

## Mesoionic Heterocyclics: Theoretical Study of the Structural Stability of Oxazoles (C<sub>3</sub>H<sub>3</sub>NO-R) and Thiazole (C<sub>3</sub>H<sub>3</sub>NS-R), with R = O and S

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Abstract: Mesoionics are five or six-membered heterocyclic structures with a wide variety of applications, such as synthesis of other heterocycles, transition metal complexes, biological activity and non-linear optics [1-5]. This class of molecules has as characteristic a high delocalization and charge separation [6,7]. The present work aims to elucidate the structural stability of the heterocyclic azoles (1,3-oxazol-5-one, 1,3-oxazol-5-thione, 1,3-thiazol-5-one and 1,3-thiazol-5-thione) and their derivatives, in the ground state. MP2 and CCSD calculations were performed with aug-cc-pVDZ basis set and Gaussian 09 program [8], as well as MCSCF using aug'-cc-pVDZ, aug-ccpVDZ and cc-pVTZ basis set and single point CI/cc-pVTZ with Columbus-7.0 program [9]. The structural stability of mesoionic compounds was investigated from relaxed scans in the coordinate referring to the ring-opening, with subsequent optimization of the structures and frequency calculations of stationary points (reagent, transition state and product) at MP2, CCSD, MCSCF and MCSCF//CI/cc-pVTZ. The MCSCF//CI/ccpVTZ results indicate that the rings containing oxygen (1,3-oxazol-5-one and 1,3oxazol-5-thione) spontaneously open without barrier. However, the structure with a inner S along with a exocyclic O atom (1,3-thiazol-5-one) has a small activation barrier and a small positive reaction energy (closed structure slightly more stable). On the other hand, the structure containing two S atoms (1,3-thiazol-5-thione) at MCSCF/cc-pVTZ level has a negligible energy difference between open and closed systems. Thus, there is a strong indication that these *thiazoles* (rings with sulfur) form acyclic tautomers [10,11]. The MCSCF and CI results showed a significant multiconfigurational character for these structures and their use is justified by the disagreement with the results obtained at MP2 and CCSD (regarding the relative stability between closed and opened structures), this disagreement being greater for MP2 method, especially for structures with an inner O atom.

Key-words: Mesoionics, structural stability, multiconfiguration, MCSCF and CI.

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## **References:**

- [1] GRIBBLE. G. W. Mesoionic Ring Systems. *The Chemistry of Heterocyclic Compounds: Synthetic Applications of 1,3-Dipolar Cycloaddition Chemistry Toward Heterocycles and Natural Products.* v. 59, cap 10, (2002).
- [2] MORIN. M. S. T. et al. Modular Mesoionics: Understanding and Controlling Regioselectivity in 1, 3-Dipolar Cycloadditions of Münchnone Derivatives. J. Am. Chem. Soc., 135, p.17349–17358 (2013).
- [3] REISSIG. H. U.; ZIMMER. R. Münchnones New facets after 50 years. Angewandte Chemie - International Edition., v. 53, n. 37, p. 9708–9710 (2014).
- [4] GALUPPO. L. F. et al. Sydnone 1: A Mesoionic Compound with Antitumoral and Haematological Effects In Vivo. Basic and Clinical Pharmacology and Toxicology., v. 119, n. 1, p. 41–50 (2016).
- [5] RODRIGUES. R. F. et al. Antileishmanial activity of 1,3,4-thiadiazolium-2-aminide in mice infected with Leishmania amazonensis. Antimicrobial Agents and Chemotherapy., v. 53, n. 2, p. 839–842 (2009).
- [6] ANJOS. I. C.; VASCONCELLOS, M. L A A.; ROCHA, G. B., A DFT and Natural Resonance Theory investigation of the electronic structure of mesoionic compounds. Theoretical Chemistry Accounts., v. 131, n. 12, p.1–9 (2012).
- [7] ANJOS. I. C.; ROCHA. G. B., A topological assessment of the electronic structure of mesoionic compounds. Journal of Computational Chemistry. v. 36, n. 25, p. 1907–1918 (2015).
- [8] Gaussian 09, Revision D.01, Frisch, M. J. et al. (2009).
- [9] *Columbus-7.0*, disponível em <https://www.univie.ac.at/columbus/>. Acesso em 24 Julho (2017).
- [10] OLLIS. C. A; RAMSDEN, W. D., Adv. Heterocyclic Chem. 19, 1 (1976).
- [11] KATRITZKY. A. R; BOULTON. A. J., Advances In Hetorocyclic Chemistry. v.19 (1976).