A Conformational Study of Flexible Cyclic Compounds (Hydrocarbon Rings of 9-12 Members)

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Abstract: We report here a conformational study of cyclic flexible compounds (rings with 9-12 members). Two methods of systematic search for the minima were used. The results were compared with those obtained using other exploratory methods.

Introduction

It is clear that the choice of good starting geometries for conformationally flexible molecules is one of the greatest challenges, in applying quantitative molecular orbital calculations. There are several reasons for extending the search for new algorithms and to improve the available methods. The principal problem is that the various energy minimization processes do not go through potential energy barriers. They only move down-hill from the trial starting structure towards the nearest minimum, which may of course be only a local minimum. Even worse, after a search has been completed, there is no immediate indication of whether important conformers have been missed. A particular attention was devoted to the cyclic molecules [1-3] because the conformational search in these compounds is more complex.

Recently, we have reported a systematic search method (GASCOS) (4) which has a number of advantages over methods described previously. In the present study we report the conformational study of cyclic compounds (rings with 9-12 members) using two algorithms one of them developed by our group.

Calculation Methods

Two methods were used in the systematic conformational search.

a) Osawa's method from the SPARTAN program.

b) GASCOS method which was developed by our group. The mathematical bases of this method were reported in references 4 and 5.

The starting points obtained from the above methods were geometrically optimised using MM2 and ab-initio calculations.

Results and Discussion

Results obtained from programs using systematic search (OSAWA and GASCOS) were more complete in comparison with those previously reported using Monte Carlo (1) and Annealing simulation techniques (2) or estochastic methods (3).

The results obtained using OSAWA and GASCOS methods are summarised in Table 1.

Although in general all the methods are able to found the low-energy conformations in the MM2 hypersurface of the Potential Energy, only the systematic algorithms can obtain the overall spectrum for the conformational possibilities.

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Table 1. Structural characteristics of the eight previously reported MM2 stable structures of cyclononane.

CONF.	ϕ1	ϕ2	ϕ3	ϕ4	ϕ5	ϕ6	ϕ7	ϕ8	ϕ9	RELAT. ENERGY*
01	125.39	-56.20	-56.03	125.30	-56.11	-56.21	125.44	-56.08	-56.16	0.00
02	102.85	-85.91	102.97	-51.27	-70.26	66.74	66.33	-70.66	-50.78	0.76
03	-122.04	85.65	-73.24	117.71	-64.76	-64.86	117.71	-73.23	85.68	0.78
04	51.52	37.55	-103.71	128.90	-53.07	-57.25	68.82	51.30	-134.03	3.17
05	-103.01	117.74	-88.22	55.5	-90.38	148.07	-59.71	-47.10	96.53	2.23
06	-84.28	68.45	-84.52	130.36	-122.06	40.05	40.06	-122.05	130.19	5.67
07	105.42	-101.36	74.58	-33.60	-170.72	-171.00	-33.61	74.68	-101.77	21.55
08	-0.67	53.90	45.01	-60.43	-60.57	44.91	54.10	-0.77	-86.63	10.36

*in kcal/mol

References and Notes

1. Ferguson, D. M.; Glauser, W. A.; Raber, D. J. *J.Comput. Chem.* **1989**, *10*, 903.
2. Wilson, S. R.; Cui, W.; Moskowitz, J. W.; Schmidt, K. E. *J. Comput. Chem.* **1991**, *12*, 342.
3. Saunders, M. *J. Comput. Chem.* **1991**, *12*, 645.
4. Santagata, L. N.; Suvire, F. D.; Enriz, R. D.; Torday, L. L.; Csizmadia, I. G. *J. Mol. Struct. (Theochem)* **1999**, *465*, 33.
5. Santagata, L. N.; Suvire, F. D.; Enriz, R. D. An analytic ring closure condition for geometrical algorithm to search the conformational space. *J. Mol. Struct. (Theochem)* (in press).