USA

and

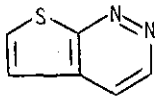
Per Njal Skancke

Department of Chemistry, Box 874, University of Tromsø

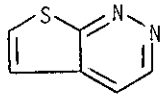
N-9001 Tromsø, Norway

*The calculated reactivity indices and bond distances for thieno-[2,3-c]pyridazine, an unknown heterocycle, are presented.*

Thieno[2,3-c]pyridazine (1) remains one of the two unknown thienopyridazines.[1] However, in view of its structural relationship with cinnoline and its isomeric relationship with the remaining thienopyridazines and the thienopyrazines and thienopyrimidines, a theoretical picture of 1 becomes crucial to designing research objectives which will reveal its chemical properties. In this direction the calculated reactivity indices and bond distances for 1 have been performed and are presented in the Table. The methods employed for these calculations have been discussed in detail elsewhere.[2]



1a



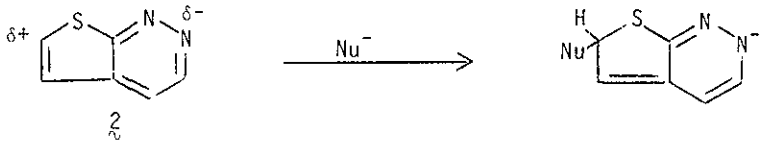
1b

Bond Distances. The bond distances indicate that a certain amount of bond fixation prevails for 1 and that structure 1b best represents thieno-[2,3-c]pyridazine. This is a surprising result since (a) the isomeric thieno-[3,2-c]pyridazine[1,2] exists predominantly in the form illustrated by structure iii in reference 1 and (b) 1b imposes a rather unlikely ortho-quinoid structural situation around the thiophene nucleus. The rationale for this bonding picture is puzzling.

Reactivities. The ease with which an aromatic heterocyclic molecule interacts with various reactive species (i.e., free radicals, electrophiles, and nucleophiles) can be expressed in terms of reactivity indices. Such readily[2] derived indices are the frontier radical density (FRD), an index for radical substitution; the frontier orbital density (FOD), an index for nucleophilic substitution; and the frontier electron density (FED), an index for electrophilic substitution.

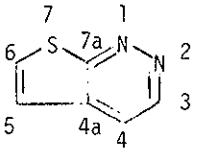
As revealed by the FRD and FED indices compound 1 should undergo free radical reactions and electrophilic substitutions at C-5. This result is to be anticipated in view of the chemical properties which have been reported for similarly fused thiophene compounds (for example, benzo[b]thiophene,[3] various thienopyridines[4] and thienopyrimidines[5]). On the other hand, the FOD index indicates that nucleophilic substitution will occur preferentially at C-6. This predicted occurrence can be explained as being due to the extended vinylogous relationship of C-6 with N-2 in compound 1. This, in turn, implies

(a) that a polarized species (i.e., 2) is significant for 1 when it is subjected to nucleophilic reaction conditions and (b) that H-6 of 1 should be sufficiently acidic to react with a judiciously chosen base.




TABLE

Molecular Orbital Data for Thieno[2,3-c]pyridazine




Bond Distances

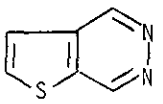
| Bond | |
|---|---|
| 1-2 | 1.426 Å |
| 2-3 | 1.296 |
| 3-4 | 1.447 |
| 4-4a | 1.372 |
| 4a-5 | 1.457 |
| 5-6 | 1.352 |
| 6-7 | 1.733 |
| 7-7a | 1.730 |
| 7a-1 | 1.306 |
| 4a-7a | 1.455 |

Reactivity Indices

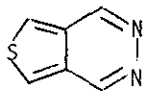
| Atom | FRD | FOD | FED |
|---|---|---|---|
| 1 | 0.160 | 0.146 | 0.173 |
| 2 | 0.193 | 0.349 | 0.036 |
| 3 | 0.051 | 0.019 | 0.083 |
| 4 | 0.184 | 0.230 | 0.137 |
| 4a | 0.130 | 0.255 | 0.005 |
| 5 | 0.255 | 0.270 | 0.240 |
| 6 | 0.216 | 0.387 | 0.044 |
| 7 | --- | --- | --- |
| 7a | 0.032 | 0.064 | --- |

REFERENCES

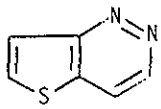
1. Thieno[2,3-d]pyridazine (i),[6] thieno[3,4-d]pyridazine (ii),[7] and thieno-[3,2-c]pyridazine (iii)[8] are known while thieno[2,3-c]pyridazine (iv) and thieno[3,4-c]pyridazine (v) remain unreported in the literature.



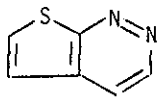
i



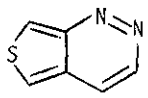
ii



iii



iv



v

2. A. Helland and P.N. Skancke, Acta Chem. Scand., 1972, 26, 2601.
3. B. Iddon and R.M. Scrowston in "Advances in Heterocyclic Chemistry," Vol. 11, A.R. Katritzky and A.J. Boulton, Eds., Academic Press, New York, N.Y., 1970, pp. 244-247.
4. (a) Thieno[2,3-b]- and thieno[3,2-b]pyridine: L.H. Klemm, C.E. Klopfenstein, R. Zell, D.R. McCoy, and R.A. Klemm, J. Org. Chem., 1969, 34, 347; L.H. Klemm, R. Zell, I.T. Barnish, R.A. Klemm, C.E. Klopfenstein, and D.R. McCoy, J. Heterocycl. Chem., 1970, 7, 373 ; (b) Thieno[2,3-c]- and thieno[3,2-c]pyridine: F. Eloy and A. Deryckere, Bull. Soc. Chim. Belges, 1970, 79, 407; S. Gronowitz and A. Sandberg, Arkiv Kemi, 1970, 32, 249; M.L. Dressler and M.M. Joullié, J. Heterocycl. Chem., 1970, 7, 1257.
5. Thieno[3,2-d]pyrimidine: M. Robba, J.-M. Lecomte, and M. Cugnon de Sevricourt, Tetrahedron, 1971, 27, 487.
6. M. Robba, R.C. Moreau, and B. Roques, C. R. Acad. Sci. Paris, 1964, 259, 4726.

7. M. Robba, B. Roques, and M. Bonbomme, Bull. Soc. Chim. Fr., 1967, 2495.

8. A.J. Poole and F.L. Rose, J. Chem. Soc. (C), 1971, 1285.

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