Tetrahedron Letters Vol. 21, pp 1875 - 1876
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0040-4039/80/0501-1875$02.00/0

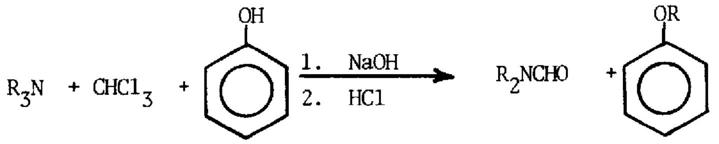
CONVERSION OF TERTIARY AMINES TO FORMAMIDES IN PRESENCE OF DICHLOROCARBENE AND PHENOXIDE ION

Minda Yonovich and Yoel Sasson
Casali Institute of Applied Chemistry, The Hebrew University of Jerusalem
Jerusalem, Israel

Abstract: Tertiary amines were found to be a convenient alkyl source for O-alkylation of substituted phenol, in presence of dichlorocarbene in a two-phase system.

Primary and secondary amines are very susceptible to attack by dichlorocarbene under phase transfer conditions to yield isocyanides (1) and formamides (2) respectively. Tertiary amines, on the other hand, are usually stable in basic aqueous chloroform mixtures (3). Furthermore, tertiary amines have been used as phase transfer catalysts in addition reactions of dichlorocarbenes to olefins (4-6).

We have now found that when strong nucleophiles are present in a chloroform-hydroxide-tertiary amine mixture a smooth decomposition reaction takes place with formation of dialkyl formamide. A typical example is reaction with 4-tert-butylphenol according to the following scheme:



R = n-C_4H_9, n-C_6H_{13}

In a typical example 15 g (0.1 mole) p-tert-butylphenol was dissolved in solution of 24 g (0.6 mole) sodium hydroxide in 24 ml water. 71.7 g chloroform (0.6 mole) and 18.5 g (0.1 mole) tributylamine in 200 ml benzene added. The mixture is mechanically stirred at reflux temperature (80°C) for 2 hours. After cooling the product is acidified with 10% hydrochloric acid to pH 1. The organic phase is separated and the aqueous layer is extracted with 40 ml of benzene. The combined benzene portions are dried (magnesium sulfate) and the solvent evaporated. G.L.C. analysis of the product indicated that it contained 11.5 g (0.056 mole) of 4-tert-butylphenyl-n-butyl-ether and 8.02 g (0.051 mole) N,N-di-n-butylformamide. Additional experiments are presented in the table.

As was previously assumed by Makosza and co-workers (5) tertiary amines react with dichlorocarbene to yield quaternary salts according to the following sequence:

$$R_3N + :CCl_2 \longrightarrow R_3\overset{+}{N}\,\overset{-}{C}Cl_2 \xrightarrow{CHCl_3} [R_3\overset{+}{N}\ CHCl_2]\ \overset{-}{C}Cl_3$$

$$\xrightarrow{-\ :CCl_2} [R_3\overset{+}{N}\ CHCl_2]\ \overset{-}{C}l$$

This intermediate will exchange ions with phenoxide to yield a quaternary phenoxide salt:

$$[R_3\overset{+}{N}\,CHCl_2]\,Cl^- \xrightarrow{ArO^-} [R_3\overset{+}{N}\,CHCl_2]\,\bar{O}Ar \qquad Ar = \text{substituted phenyl}$$

We suggest that under basic conditions the formed salt will decompose, either by attack of the dichloromethyl group on the phenoxide ion in a Reimer-Tiemann type reaction (7), or by transfer of an R group to the anion to yield ether.

We have found that either formation is favored when high concentration of sodium hydroxide solution (50%) is used in presence of an apolar organic solvent (Benzene) and the mixture is effectively mixed. Ether yield is particularly increased when the phenolate ion is p-substituted with bulky alkyl groups. Phenol, cresols, and chlorophenols, on the other hand, reacted via the Reimer-Tiemann formylation reaction.

TABLE

O-Alkylation of Phenols with Tertiary Amines in Presence of Dichlorocarbenes(a).

Exp.	Amine	Phenol	Ether (Yield %) (b,c)
1	tri-n-butylamine	4-tert-butylphenol	4-tert-butylphenyl-n-butyl ether (56.0)
2	tri-n-hexylamine	4-tert-butylphenol	4-tert-butylphenyl-n-hexyl ether (52.0)
3	tri-n-butylamine	4-sec-butylphenol	4-sec-butylphenyl-n-butyl ether (28.0)
4	tri-n-butylamine	4-ethylphenol	4-ethylphenyl-n-butyl ether (2.0)
5	tri-n-butylamine	4-methyl phenol	4-methylphenyl-n-butyl ether (1.0)
6	tri-n-butylamine	phenol	phenyl-n-butyl ether (0)

(a) Procedure similar to the description in the text of exp. 1

(b) Analysis by G.L.C. using 6' 7.5% diethyleneglycolsuccinate on chromosorb W column at 140°C. Products identified by comparison with authentic samples.

(c) Similar yields of the corresponding formamide were obtained.

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(Received in UK 7 March 1980)