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GEOMETRICAL ISOMERIZATION IN O-ALKYL OXIMES

E. J. Grubbs and J. A. Villarreal
Department of Chemistry, San Diego State College
San Diego, California 92115

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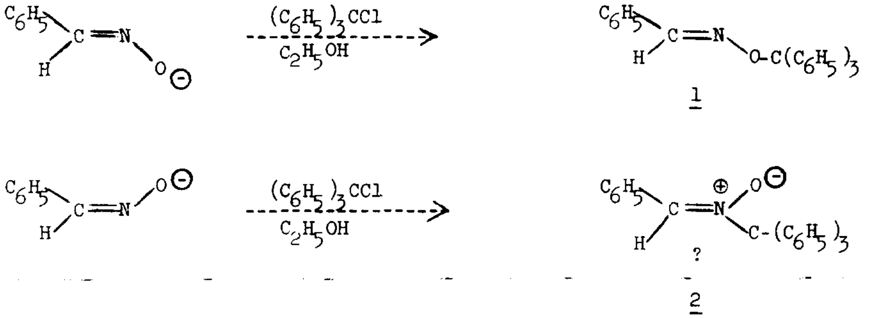
In a recent study (1), the alkylation of syn-benzaldoxime* with chlorotriphenylmethane, as expected, gave syn-O-triphenylmethylbenzaldoxime 1. However, a similar alkylation of the anion of the anti isomer reportedly led to α-phenyl-N-triphenylmethylnitrone 2, the geometry of which was believed to be trans. This apparently facile preparation of 2 in high yield and its unexpected stability intrigued us. We had been unable to isolate this nitrone in a previously attempted synthesis using benzaldehyde and N-triphenylmethylhydroxylamine under mild conditions even though we could detect it spectroscopically (2). Upon closer examination of the structural credentials cited (1) for 2, we became doubtful that this was the correct structure. Elemental analyses for the two compounds revealed them to be isomeric, but the ultraviolet spectrum reported for 2, [λ max 252mμ (log ϵ 4.23)] appeared to be inconsistent with the assigned structure. There was no indication of an absorption band at longer wavelengths. Nitrones having the general structure 3 are known to have intense π-π* transitions with maxima in the region from about 300 to 340mμ (3).



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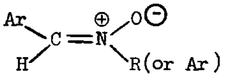
*In the form of its sodium salt in absolute ethanol.



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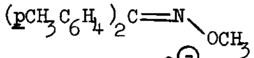
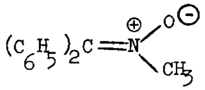
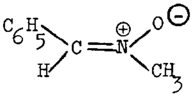
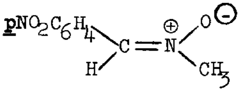
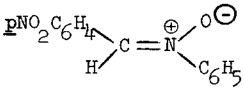
We have repeated the alkylations of syn-and anti-benzaldoximes with chlorotriphenylmethane under conditions used previously (1). From the syn-oxime (anion) we obtained 1* in 63% yield, mp 120.5-121.5° [lit (1) mp 118°], ultraviolet spectrum (ethanol) λ max 260mμ (log ε 4.26), [lit (1) λ max 260mμ (log ε 4.27)]. From the anti oxime (anion) we obtained 52% of the isomeric product 4, mp 144-145.5° [lit (1) mp 143-144°], ultraviolet spectrum (ethanol) λ max 251mμ (log ε 4.24) [lit (1) λ max 252mμ (log ε 4.23)]. The structure we assign to 4 is that of the anti-O-triphenylmethylbenzaldoxime and not the isomeric nitrone. This assignment is made on the basis of the previously reported properties of this compound, the absence of an intense longer wavelength absorption characteristic of nitrones such as 3 and the dipole moment measurements shown in Table 1. It is clear that the nitrone 2 would be expected to have a dipole moment

TABLE 1. DIPOLE MOMENTS OF REPRESENTATIVE NITRONES AND O-ALKYL OXIMES

Compound	μ,D	Solvent	Reference
1	0.84 (0.86)	benzene	**
	1.16	benzene	**
	4.31	benzene	**
4	1.23 (1.34)	benzene	**
	3.49	benzene	(3)
	6.20	dioxane	(3)
	6.32	dioxane	(3)

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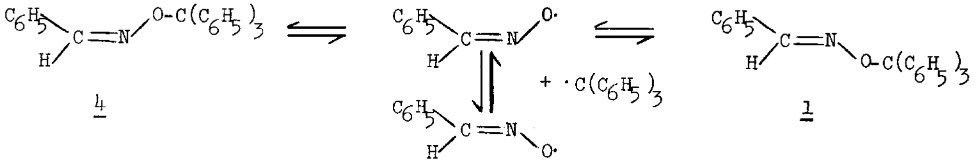
*Since we have recently observed geometrically stereospecific O-alkylations of isomeric p-methylbenzophenone oximes with trityl and benzhydryl halides under similar conditions (4), the geometrical structural assignment for 1 rests on firm ground.

**These values were determined in the course of this work. Dielectric constants of solutions were measured using a Dipolmeter Type DM 01 (Wissenschaftlich-Technische Werkstatten GmbH, Weilheim, Germany). The Guggenheim method (5) was employed for obtaining dipole moments.

several times larger than that exhibited by 4. Consequently this isomeric product must be the *anti* O-trityl oxime.

We next examined the thermal isomerization of 4 to 1. Samples of 4 were sealed in glass tubes under vacuum and heated at 200°. The products were chromatographically separated on alumina-packed columns eluting with hexane-benzene mixtures. A sample analyzed in this way after being heated for 0.5 hr yielded 87% 1 and 9% 4 (yields of pure, crystalline isomers based on initial *anti* isomer employed). A similar isomerization at 200° after 1 hr afforded 89% 1 and 9% 4. The composition of the equilibrium mixture is approximately the same after starting with the *syn* isomer, 1. No other products were detected in these melts. The equilibration data at this temperature lead to a free energy difference between 1 and 4 of approximately 2 Kcal/mole. The decomposition of 4 in diethylcarbitol yields 1, traces of triphenylmethane and other products not yet identified. The decomposition in solution is clearly more complex and will be reported at a later time. The remarkably clean isomerization of 1 and 4 is reminiscent of the relatively high yields of oxime O-ethers from *α,α*-diaryl-N-benzhydrylnitrones in melts (2,6). The evidence in that case as well as in the present points to dissociation to radical pairs followed by recombination (very likely cage recombination). We suggest then that the equilibration between 1 and 4 in melts probably takes place by dissociation to the triphenylmethyl radical and a rapidly equilibrating iminoxy radical as shown. The iminoxy radicals which are represented here have



been previously generated from the two separate oximes with ceric ammonium nitrate at lower temperatures (7). The two geometric forms of the iminoxy radical (but not the oximes) were rapidly interconverting under these conditions. Consistent with the isomerization mechanism proposed is the following observation. When either 1 or 4 was heated between the temperatures of 140 and 180° (with or without solvent), we observed complex radical signals by epr with an intense spectrum from the triphenylmethyl radical easily discernable.

The thermal equilibration of 1 and 4 described above appears to be the first sample of measurable thermal geometrical isomerization of O-alkyl oximes, compounds which normally have remarkable if not spectacular configurational stability (4,8). It is unlikely that 1 and 4 equilibrate without dissociating. This is supported by our recent observation that pure geometric isomers of O-benzhydryl-p-methylbenzophenone oxime show no detectable equilibration at temperatures capable of effecting equilibration of 1 and 4 (4). Nonetheless, the scarcity of published data concerning the thermal configurational stability of isomeric O-alkyl aldoximes leaves this question unresolved and we intend to explore this further. The isomerizations in the present case appear to be facilitated by the considerable stability of the triphenylmethyl radical and its influence on the energy of the activated complex during dissociation. The same triphenylmethyl and iminoxy radical intermediates proposed in the above described isomerizations are probable intermediates in the rearrangement of N-triphenylmethyl-α-phenyl nitrone to 1 (9). Additional equilibration studies of 1 and 4 and suitable model compounds may provide independent evidence for the rapid equilibration of geometrically isomeric iminoxy radicals in the absence of oxidizing agents.

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