1360 (m), 1300 (vs), 1145 (vs), 775 (s), 755 (m), 700 (s) cm^{-1}; ultraviolet (CH_3CN), 219, 243 303 (sh), 313, 343, 358 (sh), and 375 mμ; nmr ($CDCl_3$), δ 8.32–6.88 (multiplet, relative area 19), 6.29 (singlet, relative area 0.13), 5.82–5.47 (quartet, relative area 0.87), 3.67–3.10 (quartet, relative area 0.87), and 2.94–2.52 (quartet, relative area 0.87); mass spectrum, *m/e* 446 (30%), 444 (42%), 412 (90%), 355 (100%), 262 (57%), 141 (37%), 105 (60%), 91 (18%) (base peak is at *m/e* 78 but *m/e* 355 was used as base for above).

Attempts at further reduction of **3a** by using a greater hydride to sulfone ratio or by using longer reaction times appear to lead to a complex mixture of undetermined nature.

Attempted Condensation of 3,8-Diphenyl-2H-naphtho[3,2-*b*]thiete 1,1-Dioxide with *p*-Nitrobenzaldehyde.—To a refluxing solution of sodium ethoxide in ethanol, prepared by dissolving 0.5 g (0.022 g-atom) of sodium in 40 ml of absolute ethanol, was added 3,8-diphenyl-2H-naphtho[3,2-*b*]thiete 1,1-dioxide (1.78 g, 0.005 mol) followed by *p*-nitrobenzaldehyde (1.25 g, 0.008 mol). The solution was refluxed for 1 hr, cooled, diluted with 100 ml of saturated sodium chloride solution, and extracted with three 50-ml portions of chloroform. The organic layer was dried over magnesium sulfate, concentrated to about 10 ml, and chromatographed on a Florisil column. The column was eluted with 1:1 benzene–chloroform. The eluent containing the first orange band was collected and was concentrated on a rotary evaporator using a water aspirator. Ethanol was added to precipitate a light orange solid (0.18 g, 8%), mp 215–220°. Two recrystallizations from chloroform–ethanol produced an analytical sample, mp 227–228°, of a compound tentatively identified as 2-(ethoxymethylene)-3,8-diphenyl-2H-naphtho-[3,2-*b*]thiete 1,1-dioxide (**8**) which had the following spectral properties: infrared (KBr), 3000 (w), 1590 (m), 1500 (m), 1430 (m), 1325 (s), 1285 (vs), 1170 (s), 1120 (s), 950 (m), 850 (m), 825 (m), 770 (s), 695 (s), cm^{-1}; ultraviolet (CH_3CN), 218, 241, 316 (sh), 339, and 401 mμ. There was insufficient sample left for a proton nmr spectral analysis.

Anal. Calcd for $C_{26}H_{20}O_3S$: C, 75.79; H, 4.89; S, 7.78; mol wt, 412. Found: C, 75.82; H, 4.70; S, 7.62; mol wt, 416 (osmometric).

Further elution of the remaining column with chloroform produced 0.44 g of a red-orange solid which could not be recrystallized from chloroform–ethanol or from ethanol, but which precipitated from a concentrated chloroform solution on addition of an excess of petroleum ether (bp 65–75°). The red-orange solid from the second fraction had infrared and ultraviolet spectra similar to those of the previously obtained $C_{26}H_{20}O_3S$ compound. There was no characteristic aromatic nitro group absorption in the 1570–1500- and 1370–1330-cm^{-1} regions.

Registry No.—**3a**, 15856-32-3; **3b**, 15892-86-1; **3c**, 15856-33-4; **4**, 15814-50-3; **8**, 15814-51-4.

2-Oxazolidinones from an N-Dealkylation Reaction of Phosgene with Dialkylaminoalkanols. The Isolation and Reactivities of an N-Acyl Quaternary Ammonium Intermediate

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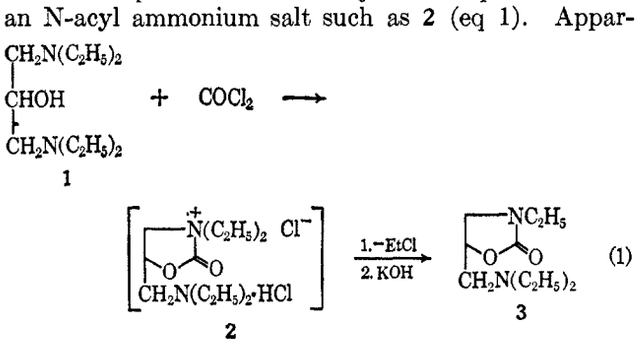
Received November 2, 1967

Phosgene condensed with 1-dimethylamino-2-propanol in the presence of pyridine to form a labile, cyclic N-acylium salt, **4**. This salt behaved as a powerful acylating agent toward *p*-toluenethiol, aniline, and methanol to form adducts **6**, **7**, and **8**. Toward chloride ion it was a mild methylating agent, concurrently forming 3,5-dimethyl-2-oxazolidinone **5**. Analogous formation of other oxazolidinones required a C substituent geminal to either the amino or hydroxyl group of the amino alcohol. A conformational explanation of this requirement for branching is proposed.

In another investigation phosgene was allowed to react with nonvicinal dialkylamino alcohols. Subsequent reaction of the unisolated condensation products with alcohols or nontertiary amines gave the expected carbonate esters or urethans,[1] but with bisdiethylamino alcohol **1** and phosgene the reaction took another course. With or without later addition of a secondary amine a cyclization–N-dealkylation reaction gave oxazolidinone **3**. By analogy with results described below it is probable that the cyclization proceeded *via* an N-acyl ammonium salt such as **2** (eq 1). Apparently one amino group served to bind hydrogen chloride, allowing acylation of the remaining free amino group.

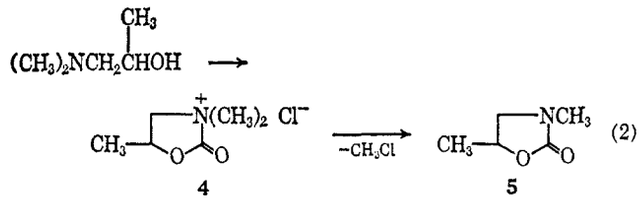


(1)

(1) R. B. Angier, K. C. Murdock, and W. V. Curran, *J. Med. Chem.*, in press.

This report describes the isolation of a very reactive N-acyl ammonium analog of **2** and a study of its reactions with some representative nucleophiles. The scope of a novel synthesis of 2-oxazolidinones from phosgene and 2-dialkylaminoalkanols has also been explored.

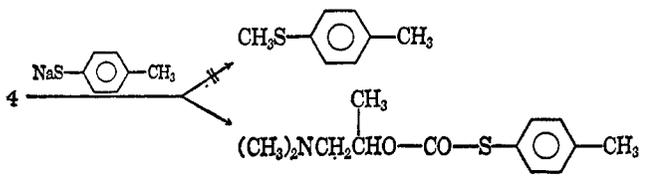
When equimolar amounts of 1-dimethylamino-2-propanol and pyridine were added to excess phosgene in methylene chloride solution at $\leq -40°$, then allowed to come to room temperature, a crystalline solid separated. This solid gave analyses and an infrared absorption peak at 5.42 μ which were in accord (see below) with a cyclic N-acyl ammonium structure (**4**), but, when the crystalline acylium salt was allowed to remain at 25° in the stirred reaction mixture, it disappeared within 5 hr, forming 3,5-dimethyl-2-oxazolidinone (**5**) (see eq 2).



(2)

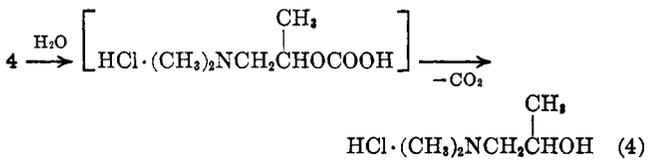
The same product was obtained instantly, along with gaseous methyl chloride, when the acylium salt was heated above its melting point (97°).

In contrast to the modest reactivity of **4** as an alkylating agent, it was found to be an avid acylating agent. In a competitive experiment with the sodium salt of *p*-toluenethiol in cold dimethylformamide solution no S-methylation was detected, while an S-acylation leading to **6** was very rapid (eq 3). Reaction with water gave



6 (3)

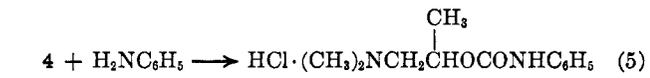
immediate effervescence, liberating carbon dioxide and the hydrochloride of the precursor amino alcohol (eq 4).



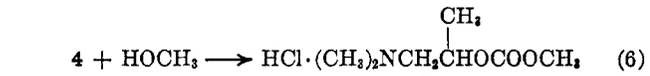
(4)

In fact, after 3 days in a stoppered vial a little "dry" **4** had all decomposed, also forming the same hydrochloride.

Acylation reactions in the cold with 1 equiv of aniline or methanol were complete within a minute or two, leading to urethan **7** and carbonate **8** in high yields (eq 5 and 6). The high reactivity of **4** as an



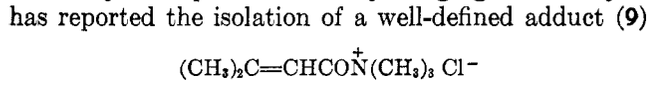
7 (5)



8 (6)

acylating agent is not unexpected. N-Acylium salts have long been postulated as intermediates in tertiary amine-catalyzed acylation reactions[2] of acid halides, anhydrides, and certain esters (and in N-dealkylation[3] reactions). Solid acylpyridinium salts of high lability and uncertain composition have been investigated by several groups.[4]

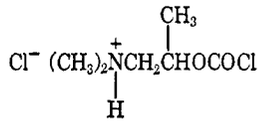
Klages and Zange characterized antimony pentachloride complexes with benzoyl chloride and trialkylamines, $C_6H_5CO\text{–}\overset{+}{N}R_2\ SbCl_6^-$, and demonstrated that they were powerful benzoylating agents.[5] Payne has reported the isolation of a well-defined adduct (**9**)



9

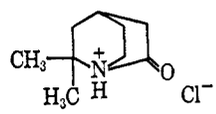
of 3,3-dimethylacryloyl chloride with trimethylamine.[6] Facile elimination of trimethylamine hydrochloride from **9** generated a presumed ketene which underwent cycloaddition with itself or with an added olefin. But the potential of **9** as an acylating agent and any tendency to undergo N-dealkylation apparently were not explored.

Spectral Correlations.—The infrared absorption maximum of acylium salt **4** at 5.42 μ and its high reactivity are in accord with the general association[7] of lowered wavelength of carbonyl absorption with heightened reactivity toward nucleophiles. In an open-chain model system we found that the position of the carbonyl peak of ethyl chloroformate in a cold methylene chloride solution was lowered from 5.63 to 5.49 μ after interaction with 1 equiv of triethylamine, presumably owing to formation of $C_2H_5OCO\overset{+}{N}(C_2H_5)_3\ Cl^-$. Conversely, when acylium salt **4** was allowed to stand for several days in methylene chloride saturated with hydrogen chloride the infrared absorption at 5.42 μ was almost entirely supplanted by a new peak at 5.64 μ, as might be expected for the formation of open-chain chloroformate structure **10**.



10

Another spectral model is the N-protonated form (**11**, ir peak at 5.56 μ) of the quinuclidone of Pracejus,[8] a compound in which the usual O protonation of amides is believed to be precluded by Bredt's rule. Thus, if the usual[9] 0.1-μ shift to lower wavelength is allowed for incorporation of a carbonyl group into a five-



11

membered ring, then a 5.42-μ peak would be reasonable for cyclic acylium salt **4** and would contraindicate a linear, polymeric N-acylium structure.

Oxazolidinone Syntheses.—When other β-dialkylamino alcohols were subjected to the conditions used in the above synthesis of oxazolidinone **5** it was found (Table I) that branching in the central carbon chain was essential for oxazolidinone formation. The results with 2,2-dimethyl-2-dimethylaminoethanol (**18**, in Table I) established, however, that the branching did not necessarily have to be at the hydroxylic carbon atom. This amino alcohol also gave an isolable, crystalline acylium salt intermediate (ir peak at 5.40 μ) analogous to **4**. Transient spectral peaks at 5.42 and 5.38 μ were also present in the reaction solutions from 1-diethylamino-2-propanol and *dl-erythro*-2-dimethylamino-1-phenyl-2-propanol (**17** and **19** in Table I). Without any branching the reaction took another course (eq 7). Thus the major product (52%) from

(2) M. L. Bender, *Chem. Rev.*, **60**, 53 (1960); L. P. Hammett, "Physical Organic Chemistry" McGraw-Hill Book Co., Inc., New York, N. Y., 1940, p 367; E. S. Gould, "Structure and Mechanism in Organic Chemistry," Henry Holt and Co., Inc., New York, N. Y., 1959, pp 330–334.

(3) W. B. Wright, Jr., and H. J. Brabander, *J. Org. Chem.*, **26**, 4057 (1961), and references cited therein; F. Möller in Houben-Weyl's "Methoden der organischen Chemie," Vol. II, E. Müller, Ed., Thieme Verlag, Stuttgart, Germany, 1957, pp 985–987; R. F. Meyer and B. L. Cummings, *J. Heterocycl. Chem.*, **1**, 186 (1964); B. J. Calvert and J. D. Hobson, *J. Chem. Soc.*, 2723 (1965); A. C. Pierce and M. M. Joullié, *J. Org. Chem.*, **27**, 3968 (1962).

(4) F. Bayer and Co., German Patents 114,025, 117,625, 118,566; *Friedländer*, **6**, 1161, 1162, 1163 (1900). Chem. Fabrik von Heyden, A.-G., German Patents 109,933, 117,346, 116,386; *Friedländer*, **5**, 730, 954 (1900), and **6**, 1160 (1900). T. Hopkins, *J. Chem. Soc.*, **117**, 278 (1920). H. Adkins and Q. E. Thompson, *J. Amer. Chem. Soc.*, **71**, 2242 (1949). D. E. Koshland, Jr., *ibid.*, **74**, 2286 (1952).

(5) F. Klages and E. Zange, *Ann.*, **607**, 35 (1957).

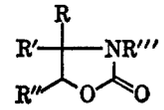
(6) G. B. Payne, *J. Org. Chem.*, **31**, 718 (1966).

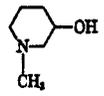
(7) H. A. Staab, *Angew. Chem. Intern. Ed. Engl.*, **1**, 351 (1961).

(8) H. Pracejus, *Chem. Ber.*, **92**, 988 (1959).

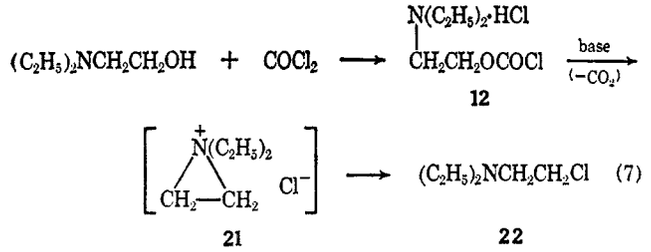
(9) K. Nakanishi, "Infrared Absorption Spectroscopy," Holden-Day, Inc., San Francisco, Calif., 1962, p 42.

TABLE I
2-OXAZOLIDINONES FROM PHOSGENE AND 2-DIALKYLAMINOALKANOLS[a]



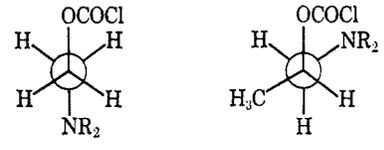
No.	Dialkylaminoalkanol	2-Oxazolidinone R	R′	R″	R‴	Yield, %	Formula	Calcd, % C	H	N	Found, % C	H	N
13	$(C_2H_5)_2NCH_2CHOH$		(compound 3)			68[b]	$C_{10}H_{20}N_2O_2$	60.0	10.1	14.0	60.0	10.1	13.9
14	$(CH_3)_2NCH_2CH_2OH$					0							
15	$(C_2H_5)_2NCH_2CH_2OH$					0							
16	$(CH_3)_2NCH_2CHOH$	H	H	CH_3	CH_3	68[c]	$C_5H_9NO_2$	52.2	7.9	12.2	52.0	8.0	12.0
17	$(C_2H_5)_2NCH_2CHOH$	H	H	CH_3	C_2H_5	77[d]	$C_6H_{11}NO_2$	55.8	8.6	10.8	56.1	8.8	10.7
18	$(CH_3)_2NCCH_2OH$	CH_3	CH_3	H	CH_3	80[e]	$C_6H_{11}NO_2$	55.8	8.6	10.8	55.9	8.9	10.9
19	$(CH_3)_2NCHCHOH$	H	CH_3	C_6H_5	CH_3	81[f]	$C_{11}H_{13}NO_2$	69.1	6.8	7.3	68.6	6.9	7.6
			(*dl-cis*)										
20						0							

[a] The general synthetic procedure is described in detail in the Experimental Section for the preparation of **5**. [b] No pyridine was used in this synthesis: bp 104° (0.1 mm), $n^{26.7}D$ 1.4610, λ_{max} 5.68 μ, neut equiv 188 and 185 (theory, 200.3). [c] Bp 63–65° (0.08 mm), $n^{25.0}D$ 1.4470; A. B. Steele [U. S. Patent 2,868,801 (1959); *Chem. Abstr.*, **53**, 10261 (1959)] reports bp 92° (1.5 mm), $n^{21}D$ 1.4464. [d] Bp 88° (1.2 mm), $n^{22.0}D$ 1.4482; A. B. Steele[c] reports bp 87° (1 mm), $n^{21.2}D$ 1.4458. [e] Bp 62° (0.05 mm), $n^{25.0}D$ 1.4490. [f] Prepared by reaction of *dl*-norephedrine with formic acid and formaldehyde. [g] Mp 61–62° (from heptane); V. Ettel and J. Weichet [*Collect. Czech. Chem. Commun.*, **13**, 316 (1948); *Chem. Abstr.*, **42**, 8190 (1948)] report mp 57–58°.



2-diethylaminoethanol and phosgene was 2-diethylaminoethyl chloride (**22**). (A little of the symmetrical carbonate ester of the amino alcohol was also obtained.) A chloroformate intermediate (**12**) could be isolated if reaction was brief and no added base was used.[10] Infrared spectral data did not reveal a reaction intermediate with a peak near 5.40 μ, and no 3-ethyl-2-oxazolidinone was found in the product. Results with 2-dimethylaminoethanol were analogous, and vapor phase chromatography detected no formation of 3-methyl-2-oxazolidinone. Participation of a neighboring amino group to form an ethylenimmonium intermediate (*i.e.*, **21**) is well precedented[11] and would explain the distinctive[12] lability of chloroformate **12** in the presence of base.

The decisive influence of branching may be explained by considering the probable conformations of chloroformate intermediates. Without branching, *anti* form **23** would predominate and be well disposed for a backside attack to generate an ethylenimmonium ion such as **21**. Moreover, resistance to formation of the ethylenimmonium ring system with its necessarily eclipsed substituents would be least when the carbon atoms of the ring bore only hydrogen atoms, but branching at either of the central carbon atoms would not only correspond to increasingly unfavorable eclipsing interactions in an ethylenimmonium pathway, but would generally favor *gauche* forms such as **24**, facilitating conversion into N-acylium salts (*i.e.*, **4**).



23 **24**

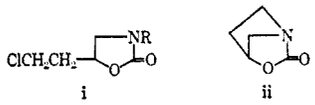
An attempt to form a bridged-ring oxazolidinone from 1-methyl-3-piperidinol (**20**, in Table I) was unsuccessful, as was an analogous attempt with a 1-methyl-4-piperidinol.[13] A low yield of a tetrahydro-

(10) A purer product might be obtained from the reported preparation of **12** from the hydrochloride of diethylaminoethanol: T. K. Brotherton, U. S. Patent 3,003,978; *Chem. Abstr.*, **57**, 5807 (1962).

(11) W. C. J. Ross, "Biological Alkylating Agents," Butterworth and Co., Ltd., London, 1962. B. Capon, *Quart. Rev.* (London), **18**, 62 (1964); S. D. Ross, *J. Amer. Chem. Soc.*, **69**, 2982 (1947); A. Streitweiser, "Solvolytic Displacement Reactions," McGraw-Hill Book Co., Inc., New York, N. Y., 1962, p 105.

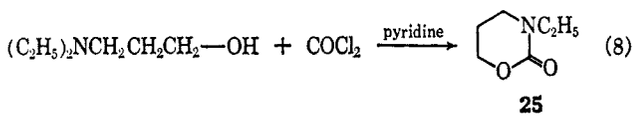
(12) Chloroformates are commonly purified by distillation without decomposing; elimination of carbon dioxide to form alkyl halides or olefins usually occurs only at higher temperatures: M. Matzner, R. P. Kurkjy, and R. J. Cotter, *Chem. Rev.*, **64**, 645, 670 (1964); K. W. Buck and A. B. Foster, *J. Chem. Soc.*, 2217 (1963).

(13) Earlier lack of success in attempts to synthesize the same bridged-ring oxazolidinones from 3- and 4-piperidinol by another method was believed to be due to lack of resonant stabilization of the amide link at the bridgehead N-atom of the desired product, as predicted by Bredt's rule [H. K. Hall, Jr., *J. Amer. Chem. Soc.*, **80**, 6412 (1958)]. In this connection it seems pertinent that the tertiary amine promoted reaction of phosgene with N-alkyl-3-pyrrolidinols gave ring opening rather than loss of the N-alkyl group, *i.e.*, i rather than ii [M. L. Fielden, W. J. Welstead, and C. D. Lunsford, Abstracts, 152nd National Meeting of the American Chemical Society, New York, N. Y., Sept 1966, p 5P].



i ii

oxazinone (**25**, 2%) was obtained from 3-diethylamino-1-propanol (eq 8), but not from 3-dimethylamino-

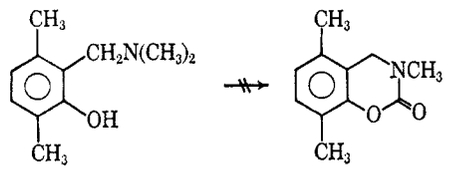


(8)

25

1-propanol or a branched-chain homolog, 4-dimethylamino-2-butanol.

Although *o*-(aminomethyl)phenol **26** might be expected to have special conformational restraints favoring cyclization, the product was apparently polymeric.



26

Thus for practical purposes the present cyclization–dealkylation reaction appears to be limited to the synthesis of 3,4- and/or 5-substituted 2-oxazolidinones. Since many dialkylamino alcohols are more readily available than their monoalkyl- or N-unsubstituted analogs, this reaction conveniently supplements the previously reported routes[14] to 2-oxazolidinones.

Experimental Section

Evaporations were conducted under reduced pressure using a water aspirator. Solids were pressed with potassium bromide for infrared spectral determinations, liquids were scanned neat as smears. In monitoring the course of a reaction, *ca.* 0.01 ml of the reaction mixture was evaporated on 0.2 g of potassium bromide and the spectrum was obtained immediately with a Perkin-Elmer Infracord spectrophotometer. This procedure was effective even with liquid products. Other spectra were obtained with a Perkin-Elmer Model 21 spectrophotometer by W. Fulmor and his group. Microanalyses and gas chromatography were done by L. Brancone and C. Pidacks and their groups, respectively. Unless specified otherwise, liquid products were fractionated in a 42 cm × 0.8 cm Nester-Faust spinning-brush distillation column operated at 1125 rpm and having a rated maximum efficiency of about 58 theoretical plates.

3,3,5-Trimethyl-2-oxooxazolidinium Chloride (**4**).—To 200 ml of a 2 *N* solution of phosgene in methylene chloride kept at $\leq -40°$ was added dropwise with stirring a solution of 20.63 g (0.2 mol) of 1-dimethylamino-2-propanol and 15.82 g (0.2 mol) of dry pyridine in 200 ml of methylene chloride. The cooling bath was removed and stirring continued until (*ca.* 2 hr) the temperature had reached 20°. A 10-ml aliquot of the resulting suspension was removed. The solid therein was collected by filtration and washed with methylene chloride to yield 0.52 g: mp 96–97°, with gassing; λ_{max} 5.42, 8.45, 8.36 μ. [In an otherwise identical experiment all of the solid was collected giving 28.33 g (86%).] Analyses were done immediately.

Anal. Calcd for $C_6H_{12}NO_2Cl$: C, 43.5; H, 7.3; N, 8.5; Cl, 21.4. Found: C, 43.0; H, 7.9; N, 8.6; Cl, 21.5.

After 3 days in a capped vial the product no longer showed an infrared absorption peak at 5.42 μ; the spectrum was identical with that of the hydrochloride of the starting amino alcohol, except for a weak additional peak at 7.24 μ. Accordingly, all reactions of **4** were run with freshly prepared material.

3,3,4,4-Tetramethyl-2-oxooxazolidinium Chloride.—Starting with 23.44 g (0.2 mol) of dimethylamino-2-methyl-1-propanol the reaction was otherwise as in the preceding experiment. After 1.5 hr the temperature was 19°. The white solid in a 2.0-ml aliquot was collected by filtration to yield 0.121 g: mp 95–97°, with gassing; λ_{max} 5.40, 8.70, 8.53, 7.81 μ. Analyses were done immediately.

Anal. Calcd for $C_7H_{14}NO_2Cl$: C, 46.8; H, 7.9. Found: C, 47.0; H, 8.0.

3,5-Dimethyl-2-oxazolidinone (**5**).—The following general procedure was used to prepare the products of Table I. The main reaction mixture described for the preparation of acylium salt **4** (isolated from an aliquot) was stirred at 25° for an additional 5 hr, when an infrared spectrum no longer showed any of the 5.42-μ peak of **4**. No additional spectral change was noted after another 15 hr. Solvent was removed by evaporation at $\leq 40°$, residual slush was agitated with 200 ml of dry ether, and solids were removed by filtration and washed with ether. Evaporation of the filtrate left a yellow oil which was distilled rapidly at 55–69° (0.07 mm), then fractionated, giving 15.25 g (68%) of distillate, λ_{max} 5.70 and 7.92 μ. Without the preliminary distillation the boiling point gradually dropped 7° during total reflux, after careful removal of forerun, indicating that a labile by-product in the still pot was gradually "cracking" to give volatile material.

Thermal Decomposition of 3,3,5-Trimethyl-2-oxooxazolidinium Chloride (**4**).—A test tube containing 0.166 g of **4** was fitted with a cork bearing a glass exit tube, then heated with an oil bath at 110–115° until (4 min) gas evolution stopped. The effluent gas gave an infrared spectrum which corresponded to the spectra[15] of methyl chloride and carbon dioxide. The residue was agitated with ether and the ether was filtered. Evaporation of the filtrate, finally at 0.05 mm, left 0.081 g (70%) of a colorless oil, $n^{26.2}D$ 1.4471. An infrared absorption spectrum from this oil was identical with that from 3,5-dimethyl-2-oxazolidinone (**5**), $n^{25.0}D$ 1.4470.

Carbonic Acid, Thiol-, O-2-Dimethylamino-1-methylethyl S-*p*-Tolyl Ester, Hydrochloride (**6**).—Two portions of petroleum ether were used to wash the oil (by decantation) from 0.439 g (0.01 mol) of a 54.7% suspension of sodium hydride in mineral oil. After the addition of 15 ml of dry dimethylformamide and 1.24 g (0.01 mol of *p*-toluenethiol to the finely divided sodium hydride, the mixture was agitated until gas evolution ceased. The solution was chilled and 1.65 g (0.01 mol) of **4** was added. The ice bath was removed. After 5 min an evaporated aliquot of the reaction mixture gave an infrared spectrum with no trace of the 5.42-μ peak of **4**. Spectra obtained similarly after 1 and 20 hr showed no further change. The mixture was diluted with 45 ml of water and extracted with three portions of ether. The ethereal extracts were shaken successively with water, with 0.2 *N* sodium hydroxide solution, with water, with 1 *N* hydrochloric acid, and with water and then dried over anhydrous magnesium sulfate. Evaporation of the filtered ethereal solution left 0.272 g of a yellow oil with an infrared spectrum lacking the 6.62- and 12.46-μ peaks which were the most prominent peaks in the spectrum of methyl *p*-tolyl sulfide. After vapor phase chromatography of the oil, the fraction with a retention time corresponding to that of the sulfide still lacked these spectral peaks.

The acidic extract and the subsequent aqueous washes were evaporated, finally at *ca.* 0.1 mm, then dried further by evaporation with three successive portions of absolute ethanol. The residue was 2.06 g (71%) of a crystalline solid (mp 135–137° dec) or 1.7 g (mp 136–138° dec) after recrystallization from butanone.

Anal. Calcd for $C_{13}H_{19}NO_2S \cdot HCl$: C, 53.9; H, 6.9; N, 4.8; S, 11.1; Cl, 12.2. Found: C, 53.7; H, 7.0; N, 4.6; S, 10.7; Cl, 12.7.

Reaction of 4 with Water.—To 3 ml of water, magnetically stirred and chilled with an ice bath, was added 0.20 g of **4**. An immediate effervescence was complete within a few seconds. The effluent gas gave an infrared spectrum identical with the spectrum[15] of carbon dioxide. A 0.04-ml aliquot of the reaction solution was evaporated at 0.1 mm on 0.2 g of potassium bromide (over phosphorous pentoxide) which was then pressed into a disk. The disk gave a sharp infrared spectrum identical with that obtained from the hydrochloride of 1-dimethylamino-2-propanol.

Reaction of 4 with Aniline. 2-Dimethylamino-1-methylethyl Carbanilate Hydrochloride (**7**).—A suspension of 8.28 g (0.05 mole) of **4** in 50 ml of methylene chloride was stirred at 5–10° during the dropwise addition of 4.22 g (0.045 mol) of aniline in 9 ml of methylene chloride. All of the suspended solid dissolved within 1 to 2 min and another solid began to separate almost immediately. An infrared spectrum obtained immediately from

(14) M. E. Dyen and D. Swern, *Chem. Rev.*, **67**, 197 (1967).

(15) R. H. Pierson, A. N. Fletcher, and E. S. C. Gantz, *Anal. Chem.*, **28**, 1218 (1956).

an evaporated aliquot of this suspension showed none of the 5.42-μ peak of **4**. After 5 hr without further cooling, the mixture gave an infrared spectrum showing essentially no further change. The solution was diluted with ether to incipient turbidity. After several hours the resulting solid was collected by filtration and washed with methylene chloride–ether, 2:1, to give 10.22 g (87%) of glistening crystals (mp 146–149°) or 9.68 g (mp 147–149°) after crystallization from methylene chloride–ether, 2:1.

Anal. Calcd for $C_{12}H_{18}N_2O_2 \cdot HCl$: C, 55.7; H, 7.4; N, 10.8; Cl, 13.7. Found: C, 55.8; H, 7.5; N, 10.8; Cl, 14.1.

Reaction of 4 with Methanol. 1-Dimethylamino-2-propyl Methyl Carbonate Hydrochloride (8).—When the preceding experiment was repeated using 2.0 ml (1.6 g, 0.02 mol) of methanol instead of the aniline solution the observed responses of the two systems were very similar. The suspension was evaporated almost to dryness and washed once with cold methylene chloride. The resulting hygroscopic solid (6.98 g, mp 159–160° dec) was augmented by another 1.11 g (total 82%, mp 159–160°), obtained from the concentrated mother liquor.

Anal. Calcd for $C_7H_{15}NO_3 \cdot HCl$: C, 42.6; H, 8.2; N, 7.1; Cl, 18.0. Found: C, 42.4; H, 8.2; N, 6.9; Cl, 17.7.

Reaction of Phosgene with 2-Diethylaminoethanol. A. Hydrochloride of 2-Diethylaminoethyl Chloroformate.[12]—To 10 ml of a 2 *M* solution of phosgene in methylene chloride agitated at $\leq -40°$ was gradually added a dried, freshly distilled solution of 1.17 g (0.11 mol) of 2-diethylaminoethanol in 5 ml of methylene chloride. The resulting solution was immediately warmed to 24°, allowed to stand just 5 min, and then evaporated to dryness at $\leq 25°$, leaving 2.10 g (97%) of white solid: mp 208–212°; λ_{max} 5.64, 8.59 μ.

Anal. Calcd for $C_7H_{14}ClNO_2 \cdot HCl$: C, 38.9; H, 7.0; N, 6.5; Cl, 32.8. Found: C, 40.3; H, 7.5; N, 7.2, 7.0; Cl, 34.0, 34.2.

When a reaction solution was prepared as above and then allowed to stand at 25° for 16 hr, the indicated spectral peaks gradually became very much weaker.

B. 2-Diethylaminoethyl Chloride (22) and 2-Diethylaminoethyl Carbonate.—To 100 ml of a 2 *M* solution of phosgene in methylene chloride agitated at $\leq -40°$ was added at a fast drip a solution of 11.72 g (0.1 mol) of 2-diethylaminoethanol in 50 ml of methylene chloride. After 24 hr without further cooling the solution was evaporated to dryness. A chilled solution of the residual solid in 10 ml of water was carefully basified by the portionwise addition of 22.4 g of potassium hydroxide. The resulting thick slurry was extracted with three 40-ml portions of ether, readily separating the extracts by decanting from a round-bottomed flask. The extracts were dried over anhydrous potassium carbonate, filtered, and evaporated. Fractional distillation of the residue gave 7.06 g (52%) of a mobile oil [bp 64° (40 mm), $n^{23.3}D$ 1.4352] with an infrared spectrum identical with that from an authentic sample of 2-diethylaminoethyl chloride ($n^{23.2}D$ 1.4352).

Continued fractionation gave 0.38 g (3%) of a more viscous oil: bp 84° (0.05 mm); $n^{22.3}D$ 1.4422; λ_{max} 5.71, 7.95 μ [lit.[16] bp 112–116° (0.25 mm)].

Anal. Calcd for $C_{13}H_{28}N_2O_3$: C, 60.0; H, 10.8; N, 10.8. Found: C, 59.7; H, 10.8; N, 10.9.

When 0.79 g of 2-diethylaminoethanol was subjected to conditions used in the synthesis of **4** and **5** an infrared spectrum revealed no trace of an intermediate with a peak near 5.40 μ. The eventual neutral product was 0.034 g of an oil with an infrared spectrum which did not resemble the spectrum of 3-ethyl-2-oxazolidinone.[17]

Reaction of Phosgene with 2-Dimethylaminoethanol.—The reaction procedure paralleled that described for the synthesis of **4** and **5**, but no reaction intermediate with an infrared peak near 5.40 μ was detected. A comparative study with vapor phase chromatography and authentic 3-methyl-2-oxazolidinone revealed none of this compound in the scanty amount of crude, neutral product.

3-Ethyltetrahydro-2H-1,3-oxazin-3-one (25).—To 200 ml of a well-stirred, 2 *M* solution of phosgene in methylene chloride kept at $\leq -40°$ was added at a fast drip a solution of 26.94 g (0.2 mol) of 3-diethylamino-1-propanol and 15.82 g of dry pyridine in 200 ml of methylene chloride. After 4 hr without further cooling the initially most prominant spectral peak in the carbonyl region (at 5.52 μ) had disappeared and a peak at 5.93 μ had become dominant. The mixture was evaporated to dryness and the solid residue was washed with ether. Evaporation of the washes left 3.55 g of a mobile oil which was fractionally distilled twice without complete removal of a slightly lower boiling contaminant: bp *ca.* 78° (0.2 mm); $n^{25.3}D \geq 1.4764$; λ_{max} 5.75 μ. Distillate cuts rich in this contaminant had a sharp odor and gave an especially heavy and immediate white precipitate with a solution of silver nitrate in nitric acid, suggesting the presence of a carbamoyl chloride. The contaminant was selectively destroyed by stirring most of the remainder of the better distillate cuts (1.21 g) for 22 hr with 5 ml of concentrated aqueous ammonia. The mixture was evaporated to dryness and the residual oily solid was washed with ether by decantation. Evaporation of the ether and simple distillation of the residual oil gave 0.58 g (2.3%) of an oil: bp 84° (0.1 mm); $n^{26.5}D$ 1.4690; λ_{max} 5.92 μ.

Anal. Calcd for $C_6H_{11}NO_2$: C, 55.8; H, 8.6; N, 10.8. Found: C, 55.6; H, 9.0; N, 11.0.

Registry No.—**3,** 15833-08-6; **4,** 15833-09-7; **5,** 15833-10-0; **6,** 15833-11-1; **7,** 15856-40-3; **8,** 15833-12-2; **17,** 15833-16-6; **18,** 15833-17-7; **19,** 15833-15-5; **25,** 15833-14-4; 3,3,4,4-tetramethyl-2-oxooxazolidinium chloride, 15833-13-3; hydrochloride of 2-diethylaminoethyl chloroformate, 15893-01-3; phosgene, 754-45.

(16) C. A. Dornfield, U. S. Patent 2,691,017; *Chem. Abstr.*, **49**, 15954 (1955).

(17) A. H. Homeyer, U. S. Patent 2,399,188; *ibid.*, **40**, 4085 (1946).