Geometrical Isomerism in Cyclic *P*-Hydrogen Phosphites. New Route to *cis*-2-Hydroxy-4-methyl-2-thio-1,3,2-dioxaphosphorinan

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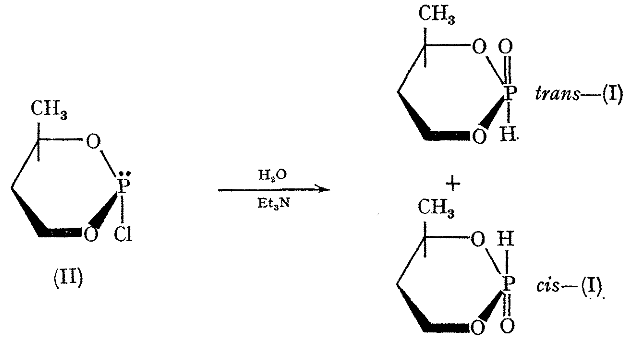
Summary Geometrical isomerism in cyclic *P*-hydrogen phosphites derived from butane-1,3- and -2,3-diols has been studied by n.m.r. spectroscopy.

DIALKYL PHOSPHITES were shown to exist entirely in the phosphonate form, although the phosphite form can be involved in some reactions.[1]

$$(RO)_2\ddot{P}\text{–}OH \rightleftharpoons (RO)_2\underset{\underset{O}{\|}}{P}\text{–}H$$

In suitably substituted cyclic analogues of dialkyl phosphites this situation leads to the occurrence of geometrical isomers, which may have the *P*-hydrogen atom *cis* or *trans* to the ring substituent. For example, the cyclic phosphite (I), derived from butane-1,3-diol, should exist in two isomeric forms *cis*-(I) and *trans*-(I). This best explains the discrepancies in physical properties of the phosphite (I) reported in the literature.[2]

It has now been established that hydrolysis of 2-chloro-1,3,2-dioxaphosphorinan (II) with water in the presence of triethylamine affords the mixture of isomeric phosphites (I) in varying ratios.



They can be very easily distinguished by ^{1}H n.m.r. Taking into account the deshielding effect of the phosphoryl group, P = O,[3] the following assignments of n.m.r. data are suggested (100 MHz, in CDCl$_3$ with Me$_4$Si):

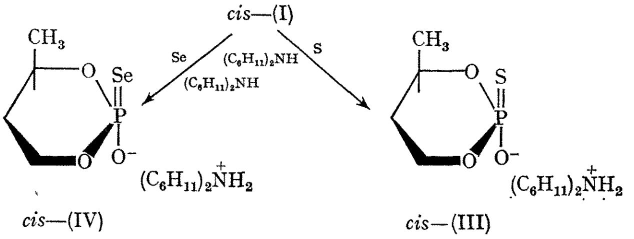
trans-(I): δ(CH$_3$) = 1·45 p.p.m. [quartet, *J*(H–CH$_3$) 6·4 Hz, *J*(P–O–CH–CH$_3$) 1·4 Hz]
δ(H) = 6·96 p.p.m. [doublet, *J*(P–H) 713·2 Hz]

cis-(I): δ(CH$_3$) = 1·43 p.p.m. [quartet, *J*(H–CH$_3$) 6·2 Hz, *J*(P–O–CH–CH$_3$) 1·8 Hz]
δ(H) = 6·89 p.p.m. [doublet, *J*(P–H) 667·3 Hz]

Aksnes *et al.*[4] have recently shown that reaction of cyclic chlorophosphite (II) with ethanol gives the less stable form of the corresponding ester with inversion of configuration at phosphorus. If the hydrolysis of (II) is also accompanied by inversion of configuration, the formation of *trans*-(I) is to be expected. Apparently, the initially formed *trans*-(I) undergoes stereomutation at phosphorus to give more stable *cis*-isomer. This point will be further investigated.

By fractional crystallization of the isomeric mixture from benzene–ether we were able to isolate in the pure state the predominant *cis*-isomer, m.p. 55—58°. The second isomer is a liquid.

cis-Phosphite (I) adds sulphur in the presence of dicyclohexylamine to give dicyclohexylammonium salt of *cis*-2-hydroxy-4-methyl-2-thio-1,3,2-dioxaphosphorinan (III) (m.p. 208—211°, yield 83%). This acid has previously been obtained by a different method.[5] Addition of selenium similarly affords the dicyclohexylammonium salt of the corresponding *cis*-seleno-acid (IV) (m.p. 203—207° yield 70%). These results strongly support our configurational assignment.



The phosphite (V) derived from commercial butane-2,3-diol[2] may exist in three forms. In addition to the *cis–trans*-pair, a *meso*-form is also possible. As expected, the ^{1}H n.m.r. spectrum (at 100 MHz in CDCl$_3$ with Me$_4$Si) showed three doublets for the *C*-methyl groups at 1·39, 1·40, and 1·46 p.p.m. [*J*(H–CH$_3$) 6·1 Hz]. Addition of sulphur to this mixture in the presence of imidazole gave a mixture of imidazolium salts of the corresponding thioacids (m.p. 99—110°, yield 95%), which has C–CH$_3$ absorptions at 1·32, 1·37, and 1·38 p.p.m. (100 MHz in D$_2$O with sodium 3-trimethylsilylpropane-1-sulphonate).

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