

viscous liquids, insoluble in water but soluble in the organic solvents. Dimorpholinoethane is a white, water soluble solid.

Summary

The β -4-morpholinoethyl ethers of methyl, ethyl, propyl, isopropyl, butyl, *s*-butyl, *t*-butyl, benzyl and β -4-morpholinoethyl alcohols and

phenol have been prepared from β -4-morpholinoethyl chloride and the corresponding sodium alkoxide or phenoxide. β -4-Morpholinoethyl amines have been made by the interaction of β -4-morpholinoethyl chloride with ammonia, *n*-butylamine, aniline, methylaniline and morpholine.

BOSTON, MASS.

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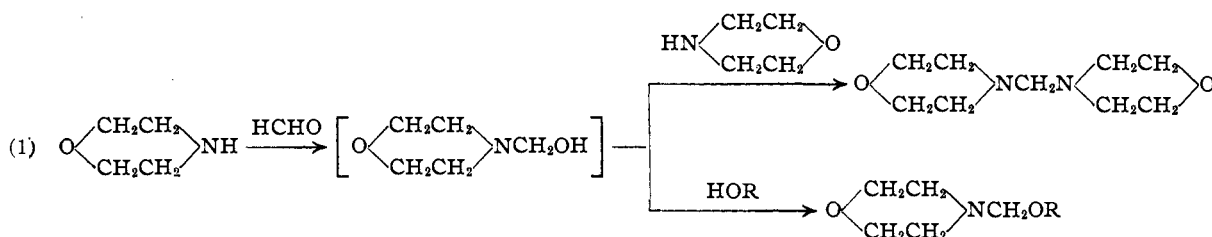
[CONTRIBUTION FROM THE CHEMICAL LABORATORIES OF BOSTON UNIVERSITY]

4-Morpholinomethyl Alkyl Ethers and N-Substituted Morpholines

BY J. PHILIP MASON AND MORRIS ZIEF¹

Dialkylaminomethyl alkyl ethers have been prepared by McLeod and Robinson² by the condensation of secondary amines with 40% aqueous formaldehyde solution and various alcohols. Stewart and Bradley³ used paraformaldehyde instead of 40% aqueous formaldehyde solution. We have made a number of 4-morpholinomethyl alkyl ethers using the method described by Stewart and Bradley³ with certain modifications.

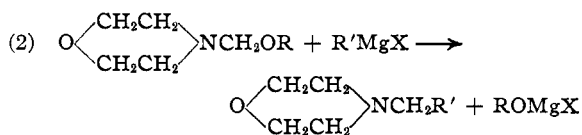
during the formation of the ether comes from the alcohol and the hydroxyl from the hypothetical 4-morpholinomethanol is found in the lower yields of ethers obtained when secondary and tertiary alcohols were used. Picrates of these ethers could not be obtained by the usual method because all of the ethers hydrolyzed to form morpholine, and morpholine picrate was the only compound obtained.



It will be seen from equation (1) that there are two reactions possible when the three reactants are mixed. In order to increase the yield of the ether, we used two equivalents of alcohol to one each of morpholine and formaldehyde.

Table I shows the percentage of morpholine converted into the 4-morpholinomethyl alkyl ether and dimorpholinomethane, together with the boiling points, nitrogen analyses and neutral equivalents. Increasing yields of ether were obtained with increasing molecular weight of the primary alcohols from methyl to *n*-propyl and *n*-butyl. This may be due to the fact that the ethers obtained from higher alcohols are hydrolyzed less readily than those from lower alcohols.² Evidence that the hydrogen of the water split off

These ethers reacted readily with Grignard reagents (equation 2), as was expected from the



work of McLeod and Robinson.² The results are reported in Table II.

Experimental

4-Morpholinomethyl Ethyl Ether.—Fifteen grams of paraformaldehyde (equivalent to 0.5 mole of formaldehyde), 23 g. (0.5 mole) of absolute ethyl alcohol and 100 cc. of dry benzene were placed in a 500-cc. three-necked flask which was equipped with a mercury-sealed mechanical stirrer, a separatory funnel and a fractionating column attached to a condenser for distilling the ternary mixture. The flask was heated in a water-bath kept at 85°. A mixture of 43.5 g. (0.5 mole) of morpholine and 23 g. (0.5 mole) of absolute ethyl alcohol was dropped slowly into the reaction mixture, which was stirred continuously. During this addition, which was completed in one hour,

(1) This material is taken from a thesis to be submitted by Morris Zief to the faculty of the Graduate School of Boston University in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

(2) McLeod and Robinson, *J. Chem. Soc.*, 119, 1470 (1921).

(3) Stewart and Bradley, *THIS JOURNAL*, 54, 4176 (1932).

TABLE I

Alcohol	% Morpholine converted to ether	% Morpholine converted to dimorpholinomethane	B. p. of ether		Neut. equiv.		Nitrogen, %	
			°C.	Mm.	Calcd.	Found	Calcd.	Found
Methyl	46.2	35.5	55.6-57	8	131	131.9	10.68	10.58
Ethyl	59.3	26.2	58-63	6	145	144.8	9.66	9.64
<i>n</i> -Propyl	74.0	12.0	100-102	22	159	158	8.81	8.80
Isopropyl ^a	29.7	53.6	64-66	6	159	158	8.81	8.89
<i>n</i> -Butyl ^a	73.8	16.3	99.5-100.5	11	171	171	8.09	8.22
Isobutyl	68.0	17.2	90.5-92.5	10	171	172	8.09	8.12
<i>s</i> -Butyl	58.9	34.0	92-94	10	171	170.5	8.09	8.23
<i>t</i> -Butyl	9.4	75.4						
Allyl	52.4	36.3	82-83	7	157	156.6	8.92	8.93
Benzyl	76.8	4.4	152-154	7	207	206	6.76	6.83

^a Harradence and Lions, *J. Proc. Roy. Soc. N. S. Wales*, **73**, 22 (1939).

TABLE II

N-Morpholine	B. p.		Yield, %	Neut. equiv.		Nitrogen, %		Picrate M. p. °C. (cor.)	Nitrogen, %	
	°C.	Mm.		Calcd.	Found	Calcd.	Found		Calcd.	Found
β -Phenethyl	147-151	13	66	191	190	7.33	7.31	166-167	13.33	13.27
α -Naphthylmethyl	185-190	9	57.7	227	225	6.17	6.00	209-211	12.28	12.40
<i>n</i> -Propyl	43-46	7	43.4	129	130.3	10.85	10.76	118-120	15.64	15.67
<i>n</i> -Hexyl	86-87	6	59.7	171	172	8.18	8.04	110-111	13.99	13.97
Benzyl	135-136.5	14	64.4	177	176.8	7.91	7.35	193.5-195	13.79	13.65

the ternary mixture of water, alcohol and benzene distilled at 65°. After all of the morpholine was added, the temperature of the water-bath was raised to 100° and the remaining benzene and alcohol were distilled. The residue was transferred to a 500-cc. round-bottom flask to which was attached an efficient fractionating column. The distillate which came over up to 58° at 6 mm. pressure was discarded. The following fractions were collected.

Fraction	B. p., °C. (6 mm.)	Wt., g.	Neut. equiv.
I	58-63	26.7	144.8
II	63-110	24.3	120.5
III	110-113	4.1	97.3

Fraction I is pure 4-morpholinomethyl ethyl ether (neutral equivalent 145) while fraction III consists chiefly of dimorpholinomethane (neutral equivalent 93). If we make the reasonable assumption that fractions II and III are mixtures of the ether and dimorpholinomethane, it is possible to determine the amount of each component from the titration data and simultaneous equations. For example, 0.2546 g. of fraction II required 20.71 cc. of 0.1024

TABLE III

Alcohol used and temp. of external bath, °C.	Frac-tion	B. p., °C. (Mm.)		Weight, g.	Neut. equiv.
		B. p., °C.	(Mm.)		
Methyl ^a	I	55.6-57	(8)	20.0	131.9
	II	57-113	(8)	8.8	127.7
	III	113-120	(8)	18.1	96.1
Propyl	I	100-102	(22)	40.9	158
	II	102-128	(22)	12.7	152
	III	128-131	(22)	10.7	120
Isopropyl	I	89-93	(21)	3.9	155
	II	93-98	(21)	5.8	155
	III	98-129	(21)	5.7	144
	IV	129-135	(21)	33.1	105

(4) Jordan, "Technology of Solvents," Chemical Publishing Company, New York, N. Y., pp. 324-325.

<i>n</i> -Butyl ^a	I	99.5-100.5 (11)	30.8	171
	II	100.5-104 (11)	14.5	166
	III	104-110 (11)	8.8	158
	IV	110-122 (11)	17.3	134
Isobutyl ^a	I	90.5-92.5 (10)	29.9	172
	II	92.5-97.5 (10)	15.1	170
	III	97.5-116 (10)	8.2	145
	IV	116-121 (10)	13.7	126
<i>s</i> -Butyl ^a	I	92-94 (10)	10.3	170.5
	II	94-100 (10)	17.0	165
	III	100-117 (10)	12.7	151
	IV	117-122 (10)	26.8	123
<i>t</i> -Butyl ^a	I	112-120 (11)	7.8	111
	II	120-123 (11)	16.0	102
	III	123-125 (11)	19.5	98
Allyl ^{a,b}	I	82-83 (7)	10.8	156.6
	II	83-88 (7)	12.3	153.4
	III	88-111 (7)	11.9	134.9
	IV	111-116 (7)	23.0	111.3
Benzyl ^{a,b}	I	140-146 (7)	6.5	173
	II	146-152 (7)	10.8	187.4
	III	152-154 (7)	64.0	206

^a No benzene used. Mixture was fractionally distilled after addition of morpholine was complete. First fraction was a binary mixture of the alcohol and water. ^b 0.75 mole of alcohol used.

N hydrochloric acid for neutralization. One gram of 4-morpholinomethyl ethyl ether requires 68.36 cc. of this acid and 1 g. of dimorpholinomethane requires 104.98 cc. of this acid for neutralization. Solving the simultaneous equations

$$x + y = 0.2546$$

$$68.36x + 104.98y = 20.71$$

x equals 0.1641. Therefore 64.5% of fraction II is 4-morpholinomethyl ethyl ether. This type of analysis was used in all subsequent experiments to determine the per-

centages of morpholine converted to the ether and dimorpholinomethane reported in Table I.

The other 4-morpholinomethyl alkyl ethers were made by the method described above, with the modifications given in the footnotes of Table III which summarizes all of the experimental data.

N-Substituted Morpholines.—The Grignard reagents were prepared in the usual way using 0.12 mole of magnesium and 0.12 mole of halide in 100 cc. of absolute ether. One-tenth mole of 4-morpholinomethyl ethyl ether dissolved in 50 cc. of absolute ether was then added slowly to the solution of Grignard reagent, the mixture refluxed for thirty minutes and allowed to stand overnight. The mixture was hydrolyzed with 10 cc. of concentrated sulfuric acid dissolved in 100 cc. of water. The ether layer was extracted with three 20-cc. portions of 20% sulfuric acid. Ten grams of ammonium chloride was added to the combined acid extracts to which concentrated ammonium hydroxide (about 65 cc.) was added until the

solutions were alkaline. The alkaline solution was extracted with four 40-cc. portions of ether. The combined ether extracts were dried over calcium sulfate, the ether distilled and the remaining oil was distilled under reduced pressure. The results are given in Table II.

Summary

The preparation of eight new 4-morpholinomethyl alkyl (or aralkyl) ethers has been described and the amount of dimorpholinomethane formed by a competing reaction has been indicated in each preparation.

Five alkyl (or aralkyl) morpholines have been prepared from 4-morpholinomethyl ethyl ether and Grignard reagents.

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[CONTRIBUTION FROM THE RESEARCH LABORATORIES DIVISION, GENERAL MOTORS CORPORATION]

The Thermal Decomposition of the Acetate of 2,2-Dimethyl-3-pentanol

BY PAUL L. CRAMER AND VERLE A. MILLER

The dehydration of primary and secondary alcohols containing a neopentyl group to form the corresponding olefin is accompanied by a skeletal rearrangement.¹ Thus, the alcohol-olefin-paraffin method in many instances is not applicable in the synthesis of the tetra-alkylmethanes. The thermal decomposition of the methyl xanthate of the alcohol has provided a successful modification of the above method for the preparation of this type of hydrocarbon.²

The thermal decomposition of the acetate rather than the methyl xanthate of the alcohol has been employed in the synthesis of 3,3-dimethyl-1-butene.^{1,3} The acetate gives much higher yields of the olefin than those obtained by the methyl xanthate procedure. Also the acetate method offers a more simple procedure in which no solvent is required. The main disadvantage of this method is the high temperature required to decompose the acetate, which would be expected to enhance the possible formation of isomeric olefins or other undesirable side reaction products. Thus, it seemed desirable to further test the acetate method as a possible general procedure

for the synthesis of the above type of olefins and the corresponding paraffins.

In the present investigation a study has been made of the thermal decomposition of the acetate of 2,2-dimethyl-3-pentanol. As in the case of the acetate of 3,3-dimethyl-2-butanol,³ a temperature of 400° is required to bring about an 80% conversion at contact times of reasonable length. Only about 12% conversion is obtained at 350°. The reaction is remarkably free of side reaction products, and the unchanged acetate may be recovered almost quantitatively.

4,4-Dimethyl-2-pentene is the principal olefin (93%) formed in the decomposition of the acetate of 2,2-dimethyl-3-pentanol. In contrast with the results obtained with the acetate of 3,3-dimethyl-2-butanol,^{1,3} rearrangement occurs in this reaction to the extent of about 7%.⁴ The rearranged products consist of a mixture containing about equal amounts of two olefins boiling in the 2,3-dimethylpentene and the 2,4-dimethylpentene range. Due to the very small amounts of these rearranged olefins, their separation and further identification by fractionation was unsuccessful.

(1) For references see Whitmore and Meunier, *THIS JOURNAL*, **55**, 3721 (1933).

(2) (a) Fomin and Sochanski, *Ber.*, **46**, 246 (1913); (b) Schurman and Boord, *THIS JOURNAL*, **55**, 4930 (1933).

(3) Cramer and Mulligan, *ibid.*, **58**, 373 (1936).

(4) To demonstrate that the rearranged olefins were not the result of the decomposition of the 2,2-dimethyl-3-pentanol contained as an impurity in the acetate, the pure alcohol, obtained by the saponification of a portion of the acetate, was found to be stable under the conditions employed in the decomposition of the acetate.