oil was obtained, which distilled to give 0.66 g. (35%) of unstable pale yellow liquid, b.p. 125–135° (air bath) at 1 mm.

Anal.[21] Calcd. for $C_{11}H_{13}ClO$: C, 67.17; H, 6.66. Found: C, 65.93; H, 6.72.

8-Methoxy-5-chloro-1-tetralone (*5-chloro-8-methoxy-3,4-dihydronaphthalene-1(2)-one.* To a cold solution of 0.20 g. of chloromethoxytetralin in 3.0 ml. of acetic acid was added slowly 0.15 g. of chromic acid in 1 ml. of water and 2 ml. of acetic acid. The mixture was allowed to warm to room temperature, and stand overnight. The green solution was poured into water, extracted twice with ether, washed well with water, and then 10% sodium carbonate. The ethereal solution was dried, and the solvent removed at reduced pressure to give 0.1 g. of yellow oil which showed infrared absorption at 5.94 μ gave on treatment with 2,4-dinitrophenylhydrazine a small amount of derivative, m.p. 245–250° (dec.). The dinitrophenylhydrazone was purified by recrystallization from a relatively large volume of ethyl acetate to give small, very dark red crystals, m.p. 250–252° (dec.).

Anal. Calcd. for $C_{17}H_{15}ClN_4O_5$: C, 52.25; H, 3.87; N, 14.34. Found: C, 52.06; H, 4.01; N, 14.54.

ATLANTA, GA.

[CONTRIBUTION FROM THE WARNER-LAMBERT RESEARCH INSTITUTE]

Substituted 1,4-Dioxanes

ROBERT I. MELTZER, ARNOLD D. LEWIS, AND ALEX FISCHMAN

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A number of substituted 1,4-dioxanes were prepared as part of a search for central nervous system depressants. Hydroxylation of 2-allyl-1,4-dioxane gave 2-(2-hydroxypropyl)- and 2-(2,3-dihydroxypropyl)-1,4-dioxane. 2,2-Dialkyl-1,4-dioxanes were prepared by cyclization of 2-(2-chloroethoxy)-1,1-dialkylethanols. Cyclization of methallyloxyethanol gave 2,2-dimethyl-1,4-dioxane. Three bis(hydroxyalkyl) ethers were also prepared.

Central nervous system depressants have been found among the dioxolanes and among glyceryl ethers.[1] Both these groups of compounds have in common α,β-dioxygen functions. In unreported work which was carried out in these laboratories some years ago, it was found that 2-hydroxymethyl-1,4-benzodioxane also exerts a depressing effect on the central nervous system. We thought it would be in order to explore the pharmacological effect of some 1,4-dioxane compounds as possible central nervous system depressants.

2-Allyl-1,4-dioxane[2] was monohydroxylated to give 2-(2-hydroxypropyl)-1,4-dioxane. The hydroxylation was accomplished using 75% sulfuric acid after finding that 50% sulfuric acid had negligible effect and 100% sulfuric acid gave tars.

The 2-allyl-1,4-dioxane was dihydroxylated according to the hydroxylation procedure of Swern *et al.*,[3] using performic acid to give 2-(2,3-dihydroxypropyl)-1,4-dioxane.

The 2-allyl-1,4-dioxane has greater central nervous system depression activity than either of its hydroxylated derivatives or than dioxane itself.

We next turned to the preparation of some 2,2-disubstituted dioxanes. A survey of the literature showed that no compounds of this type had been reported, and we thought that a quaternary carbon in such structures might enhance central nervous system depression. To this end, methyl β-chloroethoxyacetate[4] was prepared from β-chloroethoxyacetonitrile which was obtained by the action of cuprous cyanide on β-chloroethyl chloromethyl ether. Reaction of this material with ethylmagnesium bromide gave 2-(2-chloroethoxy)-1,1-diethylethanol which was cyclized to 2,2-diethyl-1,4-dioxane (I). The cyclizing agent was sodium ethylate. In a similar manner 2-(2-chloroethoxy)-1,1-dibutylethanol was prepared and cyclized to 2,2-dibutyl-1,4-dioxane (II) using sodium amide. When phenylmagnesium bromide in large excess was allowed to react with methyl chloroethoxyacetate there was obtained 1,1-diphenylethylene glycol. This compound probably resulted from the action of the excess phenylmagnesium bromide as a base, on the expected 2-(2-chloroethoxy)-1,1-diphenylethanol to give the glycol directly or *via* the intermediate 2-(vinyloxy)-1,1-diphenylethanol. Hydrolysis of this vinyl ether would furnish the 1,1-diphenylethylene glycol. When a more nearly theoretical amount of phenylmagnesium bromide was used in the reaction, the desired product, 2-(2-chloroethoxy)-1,1-diphenylethanol, was obtained. There was also ob-

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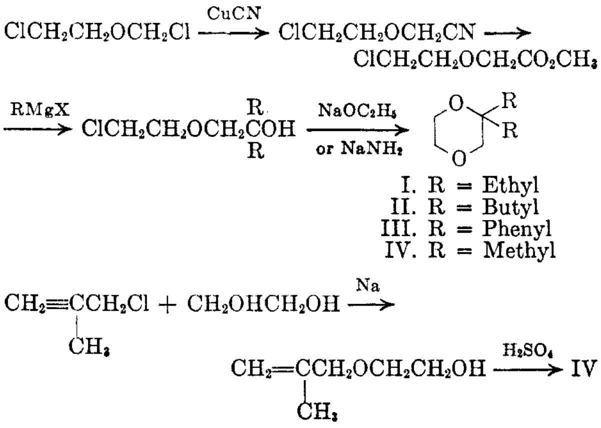
(1) F. M. Berger, *J. Pharmacol. Exptl. Therap.*, **93**, 470 (1948); *Arch. intern. pharmacodynamie*, **85**, 474 (1951); F. M. Berger, V. Boekelheide, and D. S. Tarbell, *Science*, **108**, 561 (1948); W. Bradley, J. Forrest, and O. Stephenson, Brit. Patent **613,735**; W. Bradley and J. Forrest, Brit. Patent **628,497**; C. H. Hine, H. E. Christensen, F. J. Murphy, and H. Davis, *J. Pharmacol. Exptl. Therap.*, **97**, 414 (1949); W. A. Lott, *Trans. N. Y. Acad. Sci.*, **11**, 2 (1948); G. L. Sauvage and V. Boekelheide, *J. Am. Chem. Soc.*, **71**, 2588 (1949); Boehringer and Sohne, Ger. Patent **226,454**; V. Boekelheide, L. Liberman, J. Figueras, C. Krespan, F. C. Pennington, and D. S. Tarbell, *J. Am. Chem. Soc.*, **71**, 3303 (1949); J. R. Geigy, Brit. Patent **555,191**; A. Grun, U. S. Patent **2,343,053**; C. H. Hine, H. Davis, and F. J. Murphy, *Arch. intern. pharmacodynamie*, **81**, 507 (1950).

(2) R. K. Summerbell and R. R. Umhoefer, *J. Am. Chem. Soc.*, **61**, 3016 (1939).

(3) D. Swern, G. N. Billin, and J. T. Scanlan, *J. Am. Chem. Soc.*, **68**, 1504 (1946).

(4) E. J. Salmi, R. Leimu, and H. Kallio, *Sumoen Kemistilehti*, **178**, 17 (1944); *Chem. Abstr.*, **40**, 6491 (1946).

tained some material which was probably 1,1-diphenylethylene glycol. Treatment of 2-(2-chloroethoxy)-1,1-diphenylethanol with sodium gave a small amount of the desired 2,2-diphenyl-1,4-dioxane (III). This compound has since been reported by Summerbell *et al.*[5] The trend of biological activity shown by these 2,2-disubstituted-1,4-dioxanes indicated that an improvement might be found in 2,2-dimethyl-1,4-dioxane. This compound was prepared by condensing methallyl chloride with ethylene glycol and cyclizing the resulting methallyloxyethanol using sulfuric acid. None of the compounds, however, had sufficient activity to warrant clinical investigation.



I. R = Ethyl
II. R = Butyl
III. R = Phenyl
IV. R = Methyl

In the course of the preparation of these dioxanes, screening indicated that the intermediate chloroalkoxyethanols caused central nervous system depression. This suggested the preparation of some compounds which had two tertiary alcohol groups β to an ether group. To this end diethyl diglycolate was prepared and allowed to react with methyl, ethyl, and butyl Grignard reagents to yield respectively bis(2-hydroxy-2-methylpropyl) ether, bis(2-hydroxy-2-ethylbutyl) ether, and bis(2-hydroxy-2-butylhexyl) ether. None of these compounds showed sufficient central nervous system depression to warrant further interest.

EXPERIMENTAL[6]

2,3-Dichloro-1,4-dioxane[7] was prepared according to the literature,[8] which reported a 61% yield. A 48% yield was obtained. The presence of unreacted dioxane reported by Summerbell and Bauer was not confirmed. A 28% excess of chlorine was used. The amount of chlorine required was not indicated in the literature.

1,4-Dioxene was prepared in 52% yield (reported 68%) from 2,3-dichloro-1,4-dioxane using ethylmagnesium bromide.[8] When 890 g. (5.7 moles) of 2,3-dichlorodioxane in 3.4 l. of ether was added to a mixture of 234 g. (9.65 moles) of magnesium and 288 g. (1.1 mole) of iodine[2] an 81% yield (395 g.) of product, b.p. 93.8–94.1°, n_D^{26} 1.4347 was obtained. (Reported 49%).

2-Chloro-1,4-dioxane was prepared from 1,4-dioxene in 54–68% yield using the procedure described in the literature.[8]

2-Allyl-1,4-dioxane was prepared from allylmagnesium bromide and 2-chloro-1,4-dioxane in 72–81% yield. The reported[2] yield was 73%.

2-(2-Hydroxypropyl)-1,4-dioxane. To 145 ml. of 75% (w/w) sulfuric acid at −15° was added 15 g. (0.117 mole) of 2-allyl-1,4-dioxane. The reaction mixture was allowed to warm to room temperature (29–30°) and then required cooling. The reaction mixture was kept at 25–30° for 6 hr. and poured into 200 g. of ice. A total of 550 g. of barium carbonate (theory 400 g.) was required to neutralize the acid. The filtered solution, on evaporation using a water pump, gave 15 g. of residue which was distilled through a Vigreux column at 85° (2.8 mm.) and twice redistilled through a 3-foot jacketed wire screen column at 123.5° (23 mm.), n_D^{24} 1.4539. The yield was 3.5 g. (21%).

Anal. Calcd. for $C_7H_{14}O_3$: C, 57.51; H, 9.65. Found: C, 57.38; H, 9.51.

2-(2,3-Dihydroxypropyl)-1,4-dioxane. To 20.0 g. (0.156 mole) of 2-allyl-1,4-dioxane was added 222 g. of 98–100% formic acid and then 17.0 ml. (0.164 mole) of 33.2% (as determined by permanganate titration) hydrogen peroxide. The reaction was heated to 40° and kept at that temperature by alternate cooling and heating for 5 hr. Titration[9] with thiosulfate at that time showed that the reaction was still incomplete. The reaction mixture was allowed to stand overnight at about 30° (total of 22 hr.). Titration showed the reaction to be complete because essentially all the performic acid had reacted. The reaction mixture was concentrated on a steam bath under water pump pressure and the water soluble residue (allyldioxane is not water soluble) was refluxed with 21.6 g. of potassium hydroxide in 312 ml. of ethanol for 1 hr. and allowed to stand overnight. The precipitate, potassium formate, was removed by filtration as was the potassium chloride which was formed on subsequent acidification with alcoholic hydrogen chloride. The filtrate was distilled through a one-foot Vigreux column b.p. 136–138° (2–2.2 mm.). The distillate was acidic and was therefore refluxed for an hour with 1 g. of sodium hydroxide in 100 ml. of ethanol. The solution was filtered and twice distilled. The yield was 7.5 g. (33%) of product, b.p., 136–137° (1.2 mm.), n_D^{26} 1.4788. The product is water soluble and ether insoluble.

Anal. Calcd. for $C_7H_{14}O_4$: C, 51.84; H, 8.70. Found: C, 51.63; H, 8.78.

Methyl (β-Chloroethoxy)acetate was prepared according to Salmi, *et al.*[4]

2-(2-Chloroethoxy)-1,1-diethylethanol. To ethylmagnesium bromide prepared from 229 g. (2.09 moles) of ethyl bromide in 300 ml. of anhydrous ether, was added with cooling 140 g. (0.925 mole) of methyl (β-chloroethoxy)acetate in 200 ml. of anhydrous ether over a period of 1 hr. Stirring of the suspension was continued for another hour and then 225 ml. of a solution of 150 g. of ammonium chloride in 350 ml. of water was added dropwise with cooling. Stirring was continued until a readily settling precipitate formed. Filtration through a sintered glass funnel was followed by distillation thru a 2.5-foot helices-packed column. The fraction distilling at 114° (17 mm.) was collected, n_D^{28} 1.4478. The yield was 108 g. This material decolorized permanganate solution and was redistilled twice more and substituted for analysis after the last distillation at 115.5° (16.5 mm.), n_D^{28} 1.4472. The pure product did not, of course, decolorize permanganate.

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(5) R. K. Summerbell, J. P. Settle, and M. Kland-English, *J. Org. Chem.*, **23**, 932 (1958); R. K. Summerbell and H. E. Lunk, *J. Am. Chem. Soc.*, **79**, 4802 (1957).

(6) Analyses were carried out by Miss Linda Einstein. Temperatures are uncorrected.

(7) Some of this material was kindly supplied to us by Kay-Fries Chemicals, Inc., W. Haverstraw, N. Y.

(8) R. K. Summerbell and L. N. Bauer, *J. Am. Chem. Soc.*, **57**, 2364 (1935).

(9) R. I. Meltzer and J. Doczi, *J. Am. Chem. Soc.*, **72**, 4986 (1950).

Anal. Calcd. for $C_8H_{17}O_2Cl$: C, 53.18; H, 9.49; Cl, 19.62. Found: C, 53.19; H, 9.80; Cl, 19.65.

2-(2-Chloroethoxy)-1,1-dibutylethanol was prepared in the same manner as 2-(2-chloroethoxy)-1,1-diethylethanol. The product distilled at 128–138° (6–8 mm.) and was redistilled through a 2.5-foot Fenske column at 101–103° (0.5 mm.), n_D^{28} 1.4497. The yield was 45% of theoretical.

Anal. Calcd. for $C_{12}H_{25}O_2Cl$: Cl, 14.97; C, 60.87; H, 10.64. Found: Cl, 14.97; C, 61.18; H, 10.80.

1,1-Diphenylethylene glycol. To an ether solution of phenylmagnesium bromide prepared from 314 g. (2.2 moles) of bromobenzene was added 84.7 g. (0.55 mole) of methyl (β-chloroethoxy)acetate at a rate to maintain reflux of the reaction mixture. Refluxing was continued for an additional hour after the spontaneous reaction had subsided. The reaction mixture was decomposed with sufficient 20% aqueous ammonium chloride to dissolve all solid. The aqueous layer was extracted with ether and the combined ether solutions were dried over magnesium sulfate, filtered, and concentrated to remove the ether and leave a solid residue. This solid after 2 recrystallizations from benzene melted at 122° and weighed 65 g. (55%). A 2-g. sample, recrystallized repeatedly from isopropanol and from isopropanol-Skellysolve B, melted at 123.5–124°. Analysis corresponded to the empirical formula for 1,1-diphenylethyleneglycol reported to melt at 121°.[10]

Anal. Calcd. for $C_{14}H_{14}O_2$: C, 78.48; H, 6.59. Found: C, 78.19; H, 6.82.

The acetate of this glycol, prepared by reaction with acetic anhydride, melted at 148–148.5 after recrystallization from absolute alcohol. The reported melting point is 145.5°.[11]

2-(2-Chloroethoxy)-1,1-diphenylethanol. To a solution of phenylmagnesium bromide prepared from 141 g. (0.9 mole) of bromobenzene in 200 ml. of ether, was added 62 g. (0.4 mole) of methyl (β-chloroethoxy)acetate in 80 ml. of ether. The reaction mixture was heated at reflux for 1 hr. after spontaneous reaction had ceased and then was decomposed with aqueous ammonium chloride. The aqueous layer was extracted with ether and the ether solutions were combined, dried over magnesium sulfate, filtered, and concentrated to remove solvent. The oily residue crystallized on cooling and scratching. The crystalline mass, 112 g., was triturated with cold Skellysolve B and filtered to give a residue of 80 g., m.p. 40–43°. By careful, repeated recrystallizations from large volumes of Skellysolve A, 30 g. (27%) of product m.p. 59–59.5° was obtained. Some material melting at 112–115°, probably impure 1,1-diphenylethylene glycol, was obtained from the less soluble residue.

Anal. Calcd. for $C_{16}H_{17}O_2Cl$: C, 69.43; H, 6.19; Cl, 12.81. Found: C, 69.44; H, 6.47; Cl, 12.73.

2,2-Diethyl-1,4-dioxane. To dry sodium ethylate, prepared from 5.7 g. (0.25 mole) of sodium, in 150 ml. of dry benzene, was added 36 g. (0.2 mole) of 2-(2-chloroethoxy)-1,1-diethylethanol in 100 ml. of dry benzene, over a period of 25 min. Distillation of the benzene was carried out at the same rate as addition during the addition and more slowly thereafter for a total of about 2.5 hr. The benzene was replenished as necessary to keep the volume of the reaction mixture about constant. A total of 400 ml. of distillate was collected. Filtration of the reaction mixture gave 12.5 g. of water-soluble chloride-containing alkaline solid (theory, 10.7 g. sodium chloride plus 3.4 g. sodium ethylate). Alcoholic hydrogen chloride (25 ml. of 5*N*) was added to the filtrate and the reaction mixture was distilled after a filtration. The distillate contained chlorine and was therefore heated with solid sodium hydroxide for about 5 min. and redistilled. The distillate boiling at 168–176° was redistilled through a 1-foot metal helices-packed column and 10 g. (34%) of product distilling at 168°, n_D^{25} 1.4377, was collected.

Anal. Calcd. for $C_8H_{16}O_2$: C, 66.63; H, 11.18. Found: C, 66.78; H, 11.31.

2,2-Dibutyl-1,4-dioxane. To a suspension of about 8 g. of sodamide (slightly over 0.2 mole) in 100 ml. of dry benzene, was added at reflux with stirring over a period of 0.5 hr., 46.5 g. (0.2 mole) of 2-(2-chloroethoxy)-1,1-dibutylethanol in 100 ml. of dry benzene. Ammonia was evolved from the slightly exothermic reaction. After 5 hr. at reflux, 10 ml. of methanol was added and solid material was removed by centrifugation. The solid was washed by centrifugation using methanol and then ether. The precipitate weighed 9.2 g. (theory, 11.7 g.). The supernatant liquid and washings were combined and treated with alcoholic hydrogen chloride and again centrifuged. Evaporation of the solvent from the supernatant solution left 51.6 g. of residue from which was distilled 28 g. (71.5%) of product 97.5–100° (5–6 mm.). This was redistilled after slurrying with magnesium sulfate and filtering. This material all distilled at 97–99° (6.5 mm.), n_D^{27} 1.4450.

Anal. Calcd. for $C_{12}H_{24}O_2$: C, 71.95; H, 12.08. Found: C, 71.68; H, 11.92.

2,2-Diphenyl-1,4-dioxane. To 7.39 g. of sodamide slurry (containing about 0.18 mole of sodamide) suspended in 100 ml. of dry refluxing benzene was added 32.1 g. (0.125 mole) of 1,1-diphenyl-2-(2-chloroethoxy)ethanol in 100 ml. of benzene. The reaction mixture was allowed to reflux for 4.5 hr., cooled, treated with 6 ml. of methanol, and filtered. Evaporation of the filtrate gave an oil which solidified. This material was quite basic and was taken up in 300 ml. of ether and 300 ml. of water, acidified, and extracted with ether. Evaporation of the ether left a very viscous oil. An attempt to distill a sample of this material at 1 mm. pressure gave a small amount of solid m.p. 120–122°. This material depressed the melting point of 1,1-diphenylethylene glycol. Distillation of the bulk of the material was carried out and 3 fractions collected, up to 156° (1 mm.), 156–165° (1 mm.), and 165–167° (1 mm.). These solidified and melted respectively at about 120°, 45°, and 55°. These were recrystallized from ethanol. The first two were combined when they both melted at over 115° and purification gave a product m.p. 123.5–124°. The yield was poor. The product did not decolorize permanganate.

Anal. Calcd. for $C_{16}H_{16}O_2$: C, 79.97; H, 6.71: Found: C, 79.93; H, 6.64.

The third distillate fraction melted at 55–57° after recrystallization.

2,2-Dimethyl-1,4-dioxane. To a solution of 46 g. (2 moles) of sodium in 500 ml. of ethylene glycol, was added 182 g. (2 moles) of methallyl chloride. The reaction mixture was refluxed for 2 hr., filtered, and distilled. The fraction distilling at 82–83° (25 mm.) (175 g.)[12] was collected and redistilled at 172°, n_D^{25}, 1.4372. This methallyloxyethanol weighed 162 g. (70%) and decolorized permanganate.

To 50 g. (0.43 mole) of ice cooled methallyloxyethanol was added with swirling 2 ml. of concentrated sulfuric acid. The reaction mixture was then placed under a helices-packed column in a bath at 86° at 5 mm. pressure. Practically everything distilled out of the reaction flask and was collected in the dry ice trap of the pump. Distillation of this material gave 20.5 g. (41%) of product b.p. 120–121°, n_D^{25} 1.4106, which did not decolorize permanganate.

Anal. Calcd. for $C_6H_{12}O_2$: C, 62.04; H, 10.42; Found: C, 62.10; H, 10.58.

Bis(2-hydroxy-2-ethylbutyl) ether. To a Grignard reagent prepared from 142 g. (1.3 mole) of ethyl bromide in 350 ml. of dry ether, was added 49.2 g. (0.26 mole) of ethyl diglycolate in 450 ml. of ether at such a rate as to maintain refluxing. The reaction mixture was kept at reflux for an additional hr. and then allowed to stand overnight before decomposition with saturated ammonium chloride (125 ml.) and 20 g. of solid ammonium chloride. The resulting granu-

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(10) C. Paal and E. Weidenkaff, *Ber.*, 39, 2062 (1906).

(11) R. Stoermer, *Ber.*, 39, 2288 (1906).

(12) U. S. Patent **2,148,437** reports b.p. 94–95° (48 mm.) for product obtained *via* another route.

lar precipitate was removed by filtration after stirring for 2 hr. Distillation of the filtrate gave 24 g. of product distilling at 92–97° (0.4 mm.) which solidified. The product was further purified by redistillation at 100° (1 mm.) to give 19 g. (25%) of product which melted at 38–40°.

Anal. Calcd. for $C_{12}H_6O_3$: C, 66.01; H, 12.00. Found: C, 66.18; H, 12.07.

Bis(2-hydroxy-2-methylpropyl) ether. This was prepared similarly to the bis(2-hydroxy-2-ethylbutyl) ether and distilled at 78° (0.2 mm.). The product was purified by recrystallization from Skellysolve B and melted at 65–66°[13] (22% yield).

Anal. Calcd. for $C_8H_{18}O_3$: C, 59.23; H, 11.18. Found: C, 59.19; H, 11.31.

Bis(2-hydroxy-2-butylhexyl) ether. This was prepared similarly to the bis(2-hydroxy-2-ethylbutyl)ether but on distillation of the reaction solvent the product was purified by recrystallization from Skellysolve B instead of by distillation. The product melted at 85–85.5° (23% yield).

Anal. Calcd. for $C_{20}H_{12}O_3$: C, 72.67; H, 12.81. Found: C, 72.77; H, 13.08.

MORRIS PLAINS, N. J.

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(13) M. Godchot, *Compt. rend.*, **184**, 820 (1927).

[CONTRIBUTION FROM THE DEPARTMENT OF CHEMISTRY AND CHEMICAL ENGINEERING, CASE INSTITUTE OF TECHNOLOGY]

Preparation of Substituted 1,4-Dioxanes

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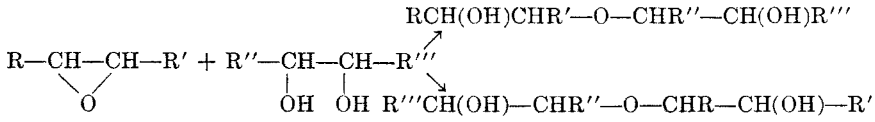
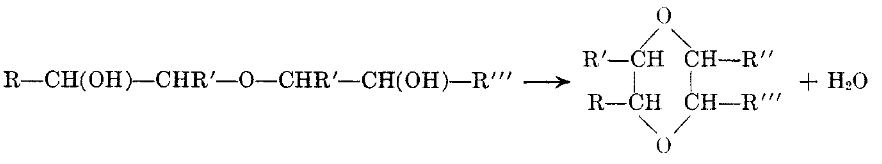
Olefin oxides and glycols react at low temperatures to give dihydroxyethers which on heating lose water to form substituted dioxanes. This seems to be a general method for making substituted dioxanes and a wide variety of such compounds can be made by proper selection of the olefin oxide and the glycol. The method is particularly useful in preparing unsymmetrical dioxanes.

It has been reported in the literature[2,3] that olefin oxides react with glycols to form dihydroxyethers. The reaction may be represented as follows:





It may be expected also that ring closure might occur to form 1,4-dioxanes, but this reaction has not been reported.

The present work describes the preparation of a number of 1,4-dioxanes from certain olefin oxides and glycols by addition and ring closure.

Reactions were carried out with three olefin oxides and five 1,2-glycols. The olefin oxides used were propylene oxide, 2,3-butylene oxide, and styrene oxide; the glycols were ethylene glycol, 1,2-propanediol, 2,3-butanediol, phenyl-1,2-ethanediol, and catechol. Eight substituted *p*-dioxanes were obtained, including methyldioxanes, phenyldioxanes, and phenylmethyldioxanes. In most of the reactions, concentrated sulfuric acid was used as a catalyst and in all but two reactions an excess of glycol was used.

EXPERIMENTAL

The reaction of propylene oxide and ethylene glycol is illustrative of the experimental procedures used.

Ethylene glycol (186 g., 3 mol.) was placed in a 3-neck flask in an ice bath and 10 g. of concentrated sulfuric acid was added gradually. Propylene oxide (116 g., 2 mol.) was then added dropwise during a 30-min. period with constant stirring of the mixture at temperatures below 30°. After addition of the oxide was complete, the mixture was gradually heated to reflux temperature and was then stirred under reflux at 120° for 2 hr. and allowed to cool to room temperature. The first distillation gave a distillate boiling at 75–97° at atmospheric pressure leaving a black tarry residue. The distillate separated into two layers on cooling. Each layer was separately extracted with ether and the combined ether extracts were dried over anhydrous sodium sulfate. The ether was evaporated and the residue redistilled.

Two low boiling fractions were obtained: the fraction boiling from 39–78° consisted largely of propionaldehyde and the one boiling from 80–100° was principally dioxane and water. Monomethyl-1,4-dioxane (b.p. 106–109° at 741 mm. n_D^{20} 1.4187) was then obtained. The yield was 54 g. or 27%. The infrared absorption spectra, which indicated clearly

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[1] From the M.S. thesis of Birgit Ekman Jacobson.

[2] P. A. Levene and A. Walti, *J. Biol. Chem.*, **75**, 325 (1927).

[3] M. S. Kharasch and W. Nudenberg, *J. Org. Chem.*, **8**, 189 (1943).