

Arbeitsvorschriften und Meßwerte • Procedures and Data

Multinuclear NMR Structural Study of 2,2,4-Trimethyl-1,3-dioxadecalanes – Fused Twist Conformations

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Dedicated to Prof. Dr. Erich Kleinpeter on the Occasion of his 50th Birthday

As a continuation of our studies on the conformations and configurations of methyl-substituted 1,3-dioxadecalanes [1] we now report the preparation and configurational assignment of all four 2,2,4-trimethyl-1,3-dioxadecalanes in order to demonstrate that even the fused 1,3-dioxane rings can escape to 2,5-twist conformations to avoid the 2,4-*syn*-axial Me,Me-interactions. For the latter purpose the ¹H, ¹³C and ¹⁷O NMR spectra of the isomers were recorded. The ¹³C NMR chemical shifts allow the application of the shift increments derived for 1,3-dioxanes [2, 3] to conformational and configurational analysis.

Experimental

A mixture of the four isomeric 2,2,4-trimethyl derivatives (**1–4**) was prepared conventionally from acetone and a mixture of the corresponding *cis* and *trans* diols [1]. The isomers were separated from the product (*b.p.* 96–110 °C; C₁₁H₂₀O₂ (184.27): C, H, O calc. 71.69, 10.94, 17.37; found 71.27, 11.05, 17.84) on a Carlo Erba Fractovap Mod P preparative gas chromatograph using a Fractonitril column at 110 °C.

The NMR spectra were recorded on a JEOL GX-400 spectrometer operating at 399.78 MHz for ¹H, 100.53 MHz for ¹³C and 54.21 MHz for ¹⁷O, respectively. All the spectra were taken in 5 mm o.d. tubes in CDCl₃. The solvent deuterium signal was used for field locking. Internal TMS was the reference for ¹H and ¹³C and external tap water for ¹⁷O chemical shifts. The 90° pulses were the following: 5.5 μs for ¹H, 9 μs for ¹³C and 22 μs for ¹⁷O. We accumulated 8 scans for ¹H, 300 scans for ¹³C and 5000 scans for ¹⁷O (pulse delay 0.1 s and acquisition time 1.33 s). A 50 Hz exponential window was applied to the FT of the ¹⁷O data.

In all measurements the temperature was kept constant at 298±2 K. The concentration for the ¹⁷O samples was ca. 2 M.

Results and Discussion

The ¹H, ¹³C and ¹⁷O NMR spectra of the four 2,2,4-trimethyl-substituted 1,3-dioxadecalanes were recorded and analyzed. The configurations of two of them were easy to assign on the basis of the vicinal H,H-coupling constants (Table 1) – both compounds have an equatorial methyl group at position 4 of the 1,3-dioxane ring and a double chair conformation – one with *cis*- (**2**) and the other with *trans*-fusion (**3**). The 2a4e substitution seems to deform the opposite side of the 1,3-dioxadecalane ring system as the 2e4a substitution since in **2** J_{5e,6a} but in *cis*-fused *r*-2,*t*-4-dimethyl-1,3-dioxadecalane [1] J_{4e,5e} is practically zero. Substituent effect calculations and ¹³C NMR chemical shifts (Table 2) confirm nicely the above assignments [1, 3].

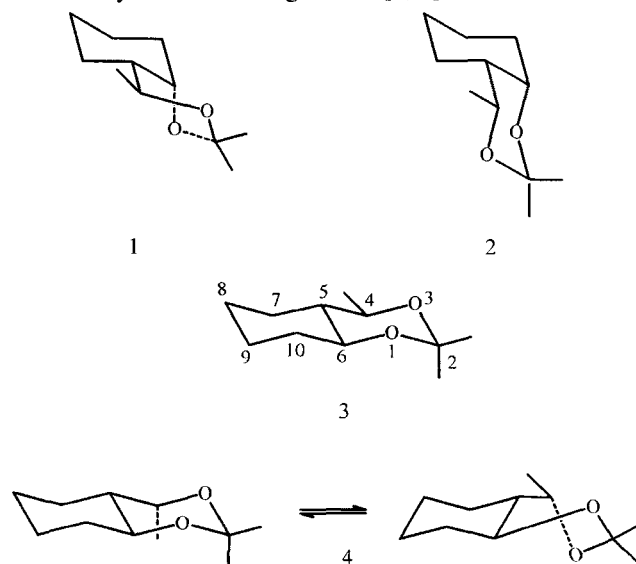
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Table 1 Some illustrative ^1H NMR data for **1–4** in CDCl_3 . Chemical shifts in ppm from TMS and coupling constants in Hz

Compound	$\delta(\text{H-4})$	$\delta(\text{H-6})$	$\delta(\text{Me-4})$	$\delta(\text{Me-2})$	$J_{4,5}$	$J_{5,6}$	$J_{6,10}$
1	3.49	3.98	1.22	1.37, 1.38	6.2	3.3	3.1, 3.1
2	4.05	4.04	1.09	1.43, 1.44	2.5	≈ 0	2.3, 2.3
3	3.66	3.48	1.14	1.48, 1.40	9.9	10.1	10.2, 4.0
4	4.13	3.62	1.22	1.38, 1.44	7.0	10.4	10.4, 4.3

For the other two compounds (**1** and **4**) both the vicinal H,H-coupling constants [1, 4] and the ^{13}C NMR chemical shifts [1, 3] reveal that the 1,3-dioxane ring escapes to a 2,5-twist conformation to avoid the 2,4-diaxial Me,Me-interaction present in the double chair conformations in agreement with the previous observation [2, 3] that when there is no pseudo-

with the experimental findings that O(1) and O(3) have equal chemical shifts in **2–4**. It is interesting to note that the chemical shifts of O(1) and O(3) of **1** where the 1,3-dioxane ring attains exclusively the 2,5-twist form, differed ca. 12 ppm from each other. For the chair the substituent effect calculations predicted again equal chemical shifts.

Table 2 ^{13}C NMR chemical shifts (ppm from TMS) for **1–4** in CDCl_3 . Some estimated values shown in parentheses

Compd.	C(2)	C(4)	C(5)	C(6)	C(7)	C(8)	C(9)	C(10)	C(Me)
1 ^{a)}	100.29 (100.26)	64.02 (64.93)	43.86 (42.27)	71.24 (70.62)	27.13	24.49	20.82	30.08	2-Me: 6.01, 24.67 4-Me: 21.30
2	98.50 (98.4)	68.08 (68.1)	39.43 (39.3)	68.27 (68.2)	18.51	25.25	20.27	31.84	2-Me: 30.17(e), 19.72(a) 4-Me: 18.24
3	98.32 (98.5)	69.90 (69.6)	47.80 (47.8)	73.18 (73.1)	25.82	25.49	24.67	32.17	2-Me: 30.35(e), 19.09(a) 4-Me: 20.00
4 ^{b)}	98.85 (98.6)	68.60 (68.5)	44.24 (43.0)	68.86 (69.2)	26.26	25.95	24.81	32.56	2-Me: 28.77, 26.30 4-Me: 17.84

^{a)} Values in parentheses are actually those for 2,2,*r*-4,*t*-5,*t*-6-pentamethyl-1,3-dioxane. ^{b)} Values in parentheses were calculated in an 1:1 ratio from the estimated chemical shifts for the double-chair conformation of **4** and the shift values of the 2,5-twist conformation in ^{a)}

axial alkyl group in the twist form, the 2,2,4-*syn*-axially alkyl-substituted 1,3-dioxane derivatives attain a 2,5-twist form. The practically exclusive dominance of the 2,5-twist conformation in the third isomer **1** is easily proved by a comparison of its C-2, C-4, C-5, and C-6 ^{13}C chemical shifts with those of 2,2,*r*-4,*t*-5,*t*-6-pentamethyl-1,3-dioxane (Table 2) which exists in a 2,5-twist form [2]. Similarly the significant contribution of the 2,5-twist conformation in the fourth isomer **4** (Table 2) is proved by the H,H-coupling constants [4] and the values of the C-2, C-4, C-5, and C-6 ^{13}C chemical shifts which are close to the average of those for 2,2,*r*-4,*t*-5,*t*-6-pentamethyl-1,3-dioxane and those calculated for the 2,4-diaxial double-chair conformation of **4** (for the latter the chemical shifts for *trans*-fused 2,2-dimethyl-1,3-dioxadecalane [1] together with the additional substituent effects caused by the axial C-4 methyl substitution were applied).

More reference data, e.g. on methyl-substituted 1,3-dioxanes, are necessary for successful application of the ^{17}O NMR chemical shifts of **1–4** to explain their configurations and conformations since, for example, no model values are available for the twist forms. However, substituent effect calculations based on our previous data [1] did not disagree

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Table 3 ^{17}O NMR chemical shifts of **1–4** (ppm from external water)

Compd.	$\delta[\text{O}(1,3)]$	Compd.	$\delta[\text{O}(1,3)]$
1	53.7, 65.4 ^{a)}	3	81.0
2	58.7	4	69.8 ^{a)}

^{a)} No model values are available for the twist form.

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