

high field conductance quotient has the value approximately 1.5% at 200 kv./cm., compared to a value of 4% for glycine.³ Although the capacitance required for balance was appreciably higher than with the usual electrolytes, there was no evidence of change of capacitance with increasing field, or of time-dependent effects during the 4-microsecond pulses employed. The use of hydrochloric acid as a reference electrolyte minimized apparent bridge unbalance due to polarization occurring in different degree in the measurement and reference cells. Hydrochloric acid is a troublesome electrolyte on which to perform conductance measurements at 10^{-4} M concentration, however. The slight curvature observable in the results of Fig. 1 is attributed to variability of the hydrochloric acid reference solution, not to the amino acid.

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Preparation and Properties of Some Octyl Ethers¹

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A few octyl ethers are mentioned in the literature but few physical constants are given and considerable discrepancy exists for those reported. In this investigation, seventeen octyl ethers were prepared by the Williamson reaction and their boiling points, melting points, densities and refractive indices determined.

functions of the molecular weight. The molecular refractions are also linear functions of the molecular weight, and agree closely with the calculated values. The odors of the octyl ethers ranged from pleasant and rather sweet in the lower molecular weight range studied to disagreeable in the mid-molecular weight range. Those of higher molecular weight had faint distinctive but pleasant odors.

Experimental

Most of the materials used were the best grade obtainable from Eastman Kodak Company. If the pure grade was not available, the material was purified by fractional distillation before using.

The general procedure consisted of allowing 11.4 g. (0.5 mole) of sodium to react with 78 g. (0.6 mole) of 1-octanol in a one-liter three neck flask fitted with a dropping funnel, mechanical stirrer and condenser. Gentle heat was applied until the reaction was complete. One-half mole of the alkyl halide (the bromides were used in every case except in the preparation of allyl octyl ether) was then added slowly with stirring and the mixture refluxed for 2 to 4 hours. In some cases it was necessary to cool the flask during the initial addition of the alkyl halide. Moisture was excluded from the reaction flask by the use of drying tubes. The resulting ethers were washed with water, dried, fractionated through a Vigreux column, allowed to stand over sodium for several days to remove any water and alcohol, and then distilled from sodium through a Lecky-Ewell column having an efficiency of approximately 15 theoretical plates. The fractionations were carried out at atmospheric pressure and the only ones which showed any tendency to decompose were those of high molecular weight such as dodecyl octyl and tetradecyl octyl ethers. The yields of the ethers were usually about 50% of the theoretical.

The boiling points were determined from a distillation curve for the purified ethers. A standard taper, three-inch immersion thermometer was used for temperatures below 250°. For higher temperatures a 360° total immersion thermometer was used, and stem corrections applied. The purified ethers were subjected to fractional freezing and re-

TABLE I
PHYSICAL CONSTANTS FOR SOME OCTYL ETHERS

Ether	B.p., °C. ^a	M.p., °C.	d_{20}^{20}	n_D^{20}	n_D^{25}	Carbon, %		Hydrogen, %	
						Calcd.	Found ^b	Calcd.	Found ^b
Methyl octyl	172.0 ^c	-52.5	0.7845 ^d	1.4104	1.4082				
Ethyl octyl	186.5 ^d	-51.0	.7847 ^d	1.4127	1.4102				
<i>n</i> -Propyl octyl	204.0 ^e	-46.0	.7883 ^e	1.4162	1.4142				
Isopropyl octyl	198.5	-60.5	.7821	1.4131	1.4110	76.67	76.63	14.04	13.95
Allyl octyl	206.0 ^f	-61.0	.8096	1.4267	1.4247	77.58	77.53	13.02	13.05
<i>n</i> -Butyl octyl	221.5 ^g	-44.0	.7925 ^g	1.4201	1.4181				
<i>s</i> -Butyl octyl	214.0	-54.0	.7891	1.4179	1.4157	77.35	77.25	14.06	14.29
Isobutyl octyl	217.0	-43.0	.7856	1.4169	1.4150	77.35	77.28	14.06	14.21
<i>n</i> -Amyl octyl	240.0	-28.0	.7965	1.4238	1.4215	77.93	77.99	14.09	13.96
Isoamyl octyl	234.5	-56.5	.7938	1.4221	1.4197	77.93	78.09	14.09	14.22
<i>n</i> -Hexyl octyl	257.5	-27.0	.8030	1.4297	1.4276	78.43	78.67	14.10	14.30
<i>n</i> -Heptyl octyl	272.6 ^h	-13.8	.8018 ^h	1.4291	1.4270				
Diocetyl	286.5 ⁱ	-7.6	.8064 ⁱ	1.4324	1.4305				
<i>n</i> -Nonyl octyl	301.0	-4.4	.8068	1.4341	1.4322	79.61	79.89	14.15	14.40
<i>n</i> -Decyl octyl	315.5	3.5	.8095	1.4361	1.4342	79.92	79.96	14.16	14.19
<i>n</i> -Dodecyl octyl	355.0	5.8	.8112	1.4406	1.4388	80.46	80.23	14.18	14.15
<i>n</i> -Tetradecyl octyl	383.0	15.6	.8186	1.4426	1.4408	80.90	80.84	14.20	14.18

^a Corrected. ^b Appreciation is hereby acknowledged to J. W. Johnson and T. L. Stegant for conducting these analyses. ^c B.p. 173°, d. 0.8014 (0/0°), *Beil.*, 1, 419. ^d B.p. 182-184°; 189.2°; d. 0.7941 (17°), 0.8008 (0°), *Beil.*, 1, 419. ^e B.p. 207°, d. 0.8039 (0°), *Beil.*, 1, 419. ^f B.p. 87-88° (12 mm.), *C. A.*, 40, 5418 (1946). ^g B.p. 225.7°, d. 0.8069 (0°), *Beil.*, 1, 419. ^h B.p. 278.8°, d. 0.8182 (0°), *Beil.*, 1, 419. ⁱ B.p. 280-282°, d. 0.8050 (17/17°), *Beil.*, 1, 419.

The physical constants for the octyl ethers prepared are shown in Table I. Within the range of this investigation, the boiling points are linear

(1) Abstracted from a thesis submitted by George W. Panian in partial fulfillment of the requirements for the Master of Arts degree, June, 1951.

(2) Linde Air Products Co., Tonawanda, N. Y.

freezing in a Dry Ice-isopropyl alcohol bath. When the cooling curve data indicated high purity of product, a melting point was taken on the solidified material. Densities were obtained with the aid of dilatometers used as pycnometers. These had graduations of 0.02 ml. between 10.00 ml. and 10.50 ml. and were calibrated with water at 20°. The refractive indices were determined at 20 and 25° with a Bausch and Lomb Abbé type refractometer.

In some cases the procedure described above proved unsuccessful or else resulted in very low yields of the desired ether. The preparation of these ethers by modified procedures is described below.

***n*-Propyl Octyl Ether.**—Only negligible yields of *n*-propyl octyl ether were formed by the addition of 1-bromopropane to sodium octoxide. A 30% yield of this ether was obtained by the addition of 1-bromooctane to sodium propoxide.

Isopropyl Octyl Ether.—The same difficulty was encountered with isopropyl octyl ether as with its normal isomer. A 12% yield of this material was obtained by the addition of 1-bromooctane to sodium isopropoxide.

Allyl Octyl Ether.—This ether was formed by the addition of allyl chloride to sodium octoxide. However, when distilling from sodium a reaction seemed to occur and a very low yield of the ether was obtained.³ Acetyl chloride was then used instead of the sodium to remove any water and alcohol which might be present. A yield of 66% of allyl octyl ether was prepared by fractionation of this product.

Isobutyl Octyl Ether.—An 80% yield of this ether was obtained by the addition of 1-bromooctane to the sodium derivative of 2-methyl-1-propanol; the reaction of sodium octoxide with 1-bromo-2-methylpropane did not prove to be very satisfactory.

***s*-Butyl Octyl Ether.**—A 56% yield of this ether was formed by the addition of 1-bromooctane to the sodium derivative of 2-butanol. The addition of 2-bromobutane to sodium octoxide resulted in low yields of the desired ether.

(3) Letsinger and Traynham, *THIS JOURNAL*, **70**, 3342 (1948), report the reaction of diallyl ether with sodium to give allylsodium.

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Configuration of Steroid Bromoketones; a Correction

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In contradiction of a report by Fieser and Dominguez,¹ Corey² has presented evidence that 2-bromocholestanone is the 2 α -bromo epimer since on reduction it yields a bromohydrin that on hydrogenation gives cholestanol and on treatment with base gives 2 β ,3 β -oxidocholestane. We have now found that by chromatography of the sodium borohydride reduction mixture it is possible to isolate two bromohydrins, one corresponding to that of Corey and giving the same reaction products, and the other identified as 2 α -bromocholestane-3 α -ol by hydrogenation to epicholestanol and by dehydrohalogenation to cholestanone. Corey's conclusion is thus fully substantiated. The material that Dominguez had in hand appears from the constants to have been a mixture of the two bromohydrins.

We also repeated the experiments¹ on the bromo derivative of testane-17 β -ol-3-one acetate and again were able to isolate both C₈-epimeric bromohydrins. One gives the transformations described for the sole product previously isolated, which appears to have been reasonably homogeneous; the other gives reactions indicating that it is the 3 β ,4 β -bromohydrin, hence the assignment of configuration is correct. Revised *M_D* differences between the methyl cholinate and 17 β -acetoxytestane derivatives are as follows: 3-ketones, +46; 4 β -bromo-3-ketones, +88; 3 α -hydroxy-4 β -bromides, +69; 3 α -acetoxy-4 β -bromides, +41; 3 α ,4 α -oxides,

(1) L. F. Fieser and J. A. Dominguez, *THIS JOURNAL*, **75**, 1704 (1953).

(2) E. J. Corey, *ibid.*, **75**, 4832 (1953).

+15; 3 β -hydroxy-4 β -bromides, +7; 3 β -acetoxy-4 β -bromides, +48.

Experimental

2 α -Bromocholestane-3 α -ol.—A mixture of 6.71 g. of 2 α -bromocholestane-3-one and 0.6 g. of sodium borohydride in 250 cc. of absolute ethanol was let stand for 12 hr. at 25°, diluted with water and extracted with ether. The total product in 40 cc. of 1:1 petroleum ether-benzene was adsorbed on 150 g. of alumina, which was then eluted with 100-cc. portions of solvent mixture of composition adjusted each time to higher eluant potency; a plot of the weights of material eluted showed two well separated peaks indicative of a two-component system. The earlier petroleum ether-benzene (2:3 to 1:4) eluates gave a total of 2.12 g. of the 2 α -epimer, m.p. 116–118°, after crystallization from ether-methanol. Rechromatographed and recrystallized, the substance formed big long blades, m.p. 117–118°, α_D +33° Chf (*c* 2.31), λ^{Chf} 2.78 μ .

Anal. Calcd. for C₂₇H₄₇OBr (467.57): C, 69.35; H, 10.13; Br, 17.13. Found: C, 69.21; H, 9.98; Br, 17.25.

The acetate crystallized from chloroform-methanol in soft needles, m.p. 195–195.5°, α_D +57° Chf (*c* 2.35).

Anal. Calcd. for C₂₈H₄₉O₂Br (509.60): C, 68.35; H, 9.69. Found: C, 68.43; H, 9.85.

A mixture of 205 mg. of 2 α -bromocholestane-3 α -ol, 0.5 g. of potassium hydroxide, 25 cc. of methanol and 10 cc. of ether was warmed to effect solution, let stand at 25° for 48 hr., diluted and extracted with ether. Crystallization from ether-methanol gave 91 mg. of crude product, m.p. 118–120°, λ^{Chf} 5.84 μ . Chromatography and recrystallization gave cholestanone, m.p. 129–130°, α_D +42° Chf (*c* 2.12), undepressed on admixture with an authentic sample.

Hydrogenation of 222 mg. of 2 α -bromocholestane-3 α -ol in 30 cc. of 95% ethanol in the presence of 80 mg. of 10% palladium-charcoal and 0.6 g. of potassium hydroxide was complete in about 10 min. On concentration of a washed and dried ethereal extract of the reaction mixture epicholestanol crystallized (123 mg., m.p. 183–184°). Recrystallized from chloroform-methanol, the alcohol melted at 185–186°, α_D +23° Chf (*c* 2.41). The acetate crystallized from ether-methanol as small prisms, m.p. and mixed m.p. 97°, α_D +27° Chf (*c* 1.83).

2 α -Bromocholestane-3 β -ol was obtained from later fractions of the above chromatogram (benzene-ether, 49:1; 19:1; 9:1); crystallization from ether-methanol gave a total of 3.33 g. of prisms, m.p. in the range 95–110°. This was rechromatographed and then recrystallized from ether-methanol to the constant m.p. 113–114°, α_D +12° Chf (*c* 3.16), λ^{Chf} 2.79 μ .

Anal. Calcd. for C₂₇H₄₇OBr·1/2CH₃OH (483.59): C, 68.30; H, 10.21; Br, 16.53. Found: C, 68.15; H, 10.00; Br, 16.57.

Terminal elution of the column with ether gave about 0.5 g. of Beilstein-negative material, m.p. 125–145°, λ^{Chf} 2.78, 2.9 μ (crystallized from ether-methanol). This consisted mainly of cholestanol, as shown by digitonin precipitation and from the infrared spectrum.

The bromohydrin acetate separated from ether-methanol in needles, m.p. 106–107°, α_D –82° Chf (*c* 2.41).

Anal. Calcd. for C₂₈H₄₉O₂Br (509.60): C, 68.35; H, 9.69; Br, 15.68. Found: C, 68.46; H, 9.77; Br, 15.85.

Treatment of 202 mg. of the 2 α ,3 β -bromohydrin with base as described for the epimer gave material that showed no selective infrared absorption in either the hydroxyl or the carbonyl region. One crystallization from ether-methanol gave 103 mg. of needles of 2 β ,3 β -oxidocholestane, m.p. 87–89°; recrystallized: 89–91°, α_D +53° Chf (*c* 1.70).

Hydrogenation of 275 mg. of the bromohydrin as above gave 189 mg. of cholestanol, m.p. 140–142°, α_D +23° Chf (*c* 1.99), identified by mixed m.p. determination and comparison of infrared spectra.

4 β -Bromotestane-17 β -ol-3-one Acetate.—Bromination of 5.1 g. of testane-17 β -ol-3-one acetate (m.p. 144–145°) in acetic acid in the presence of a trace of hydrobromic acid gave a first crop of 3.0 g., m.p. 180–181° dec., which separated directly from the reaction mixture. Dilution of the mother liquor, extraction with ether, and crystallization from ether gave a second crop of 2.0 g., m.p. 177–178°. Recrystallization from chloroform-ether gave material of m.p. 183–184°, α_D +41° Chf (*c* 2.47).