

Determination of Relative Configuration with the Aid of Gas Chromatographic Data.

An Example.*

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A brief example will demonstrate how it is possible, on the basis of gas chromatographic data, to deduce the relative configuration of substituents in a cyclopentane skeleton. The structures thus deduced have served as a working hypotheses in future chemical investigations.

(-)-Linalool (i) was heated briefly (about 0.5 sec.) at 650°C. In addition to unchanged starting material, and low-boiling decomposition products, it was possible to isolate from the reaction mixture four isomeric compounds whose spectra could be correlated with those of the 1,2-dimethyl-3-isopropenyl-cyclopentanol (the so-called plinol (ii)).

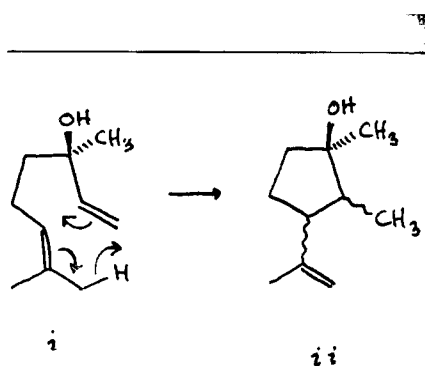


Figure 1

We wished to determine the relative configuration of the substitu-

ents in the four compounds, ii/A, ii/B, ii/C and ii/D, thus isolated. The retention indices of the four compounds were determined on two stationary phases, as shown in Table I, I_{190}^A , signifies the retention index on the stationary phase apiezon-L, and I_{190}^P , the retention index on emulphor-O, both values being for 190°C.

Apiezon-L is a mixture of saturated paraffins, a so-called non-polar stationary phase. With such stationary phases it has been shown (1,2) that there exists a simple relationship between the differences in boiling points of two isomers (δt_b) and the differences in their retention indices (δI^A), namely:

$$\delta I^A \cong 5 \delta t_b$$

The four "plinols," ii/A, ii/B, ii/C and ii/D, which are designated in order of rising I_{190}^A values should therefore, also be in order of increasing boiling points.

As shown in Figure 2, the boiling points of diastereoisomeric alkyl-cyclopentanes (\dagger), are influenced primarily by the relative orientations of the substituents in the 1,2 positions and only secondarily by the orientation of those in the 1,3 positions.

The boiling points of the four diastereoisomers shown in Figure 3, indicate that this rule is also applicable to the more highly substituted cyclopentanes.

Hence plinol-A, with the lowest

retention index must represent the (1,2-trans)-(2,3-trans) isomer, and plinol-B, with the highest retention index, must represent the (1,2-cis)-(2,3-cis) isomer. There were thus two possibilities for both plinol A and D, since, it is, a priori, not certain whether the orientation of the hydroxyl group or that of the methyl group on C-1 has the greater influence on the boiling point. If that of the methyl group plays the determining role, then plinol-A has the structure shown in row (a) (Fig. 4); if however it is that of the hydroxyl group which determines the boiling point, then plinol-A has the (with respect of the OH-group)

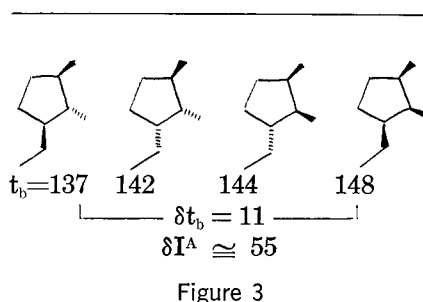


Figure 3

*Presented at the First Wilkins Symposium on Gas Chromatography, September 1964, Basel, Switzerland.

\dagger Amer. Petroleum Inst. Res. Proj. 44.

Table I. Retention Indices of Four Isomeric Plinols

Compound	ii/A	ii/B	ii/C	ii/D
$[\alpha]_D^{20}$	= -39.5	-0.2*	-12.3*	-7.9*
Percent	= 7	4	22	11
I_{190}^A	= 1102	1118	1152	1179
I_{190}^P	= 1395	1443	1448	1500
ΔI_{190}	= 293	325	296	327

*Solution in CCl_4

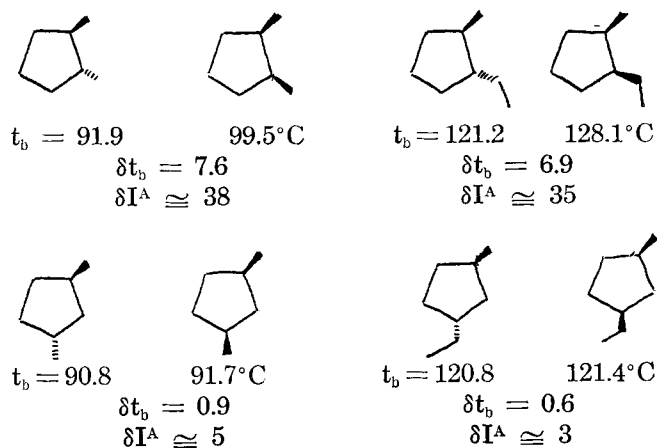


Figure 2

trans-trans structure in row (b) (Fig. 4). Analogous arguments apply in the case of plinol-D.

must have a smaller ΔI value as indicated in Figure 5.

compound shown in Figure 4, A, row (b), (I_{190}^A of plinol B is smaller than the corresponding index of plinol C).

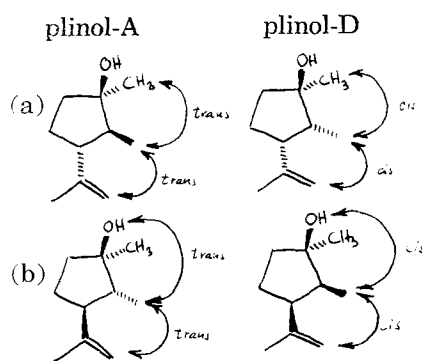


Figure 4

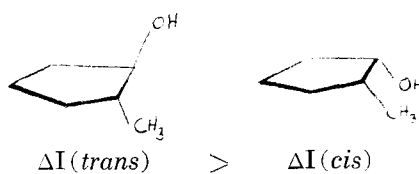


Figure 5

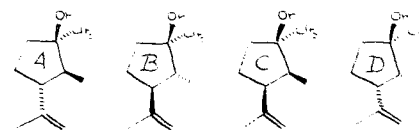


Figure 6

An analysis of the ΔI values (which are defined as the difference of the retention indices on the two stationary phases: $\Delta I = I_T^P - I_T^A$) gives an additional clue for the choice of either row (a) or row (b) of Figure 4. The stronger retention of the "plinols" on the polyethylene glycol stationary phase, Emulphor-O, can be mainly attributed to the adhesion of the "adhering zone," C-OH; the adhering zones, cyclopentane ring and methylene group, play a smaller role.

In the compounds where the methyl group on C-2 is cis to the hydroxyl group, the adhering zone (C-OH) is strongly hindered sterically, therefore such compounds

From these considerations it follows that the OH group of plinol A must be hindered sterically while that of plinol D is not, (the ΔI -values of plinols A and C are approximately 30 I.U. smaller than those of plinols B and D). This information enables us to say that the structures in row (a) (Fig. 4), represent those of plinol A and plinol D respectively. Furthermore this also means that the orientation of the methyl group on C-1 has the greater influence on the boiling point. The structures in row (b) must therefore be those of plinols B and C.

Two other considerations lead to the same result, namely:

1. Plinol B has a large ΔI value, and therefore must have the structure shown in Figure 4, A, row (b).
2. The hydroxyl group is of secondary importance to I_{190}^A , and hence plinol B must be the com-

Chemical evidence supports these structural correlations deduced from chromatographic data (3).

Acknowledgement

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