The Reaction of Nitriles with Phosgene. II.[1] The Preparation of 6-Chloro-2,5-Disubstituted 4(3H)-Pyrimidones

SHOZO YANAGIDA, MASATAKA OHOKA, MITSUO OKAHARA, AND SABURO KOMORI

Department of Applied Chemistry, Faculty of Engineering, Osaka University, Yamadakami, Suita City, Osaka, Japan

Received January 17, 1969

The reaction of aliphatic nitriles (**1**) with phosgene in the presence of hydrogen chloride at 60–65° in a sealed glass tube gives good yields of 6-chloro-2,5-disubstituted 4(3H)-pyrimidone hydrochlorides (**2**) and small amounts of 4,6-dichloro-2,5-disubstituted pyrimidines (**4**). These pyrimidone hydrochlorides (**2**) are easily converted into free bases (**3**) by treatment with water or by standing under reduced pressure, and are regenerated with dry hydrogen chloride. However, attempts to obtain the corresponding pyrimidones from 3-substituted propionitriles and most substituted acetonitriles were unsuccessful. The mechanism of this reaction is discussed.

Since the first aminopyrimidines were prepared from nitriles and alkali, such as sodium methoxide,[2] numerous methods for elaborating the pyrimidine nucleus have been extensively investigated.[3] The most important and practical synthetic route is ring closure between amidines and 1,3-difunctional compounds, such as β-diketones, β-keto esters, and malonates.

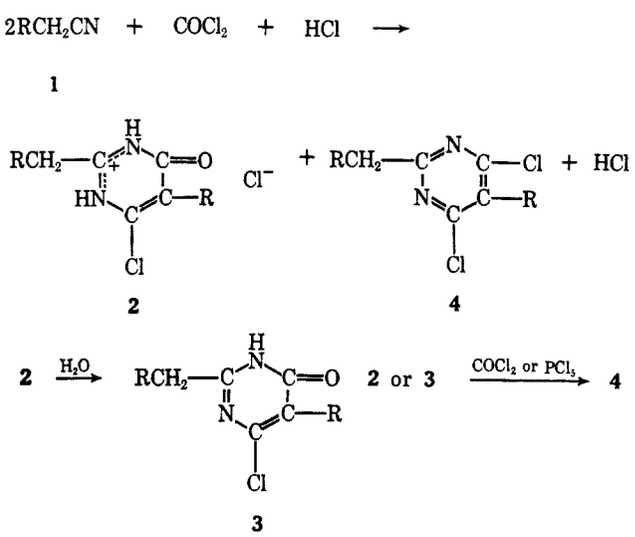
Some nitriles are reported to react with hydrogen halides to give 1,3,5-triazine,[4] substituted 3H-azepines,[5,6] pyridine derivatives,[7] and pyrroline derivatives,[8] but nitriles have been considered to be unreactive with phosgene.[9] In our preceding paper,[1] however, we reported that acetonitrile or propionitrile reacts with phosgene in the presence of hydrogen chloride to give 6-chloro-2-methyl-4(3H)-pyrimidone and 6-chloro-2-ethyl-5-methyl-4(3H)-pyrimidone, respectively.

In this paper, we report more detailed studies on this reaction.

We have studied the effect of varying the ratios of HCl to phosgene from 0.07 to 1.8 on the yield of 6-chloro-2-methyl-4(3H)-pyrimidone hydrochloride (**2a**) (Scheme I). Optimum yields were obtained with a ratio of 1:1 or greater ratio.

To determine the scope of this reaction, several other aliphatic nitriles were examined (Scheme I, Table I). The hydrochlorides (**2**) obtained by filtration from the reaction mixtures and washing with ether were found to be fairly pure. However, further purification of these products was difficult, since they readily change into pyrimidones (**3**) during recrystallization. They were therefore converted to the pyrimidones (**3**) by treating them with water, and most of the aliphatic nitriles (**1a–f**) gave 6-chloro-2,5-dialkyl-4(3H)-pyrimidones (**3**) in good yields regardless of the length of the alkyl chain. The filtrates from **2b** and **2d** were subjected to chromatographic separation, and some oily products were isolated in small yield. These were identified as 4,6-dichloro-2-ethyl-5-methylpyrimidine (**4b**) and 4,6-dichloro-2-butyl-5-propylpyrimidine (**4d**), respectively by comparing their ir spectra with those of the authentic samples prepared by the reaction of **3b** and **3d** with phosphorus pentachloride. It was ascertained that the

SCHEME I



a, R = H; **b**, R = CH_3; **c**, R = CH_3CH_2; **d**, R = $CH_3(CH_2)_2$; **e**, R = $CH_3(CH_2)_5$; **f**, R = $CH_3(CH_2)_9$; **g**, R = $(CH_3)_2CH$; **h**, R = Cl; **i**, R = $Cl(CH_2)_2$; **j**, R = $CH_3CH_2O(CH_2)_2$

reaction of **2** or **3** with phosgene in a sealed glass tube gave the corresponding dichloropyrimidines (**4**). It is thus clear that the formation of the dichloropyrimidines (**4**) is due to the further reaction of the initially formed pyrimidones with phosgene (Scheme I).

Pure pyrimidone hydrochlorides (**3**) could be obtained by treating pyrimidones (**2**) with dry hydrogen chloride in ether. Analytical details can be reported as being correct for chlorine. The ir absorption bands of all of the hydrochlorides lie in the regions 1700–1730 and 1610–1640 cm^{-1}. Their melting points, however, are the same as those of the corresponding pyrimidones (**3**) (Table I) except for **2a**. Loss of hydrogen chloride must occur before melting. In addition, it was found that the pyrimidone hydrochlorides (**2**), when allowed to stand under reduced pressure even at room temperature, lose hydrogen chloride and change into the pyrimidones (**3**). The pK_a value of **2a** was determined to be 7.91 by a spectroscopic method.[10]

Infrared spectra of the hydrochlorides support the oxo form; the absorptions observed at 1690 and 1600 cm^{-1} in **3a** may be assigned to carbonyl and ring vibrations due mainly to the C=N bond, respectively.[11] If the hydroxy form were preferable, one of these bands should shift to lower frequency. However, **2a** shows these bands with a shift to higher frequency by about 40

(1) Part I: S. Yanagida, M. Ohoka, M. Okahara, and S. Komori, *Tetrahedron Lett.*, No. 19, 2351 (1968).
(2) E. Frankland and A. W. H. Kolbe, *Ann.*, **65**, 269 (1848).
(3) D. J. Brown, "The Pyrimidines," John Wiley & Sons, Inc., New York, N. Y., 1962, p 31.
(4) C. Grundmann, G. Weisse, and S. Seide, *Ann.*, **577**, 77 (1952).
(5) W. A. Nasutavicus and F. Johnson, *J. Org. Chem.*, **32**, 2367 (1967).
(6) W. A. Nasutavicus, S. W. Tobey, and F. Johnson, *ibid.*, **32**, 3325 (1967).
(7) L. G. Duquette and F. Johnson, *Tetrahedron*, **23**, 4537 (1967).
(8) L. G. Duquette and F. Johnson, *ibid.*, **23**, 4539 (1967).
(9) G. M. Dyson, *Chem. Rev.*, **4**, 162 (1927).
(10) A. Albert and J. N. Phillips, *J. Chem. Soc.*, 1301 (1956).
(11) L. N. Short and H. W. Thompson, *ibid.*, 168 (1952).

TABLE I

PYRIMIDONES PREPARED FROM NITRILES, PHOSGENE, AND HYDROGEN CHLORIDE

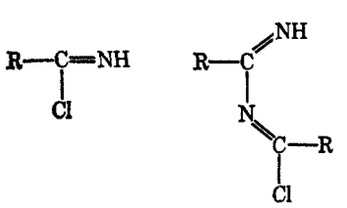
Pyrimidone	Yield, %[a]	Recrystn solvent[b] (v/v)	Mp, °C	Ir,[c] cm^{-1}	Uv,[d] λ_{max}, mμ ($\epsilon \times 10^{-3}$)	Nmr,[e] τ	Mol wt (calcd)	Elemental analyses—Calcd, %	Elemental analyses—Found, %
3a	59[f]	Ac–D (3:1)	235.5–236.5[g]	1685 1600	225 (6.08) 279 (4.33)	(s) 7.60 (3 H), 3.48 (1 H)[h]	143 (144.6)	C, 41.54; H, 3.49; N, 19.38; Cl, 24.52	C, 41.33; H, 3.22; N, 19.54; Cl, 24.3
3b	39[i]	Ac–D (1:1)	203.0–204.5	1670 1600	230 (6.06) 279 (6.83)	(t) 8.65 (3 H), (s) 7.85 (3 H) (q) 7.26 (2 H)	172 (172.6)	C, 48.71; H, 5.26; N, 16.23; Cl, 20.54	C, 48.44; H, 5.22; N, 16.31; Cl, 20.6
3c	56[i]	P	156.0–157.5	1660 1595	232 (5.74) 282 (6.84)	(t) 8.98 (3 H), 8.86 (3 H), 7.29 (2 H) (m) 8.17 (2 H), (q) 7.36 (2 H)	207 (200.7)	C, 53.87; H, 6.53; N, 13.96; H, 17.67	C, 53.99; H, 6.45; N, 13.73; Cl, 17.5
3d[j]	34[i]	Ac–D (1:1)	136.0–137.0	1655 1590	231 (6.67) 281 (7.18)	(t) 9.08 (6 H, 7.40 (2 H), 7.29 (2 H) (c) *ca.* 8.38 (6 H)	220 (228.7)	C, 57.76; H, 7.49; N, 12.25; Cl, 15.50	C, 57.32; H, 7.71; N, 12.47; Cl, 15.4
3e	48[k]	An	95.0–96.0	1670 1590	231 (6.25) 281 (7.44)	(b) 9.12 (6 H), 8.65 (18 H) (c) *ca.* 7.40 (4 H)	308 (312.9)	C, 65.26; H, 9.34; N, 8.95; Cl, 11.33	C, 65.70; H, 9.86; N, 8.92; Cl, 11.2
3f	43[k]	An	82.5–83.0	1675 1595	233 (5.06) 281 (6.55)	(b) 9.12 (6 H), 8.74 (34 H), 7.40 (4 H)	393 (425.1)	N, 6.59; Cl, 8.34	N, 6.50; Cl, 8.56
3g	14[l]	W–E (1:1)	113.0–115.0	1660 1610		(d) 9.00 (6 H), 8.66 (6 H), 7.47 (2 H) (m) *ca.* 7.80 (1 H), *ca.* 6.65 (1 H)		C, 57.76; H, 7.49; N, 12.25	C, 57.77; H, 7.80; N, 12.21
3h	70[m]	B	208.0–211.0	1695 1593	242 (5.13) 289 (5.72)	(s) 5.30[n]	201 (213.5)	C, 28.13; H, 1.41; N, 13.12; Cl, 49.83	C, 28.37; H, 1.26; N, 13.28; Cl, 49.8
3i	19[o]	P–B (1:1)	122.0–123.0	1665 1595		(m) 7.55 (2 H)[n] (t) 6.80 (2 H), 6.68 (2 H), 6.30 (2 H), 6.20 (2 H)		C, 40.10; H, 4.11; N, 10.39	C, 39.80; H, 3.84; N, 10.17
3j[p]	28[q]	W	93.0–94.0	1660 1580		(t) 8.67 (3 H), 8.58 (3 H)[n] (m) *ca.* 7.63 (2 H), *ca.* 6.73 (4 H), *ca.* 6.00 (8 H)		C, 54.07; H, 7.33; N, 9.70	C, 53.90; H, 7.52; N, 9.65

[a] Based on phosgene used. [b] Ac = acetone, D = dioxane, P = petroleum ether, An = acetonitrile, W = water, E = ethanol, B = benzene. [c] KBr disk. [d] The solvent was methanol. [e] s = singlet, d = doublet, t = triplet, m = multiplet, c = complex, b = broad. [f] Reaction time 40 hr. [g] Mp of the hydrochloride is above 240 dec. [h] The solvent was pyridine. [i] Reaction time 110 hr. [j] The filtrate was concentrated and chromatographed on silica gel. Petroleum ether eluted a small amount of **4d**. Ir (neat), 1560 cm^{-1} (ring). [k] Reaction time 100 hr. Reaction time 126 hr. [m] Based on **6** (R = Cl). [n] The solvent was CF_3COOH. [o] Reaction time 19 hr. [p] In the course of the reaction, no precipitates were formed. However, evaporation of the reaction mixture gave a brown solid residue. It was recrystallized and analyzed. [q] Reaction time 68 hr.

cm^{-1}. This is also the case for the other pyrimidones (**3**) (Table I). We observed that the pyrimidone **3a** has two crystal forms; one is needlelike and the other prismatic. Examination of these two crystals, especially structural differences, is in progress.

The reaction of nitriles with phosgene to form pyrimidones has also been extended to 4-chlorobutyronitriles (**1i**) and 4-ethoxybutyronitrile (**1j**), the products being the expected pyrimidones **3i** and **3j**, respectively (Table I). However, attempts to obtain the corresponding pyrimidones from methoxyacetonitrile, malonitrile, ethyl cyanoacetate, 3-chloropropionitrile, 3-alkoxypropionitrile, and 3-diethylaminopropionitrile were all in vain.

Johnson, *et al.*,[12] pointed out that, if imidoyl chloride (I), which may exist in the initial stage of the reaction of nitriles with hydrogen chloride,[13] has a hydrogen atom on the α carbon, it is very unstable and two molecules may condense to form an amidine (II). In addition, nitrile trimerization to 1,3,5-triazine in the presence of hydrogen chloride has been interpreted as a cycloaddition of I to II.[14]



I II

In order to know the reaction mechanism, it is of interest to isolate II and allow it to react with phosgene directly.

Grundmann, *et al.*,[4] have reported that N-(1,2-dichloroethylidene)chloroacetamidine (II, R = $ClCH_2$) is easily isolable by the reaction of chloroacetonitrile with hydrogen chloride in ether.[15] The white amorphous solid prepared according to their method indeed had the same properties as reported, but could not be assigned to II on the basis of elemental analysis.[17] In addition, this product was unstable since its melting point dropped gradually during the storage. Heating it in benzonitrile or chlorobenzene using a sealed tube, however, gave N-(1,2-dichloroethylidene)-chloroacetamidine hydrochloride (**6**, R = Cl), which was identified by elemental analysis and mass spectrum. The amidine hydrochloride (**6**, R = Cl) was also prepared by the direct reaction of chloroacetonitrile with hydrogen chloride in chlorobenzene using a sealed tube and converted to N-chloroacetylchloroacetamide by treatment with water. Treatment of **6** (R = Cl) with phosgene in chlorobenzene did indeed lead to the isolation of 5,6-dichloro-2-chloromethyl-4(3H)-pyrimidone (**3h**) in 70% yield (Table I).

Thus we propose the reaction mechanism given in Scheme II. Speziale[19] has reported that the reaction of N,N-disubstituted acetamidines with oxalyl chloride gives the furanone amines through the intramolecular acylation of α carbon to the $C{=}N^+$ group. Moreover,

(12) A. W. Johnson, C. E. Dalgliesh, and J. Walker, "Chemistry of Carbon Compounds", Vol. 1, Part A, Elseiver Publishing Co., Amsterdam, 1951, p 607.

(13) G. J. Janz and S. S. Danyluk, *J. Amer. Chem. Soc.*, **81**, 3486 (1959).

(14) M. Lora-tamayo and R. Madronero, "1,4-Cycloaddition Reactions," Academic Press Inc., London, 1967, p 134.

(15) Hinkel *et al.*[16] have isolated N-(1-chloroethylidene)-acetamidine hydrochloride by the reaction of acetonitrile with hydrogen chloride, but with difficulty.

(16) L. E. Hinkel and G. J. Treharne, *J. Chem. Soc.*, 866 (1945).

(17) In an earlier report,[18] the reaction product was assigned to chloroacetimidoyl chloride (I, R = $ClCH_2$).

(18) J. Troeger and O. Luening, *J. Pr. Chem.*, **69**, 347 (1904).

(19) A. J. Speziale and L. R. Smith, *J. Org. Chem.*, **27**, 4361 (1962).

it has been shown[20,21] that the iminium salts react with an electrophile, yielding α-substituted amide derivatives. These reaction mechanisms indicate the probability of the intramolecular C-acylation of the intermediate **8** *via* the enamine **9**.[22]

Experimental Section[23]

Preparation of Pyrimidones (3). General Procedure.—In a 50- or 100-ml glass tube was placed 10 ml of a nitrile–hydrogen chloride solution (0.04–0.06 mol) and 10 ml of a nitrile–phosgene solution (0.04–0.06 mol). The tube was stoppered, cooled in Dry Ice–acetone, sealed carefully, and heated to 60–70° in a water bath. During the course of the reaction, a white crystalline solid precipitated. After the end of the reaction, the reaction tube was chilled in Dry Ice–acetone and opened. The precipitate was filtered, washed with a small portion of the nitrile, and then washed with petroleum ether (bp 35–60°). Further material precipitated on concentration of the filtrate. This was treated in the same way. The precipitates were combined, washed with water, dried in a desiccator over $CaCl_2$ under reduced pressure, and recrystallized (Table I).

6-Chloro-2-methyl-4(3H)-pyrimidone (3a)[1] has two crystal forms: needlelike and prismatic. In the course of crystallization from acetone–dioxane (3:1 v/v), the former precipitated first, and rapid filtration and drying gave the needlelike crystals. On the other hand, when the solution containing the needlelike crystals was allowed to stand for a while, the needlelike crystals were observed to change to the prismatic form. Their ir spectra (KBr disk) are quite different; for example, the former has absorptions at 1670 and 1700 cm^{-1} but the latter has a single absorption at 1685 cm^{-1}. However, they have the same melting point and mixture melting point.

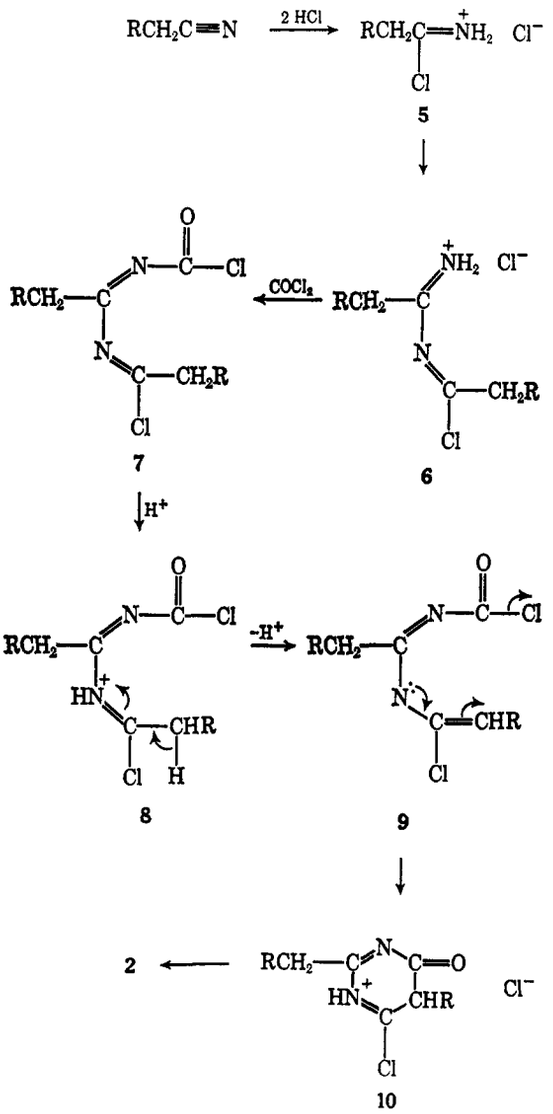
The structure of **3a** was proved by conversion to **4,6-dichloro-2-methylpyrimidine (4a)**. **3a** (7.0 g) was mixed with 10 g of phosphorus pentachloride and heated under reflux for 3 hr, causing evolution of hydrogen chloride, and the temperature was then raised to 140°. Most of the phosphorus oxychloride was removed by distillation under reduced pressure, the residue was poured onto a large amount of ice, and the oily or semisolid product was extracted with ether. After being dried over sodium sulfate, the extract was freed from ether and the residue was chilled to give 7.2 g of volatile **4a**. It was purified by sublimation; mp 45.0–45.5° (lit.[24] 46–48°). Mixture melting point, ir, and nmr showed that it was identical with an authentic sample prepared by the reaction of 2-methyl-4,6(1H, 5H)-pyrimidinedione with phosphorus oxychloride.[24]

6-Chloro-2-ethyl-5-methyl-4(3H)-pyrimidone (3b)[1] was prepared from propionitrile. The tarry product obtained by concentration of the filtrate was chromatographed on silica gel. Petroleum ether eluted 0.5 g of oily liquid, which was identified as 4,6-dichloro-2-ethyl-5-methylpyrimidine (**4b**) by glpc and direct comparison of the ir spectrum with that an authentic sample prepared from **3b** and phosphorus pentachloride; ir (neat) 1570 cm^{-1} ring. Glpc was performed with a column of silicone DC 550, 10% on Diasolid L (60–80 mesh, 1-m column, 150°, hydrogen carrier gas, 100 ml/min).

Heating **3b** (1.5 g) and phosgene (2.8 g) in 10 ml of chlorobenzene at 60–65° for 170 hr using a sealed tube and concentration of the filtrate also gave 0.5 g of **4b**.

Preparation of Pyrimidone Hydrochloride (2) from the Free Pyrimidone (3).—Into a solution of the pyrimidones (**3**) in ether, dry hydrogen chloride was bubbled. The precipitates were filtered, washed with ether, and dried to give pyrimidone hydrochlorides (**2**). Their ir spectra (Nujol) were identical with those of the initial products obtained by the reaction of nitriles and phosgene in the presence of hydrogen chloride: compound **2a**, 1730, 1640 cm^{-1}; **2b**, 1700, 1635 cm^{-1}; **2c**, 1700, 1610 cm^{-1}; **2d**, 1700, 1630 cm^{-1}; **2e**, 1700, 1620 cm^{-1}; **2f**, 1700, 1635 cm^{-1}.

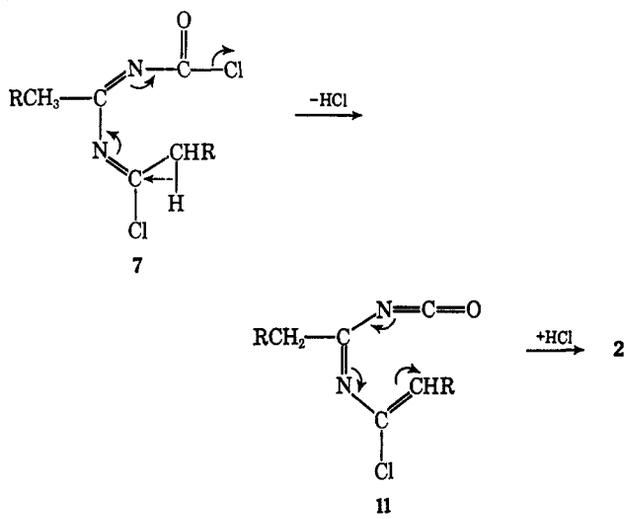
SCHEME II



(20) H. Eilingsfeld, M. Seefelder and H. Weidinger, *Ber.*, **96**, 2899 (1963).

(21) T. Oishi, M. Ochiai, M. Nagai, and Y. Ban, *Tetrahedron Lett.*, 497 (1968).

(22) Another possible mechanism for the formation of the pyrimidones (**2**) is as follows.



However, taking into account the presence of excess hydrogen chloride in the reaction system, the formation of isocyanate **11** would be difficult.

(23) Melting points were determined on a Yanagimoto micro melting point apparatus and were corrected. The nmr spectra were obtained using a Model J. N. M-G-60 spectrometer (Japan Electronic Optics Laboratory Co.); the solvent was deuteriochloroform, except where otherwise noted, with tetramethylsilane as an internal reference. The ir spectra were recorded with a Japan Electroscopic IR-E spectrophotometer. The mass spectra were recorded with a Hitach mass spectrometer Model RMU-6E. The ultraviolet spectra were recorded with a Hitach recording spectrophotometer EPS-3. Molecular weights were determined on a Mechrolab osmometer, Model 301A.

(24) H. R. Henze, W. J. Clegg, and C. W. Smart, *J. Org. Chem.*, **17**, 1320 (1952).

Reaction of Chloroacetonitrile with Hydrogen Chloride.—According to the method of Grundmann,[4] an amorphous solid was obtained. It was placed in a desiccator under reduced pressure to remove adhering hydrogen chloride; mp 142–143° (lit.[4] mp 142°).

Anal. Calcd for $C_4H_6N_2Cl$: N, 12.51; Cl, 63.33. Found: N, 12.21; Cl, 64.5.

During storage, the mp dropped to 131–134° or 126–128°. Water converted it to N-chloroacetylchloroacetamide, mp 190–192° (lit.[4] mp 192°). This solid, when heated with benzonitrile or chlorobenzene in a sealed glass tube at 60–65° for 42 hr, changed to a stable crystalline powder, mp 122–123°; ir (KBr disk) 1695, 1615 cm^{-1}; mass spectrum (70 eV) *m/e* (rel intensity) 190 (5), 188 (15), 186 (15) ($M^+ - HCl$), 153 (18), 151 (27) [$ClCH_2(=NH)N=C^+CH_2Cl$], 76 (77), 78 (25) ($ClCH_2C^+=NH$), 36 (100), 38 (33) (HCl^+).

Anal. Calcd for $C_4H_6N_2Cl_4$: C, 21.45; H, 2.70; N, 12.51; Cl, 63.33. Found: C, 21.20; H, 3.03; N, 12.57; Cl, 63.3.

Water also converts it to N-chloroacetylchloroacetamide. Thus the structure was confirmed as N-(1,2-dichloroethylidene)-chloroacetamidine hydrochloride (**6**, R = Cl).

Reaction of 6 (R = Cl) with Phosgene.—The amidine hydrochloride (**6**, R = Cl) (2.90 g) was added to 10 ml of a chlorobenzene–phosgene solution (2.73 g of $COCl_2$) and heated to 60–65° for 72 hr using a sealed tube. Filtration of the reaction mixture gave 2.32 g of brown solid. Extraction with benzene using a Soxhlet extractor and concentration gave 1.79 g of crude 5,6-dichloro-2-chloromethyl-4(3H)-pyrimidone (**3h**) (70% yield). It was recrystallized and analyzed (Table I).

Reaction of Substituted Acetonitriles and 3-Substituted Propionitriles with Phosgene in the Presence of Hydrogen Chlorides.—In the case of methoxyacetonitrile, no crystalline material could be isolated from the dark brown tar produced. The solid products from the reaction of malonitrile or ethyl cyanoacetate with phosgene in the presence of hydrogen chloride did not have the properties expected of pyrimidones. In the case of 3-chloropropionitrile, a yellow solid, apparently a polymeric substance, was isolated when the reaction mixture was evaporated and treated with water. Since it was insoluble in water and in most organic solvents, further investigation of this substance was not performed. The reaction of 3-methoxypropionitrile with phosgene under the comparable conditions led to the formation of 3-chloropropionitrile, methyl chloroformate, and 3-chloropropionamide.[25] 3-Chloropropionamide was separated from the reaction mixture during the reaction and was obtained in good yield when a small amount of water was previously added to the reaction system; mp 102–103° (lit.[27] mp 102°). Similarly, in the case of 3-ethoxy and 3-butoxypropionitrile, the expected pyrimidones were not isolated. The reaction of 3-diethylaminopropionitrile with phosgene using nitrobenzene as solvent resulted in recovery of the starting materials, even if the reaction temperature was raised to 100°.

Registry No.—Phosgene, 75-44-5; **3a**, 19874-94-3; **3a** (HCl), 20056-12-6; **3b**, 19874-95-4; **3b** (HCl), 20439-58-1; **3c**, 20439-59-2; **3c** (HCl), 20500-54-3; **3d**, 20439-60-5; **3d** (HCl), 20439-61-6; **3e**, 20439-62-7; **3e** (HCl), 20439-63-8; **3f**, 20439-64-9; **3f** (HCl), 20439-65-0; **3g**, 20439-66-1; **3h**, 19875-06-0; **3i**, 20439-68-3; **3j**, 20439-69-4; **6** (R = Cl), 20439-70-7.

Acknowledgment.—The authors are indebted to Reiji Kumagai for technical assistance. The authors also wish to express their appreciation to Dr. Daniel Swern, Temple University, for his encouragement and helpful suggestion.

(25) The easy cleavage of the ether linkage in this reaction is presumably due to the following equilibrium.

$$ROCH_2CH_2C(Cl)=NH_2Cl^- \rightleftarrows ROCH_2CH=C^+(Cl)NH_2Cl^-$$

5′ **5″**

5″ has a type of allylic structure, so that reaction with phosgene can readily produce allylic stabilized carbonium ions, giving 3-chloropropionitrile or 3-chloropropionamide, if water is present. Similar equilibrium has been reported by Speziale.[26]

(26) A. J. Speziale and R. C. Freeman, *J. Amer. Chem. Soc.*, **82**, 903 (1960).

(27) C. C. Price and J. Zomlefer, *J. Org. Chem.*, **14**, 213 (1949).

Syntheses of 2-(Chlorinated methyl)-4-methylene-1,3-dioxolanes. Deviations from the Predicted Direction in Competitive Elimination Reactions

HEINZ J. DIETRICH,[1] ROBERT J. RAYNOR, AND JOSEPH V. KARABINOS

Chemicals Division, Olin Mathieson Chemical Corporation, New Haven, Connecticut 06504

Received August 7, 1968

Several cases of competitive elimination and substitution reactions on 1,3-dioxolanes derived from chlorinated acetaldehydes were investigated. It was found that often anion attack occurred at C-4 rather than at the expected more positively charged C-2, demonstrating that eliminations adjacent to electronegative groups do not always follow the predicted pattern. Thus, the novel 4-chloro-2-trichloromethyl-1,3-dioxolane and three 2-(chlorinated methyl)-4-methylene-1,3-dioxolanes were prepared, one of the latter yielding a diene upon further dehydrochlorination. A new synthesis of 4-methylene-2-trichloromethyl-1,3-dioxolane and its allyl-type rearrangement to 4-methyl-2-trichloromethyl-1,3-dioxole is also described.

The title compounds were prepared to serve in a polymerization study which has been reported elsewhere.[2] The conventional syntheses of 4-methylene-1,3-dioxolanes by dehydrochlorination of the corresponding 4-chloromethyl-1,3-dioxolanes[3] were expected to yield preferentially ketene acetal derivatives in cases where chlorine was also available in the 2-methyl position. Reported evidence indicated that the dehydrochlorination in the 2 position is easily accomplished, such as in the syntheses of ketene acetals,[4] or of 2-4-dimethylene-1,3-dioxolane with the *t*-butoxide anion, where no monoolefin had been found.[5] Because of this evidence and also in view of mechanistic considerations it was surprising when preliminary experiments revealed that the 4-chloromethyl position could be quarternized with pyridine without apparent damage to the 2-(*x*-chloromethyl) group.

Results and Discussion

The elimination of hydrogen chloride in the 2 position of 2-(*x*-chloromethyl)-4-chloromethyl-1,3-dioxolanes (*x*

(1) Address correspondence to the author at Corporate Research, Owens-Illinois, Toledo, Ohio 43607.

(2) H. J. Dietrich, *J. Polym. Sci., Part A-1*, **6**, 2255 (1968).

(3) H. O. L. Fischer, E. Baer, and L. Feldmann, *Ber.*, **63**, 1732 (1930).

(4) S. M. McElvain and M. J. Curry, *J. Amer. Chem. Soc.*, **70**, 3781 (1948).

(5) B. G. Yagnitskii, S. A. Sarkisyants, and E. G. Ivanyuk, *Zh. Obshch. Khim.*, **34**, 1940 (1964).