

α,ω -chlorohydrin, m. p. 49–50°, and of decamethylene- α,ω -chlorohydrin, m. p. 63–64°. The melting point of the phenylurethan of nonamethylene- α,ω -chlorohydrin was 70–70.5°, 3° higher than previously reported.⁴

N-Phenyl-N'-(8-hydroxyoctyl)-piperazine Hydrate.—N-phenyl-N'-(8-hydroxyoctyl)-piperazine of m. p. 57–58.5° and neut. equiv. 292.1 (mol. wt. is 290.4) gave a compound of m. p. 80–82° and neut. equiv. 306.5 (theoretical 308.4 for a monohydrate) upon exposure to air.

Summary

A series of seven new amino alcohols, the N-phenyl-N'-(ω -hydroxyalkyl)-piperazines, with the

alkyl group having four through ten carbon atoms, has been synthesized from α,ω -chlorohydrins and N-phenylpiperazine. Their phenylurethans are reported. The formation of the monohydrate of N-phenyl-N'-(8-hydroxyoctyl)-piperazine upon exposure to air has been ascertained.

α,ω -Chlorohydrins of four through ten carbon atoms have been made by methods reported in the literature. The phenylurethan of nonamethylene chlorohydrin was found to melt 3° higher than previously reported. The α -naphthylurethans of hexamethylene and decamethylene chlorohydrins are reported for the first time.

GAINESVILLE, FLORIDA

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[CONTRIBUTION FROM THE ORGANIC CHEMISTRY LABORATORIES OF THE UNIVERSITY OF FLORIDA]

alpha,omega-Amino Alcohols. II. Morpholino Alcohols. Derivatives of Morpholine. II

BY GEORGE W. ANDERSON¹ AND C. B. POLLARD

Paden and Adkins² in their study of the reaction of amines with glycols at 200–250° in the presence of copper–chromium oxide reported one experiment in which equivalent quantities of phenethylamine and tetramethylene glycol in dioxane solution were heated for half an hour with hydrogen at 200–400 atm. with the production of 35% of 4-(N-phenethylamino)-butanol-1, 19% of 1-phenethylpyrrolidine, and 43% of unchanged amine and glycol.

On the basis of this experiment we have investigated the reaction of morpholine with α,ω -glycols of four through ten carbon atoms and, as was to be expected, have obtained only two products, namely, the morpholino alcohol and the dimorpholinoalkane. Data are shown in Tables I, II and III.

Approximately 0.5 mole of each reactant in 300 cc. of dioxane was heated at 235–270° for six hours at a pressure of 100 atm. After cooling, the dioxane was distilled off at atmospheric pressure and the remainder fractionated in an efficient electrically heated air-jacketed column 2 cm. in bore, 70 cm. long, packed with 6 × 6 mm. Raschig rings, and having a total condensation, variable take-off head. In several cases, a similar column, 1.8 cm.

in bore and 30 cm. long, packed with 5 × 5 mm. Raschig rings, and having a total condensation, variable take-off head was used.

The morpholino alcohols, with the exception of 7-morpholinoheptanol-1, were also prepared from morpholine and the corresponding chlorohydrins. Almost quantitative yields were obtained by this method. Physical and analytical data for the seven new morpholino alcohols are recorded in Table II.

The aryl urethans of the morpholino alcohols were prepared by mixing hot solutions of the aryl isocyanate and the alcohol and heating the mix-

TABLE I
MORPHOLINO ALCOHOLS BY ALKYLATION^a

Glycol	Moles used	Moles of morpholine	Yields ^b of pure compd., %		Cu-Cr-O cat. used
			Amino alcohol	Diamine	
Tetramethylene	0.75	0.94	36	22	22
Pentamethylene	.80	1.0	31	28	24
Hexamethylene	.60	0.60	21	18	20
Heptamethylene	.33	.42	19	28	10
Octamethylene	.50	.75	26	41	15
Nonamethylene	.34	.43	38	28	11
Decamethylene	.40	.40	21	13	9

^a Between 125 and 300 cc. of dioxane was used in each case as solvent. The reaction was carried out under about 100 atm. of hydrogen at 235–270° for six hours. ^b Yields are based on the glycol used. Some of the glycol did not react in each case, but was not recovered pure, so yields were not adjusted for it.

(1) This paper is abstracted from a portion of a dissertation submitted by George W. Anderson to the Graduate Council of the University of Florida in partial fulfillment of the requirements for the degree of Doctor of Philosophy, May, 1939.

(2) Paden and Adkins, *THIS JOURNAL*, **58**, 2487 (1936).

TABLE II
 PHYSICAL AND ANALYTICAL DATA FOR THE MORPHOLINO ALCOHOL SERIES

General Formula: $\begin{matrix} \text{O} & \text{CH}_2-\text{CH}_2 \\ & \diagup \quad \diagdown \\ & \text{CH}_2-\text{CH}_2 \end{matrix} \text{N}-(\text{CH}_2)_n-\text{OH}$

<i>n</i>	Neut. equiv. ^a		B. p., °C. at 5 mm. pressure	Refrac. index	<i>d</i> ₂₅ ⁴	M.R.		Anal., % N	
	Calcd.	Found				Calcd.	Found	Calcd.	Found
4	159.2	159.3	116.5-7.0	<i>n</i> _D ²⁴ 1.4745	1.018	44.05	43.93	8.81	8.92
5	173.2	173.2	133.0-3.5	<i>n</i> _D ²⁴ 1.4755	1.005	48.67	48.50	8.09	8.09
6	187.3	184.9	146.0-7.0	<i>n</i> _D ²⁵ 1.4750	0.9884	53.29	53.30	7.49	7.34
7	201.3	203.6	155.5-8.0	<i>n</i> _D ²⁵ 1.4747	.9783	57.91	57.80	6.96	6.93
8	215.3	214.7	164.0-4.2	<i>n</i> _D ²⁷ 1.4735	.9675	62.52	62.55	6.51	6.37
9	229.3	227.6	173.0-3.5	M. p. 31°	....	....	....	6.11	5.86
10	243.3	243.5	164.0-5.0 ^b	M. p. 39.5-40.5°	....	....	....	5.76	5.66

^a With methyl orange indicator, using buffer of pH 4.0 for color standard. ^b At 2 mm. pressure.

 TABLE III
 PHYSICAL AND ANALYTICAL DATA FOR THE DIMORPHOLINOALKANE SERIES

General Formula: $\begin{matrix} \text{O} & \text{CH}_2-\text{CH}_2 \\ & \diagup \quad \diagdown \\ & \text{CH}_2-\text{CH}_2 \end{matrix} \text{N}-(\text{CH}_2)_n-\text{N} \begin{matrix} \text{CH}_2-\text{CH}_2 \\ \diagdown \quad \diagup \\ \text{O} \end{matrix}$

<i>n</i>	Neut. equiv. ^a		B. p., °C. at 5 mm.	Refrac. index or m. p., °C.	<i>d</i> ₂₅ ⁴	M.R.		Anal., % N	
	Calcd.	Found				Calcd.	Found	Calcd.	Found
4	114.1	114.7	147.5-8.5	51.5-52.5	....	....	....	12.28	12.00
5	121.1	121.3	161.0-2.0	<i>n</i> _D ²⁵ 1.4804	0.9980	69.10	69.29	11.56	11.32
6	128.1	129.3	169.5-171	35.5-38.5	....	....	....	10.93	10.76
7	135.2	136.3	183.0-4.0	<i>n</i> _D ²⁷ 1.4796	0.9789	78.34	78.46	10.37	10.18
8	141.2	141.6	191.5-3.5	46.5-47.5, ^b 48	....	....	....	9.85	9.72
9	149.2	146.7	203.5-4.0	<i>n</i> _D ²⁵ 1.4789	0.9639	87.38	87.42	9.39	9.11
10	156.2	152.5	187.0-9.0 ^d	48.0-49.0, ^c 50.5-51.5	....	....	....	8.97	8.87

^a With methyl orange indicator, using buffer of pH 4.0 for color standard. ^{b,c} Double melting points. Not complete resolidification after first melting, but distinct crystal formation. ^d At 2 mm. pressure.

ture for half an hour. The urethans separated on cooling and were recrystallized from ligroin until successive crystallizations did not raise the m. p. Physical and analytical data for the urethans are summarized in Table IV.

 TABLE IV
 ARYL URETHANS OF MORPHOLINO ALCOHOLS
 GENERAL FORMULA: $\text{O}(\text{CH}_2\text{CH}_2)_2\text{N}-(\text{CH}_2)_n-\text{O}-\text{CONHR}$,
 WHERE R IS EITHER PHENYL OR α -NAPHTHYL

<i>n</i>	R	M. p., °C. (corr.)	Anal., % N	
			Calcd.	Found
4	Phenyl	86.0-87.0	10.07	9.80
5	Phenyl	55.5-57.0	9.58	9.32
6	α -Naphthyl	71.0-72.0	7.86	7.53
7	Phenyl	71.0-72.0	8.74	8.56
8	α -Naphthyl	73.0-74.0	7.29	6.96
9	α -Naphthyl	54.0-56.0	7.03	6.83
10	α -Naphthyl	66.5-67.5	6.79	6.75

Summary

1. A series of seven morpholino alcohols of the type $\text{R}-(\text{CH}_2)_n-\text{OH}$, where R is the morpholine group and *n* is 4 through 10, has been synthesized by the catalyzed reaction of α,ω -glycols and morpholine, and also by the reaction of chlorohydrins and morpholine except in the case of 7-morpholinoheptanol-1. Their phenyl- or α -naphthylurethans have been made.

2. A series of seven dimorpholinoalkanes of the type $\text{R}-(\text{CH}_2)_n-\text{R}$, where R is the morpholine group and *n* is 4 through 10, has been obtained as a by-product in the catalyzed reaction of morpholine and α,ω -glycols. Physical and analytical data are reported.

GAINESVILLE, FLORIDA

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