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The Schotten-Baumann Reaction of Dimethylaminobenzyl Alcohols[1)]

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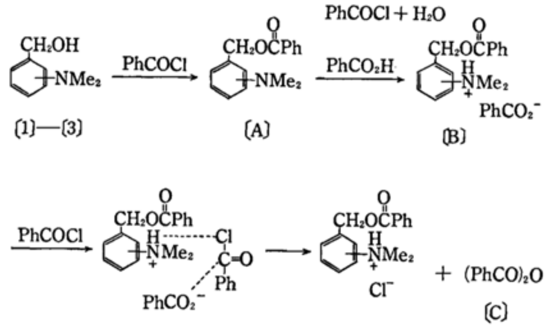
As an extension of our previous work on the benzoylation of aliphatic *t*-aminoalcohols, we have carried out the benzoylation of such aromatic *t*-aminoalcohols as *ortho*-〔1〕, *meta*-〔2〕, and *para*-dimethylaminobenzyl alcohol 〔3〕. When the reaction mechanism proposed in a previous paper[2)] is applied to dimethylaminobenzyl alcohols, it should be written as follows:



The *t*-aminoalcohols and the *t*-amines used in this experiment are as follows: *o*-dimethylaminobenzyl alcohol 〔1〕, *m*-dimethylaminobenzyl alcohol 〔2〕, *p*-dimethylaminobenzyl alcohol 〔3〕, 2-dimethylaminocyclohexylmethanol 〔4〕, *N,N*-dimethylaniline 〔5〕, *N,N*-dimethyl-*o*-toluidine 〔6〕, *N,N*-dimethyl-*p*-toluidine 〔7〕, *N,N*-dimethyl-*o*-cumidine 〔8〕, and *N,N*-dimethyl-*p*-cumidine 〔9〕.

Results and Discussion

The Schotten-Baumann reactions of 〔1〕—〔3〕 were carried out under the same conditions as those described in a previous paper[2)] and also under other conditions using different amounts of sodium hydroxide (0.35 mol)*[2]. The results are summarized in Table 1. The yields of 〔A〕 from 〔1〕—〔3〕 were almost all the same, but the yields of 〔C〕 increased in the order of 〔1〕, 〔2〕, and 〔3〕. According to previous works,[2,3)] the yield of 〔C〕 seems to depend mainly on the basicity of 〔A〕 because of the facility of the formation of 〔B〕. In the cases of 〔1〕—〔3〕, however, the observed pK_a-values of 〔A〕[4)] decreased slightly in the order of 〔1〕, 〔2〕, and 〔3〕, as is shown in Table 1. Therefore, the yields of 〔C〕 can not simply be correlated with the basicity.

TABLE 1. BENZOYLATION OF AMINOALCOHOLS

Method	Aminoalcohol	〔A〕 (g)	Yield[a)] (%)	〔C〕 (g)	pK_a of 〔A〕
I	*o*-〔1〕	11.6	(91)	0	
	m-〔2〕	11.8	(93)	2.3	
	p-〔3〕	11.2	(88)	4.2	
II	*o*-〔1〕	11.3	(89)	7.6	2.6
	m-〔2〕	11.2	(88)	10.5	2.5
	p-〔3〕	11.4	(90)	12.1	2.4
	〔4〕	12.2	(94)	18.8	7.4

Method I : aminoalcohols 0.05 mol, benzoyl chloride 0.25 mol, sodium hydroxide 0.525 mol 10% aqueous solution.

Method II : aminoalcohol and benzoyl chloride: the same as the above, sodium hydroxide: 0.35 mol 10% aqueous solution.

a) Yield shows a crude one.

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1) Partly presented at the 20th Annual Meeting of the Chemical Society of Japan, Tokyo, April, 1967.

2) T. Ogata, T. Asano, H. Yoshida, and S. Inokawa, This Bulletin, **40**, 997 (1967).

3) K. Oshiro, T. Ogata, H. Yoshida and S. Inokawa, *Nippon Kagaku Zasshi (J. Chem. Soc. Japan, Pure Chem. Sect.)*, **89**, 211 (1968).

*[2] In the reaction of benzoyl chloride with different amounts of a 10% aqueous sodium hydroxide solution in the presence of 〔5〕, the yield of 〔C〕 increased as the amount of sodium hydroxide decreased, reaching a maximum at the concentration of an equimolar amount of the benzoyl chloride used.

4) S. Nakamura, *Yuki Gosei Kagaku Kyokaishi (J. Synth. Org. Chem., Japan)*, **24**, 923 (1966).

TABLE 2. RELATION BETWEEN YIELD OF 〔C〕 AND TWIST-ANGLE

Dimethylaniline	$\lambda_{\max}$ (mμ)	$\varepsilon_{\max}$	φ°C	〔C〕 g[b]
〔5〕	250	14700	0	16.3
2-Me 〔6〕	249	6160	50	12.0
4-Me 〔7〕	252	14300	10	18.3
2-*i*-Pr 〔8〕	248	4180	58	7.3
4-*i*-Pr 〔9〕	252	14300	10	17.0
2-CH_2OCOPh 〔1A〕	248	5960	51	7.6
3-CH_2OCOPh 〔2A〕	255	13200	19	10.5
4-CH_2OCOPh 〔3A〕	250[a]	14700[a]	0	12.1

a) There is no $\lambda_{\max}$ near 250 mμ. The value is one at 250 mμ.

b) amine 0.05 mol, benzoyl chloride 0.25 mol, sodium hydroxide 0.35 mol 10% aq. soln.

In order to obtain further knowledge on the yields of 〔C〕 in the case of weak bases, the aromatic *t*-amines of 〔5〕—〔9〕 were treated with benzoyl chloride under the same conditions (0.35 mol of 10% sodium hydroxide solution) as in the cases of 〔1〕—〔3〕. The results are shown in Table 2. Though 〔6〕 and 〔8〕 are stronger bases5) than 〔7〕 and 〔9〕 respectively, the *ortho* isomers, [6] and 〔8〕, gave smaller amounts of 〔C〕 than do the *para* isomers, 〔7〕 and 〔9〕, undoubtedly due to the steric hindrance in the former compounds. The degree to which the ester-group in 〔A〕 hinders the front of the nitrogen therein from the formation of 〔B〕 is possibly related to the twist-angle (φ)6) between the *t*-amino group and the benzene ring. Just as is shown in Table 2, the yields of 〔C〕 are found to decrease as the φ values increase. This consideration was also supported by the fact that the titration curve of benzoic acid in the presence of 〔A〕 with sodium hydroxide coincided more closely with the blank titration curve without 〔A〕 in the order of 〔3〕, 〔2〕, and 〔1〕.

Finally, though there may be little difference in steric hindrance between 〔1〕 and 〔4〕, the yield of 〔C〕 from 〔4〕 was found to be more than twice that from 〔3〕.

In conclusion, the yield of 〔C〕 depends mainly on the basicity of〔B〕, but in the case of weak bases of a similar basicity, steric hindrance has a great effect on the yield of 〔C〕.

Experimental

***o*-Dimethylaminobenzyl Alcohol 〔1〕.** 〔1〕 was prepared by the method of Willstätter.7)

***m*-Dimethylaminobenzyl Alcohol 〔2〕.** *m*-Dimethylaminobenzaldehyde8) was reduced with lithium aluminum hydride. Bp 127—130°C/3 mmHg, n_D^{12} 1.5710, Found: N, 9.11%. Calcd for $C_9H_{13}NO$: N, 9.27%.

***p*-Dimethylaminobenzyl Alcohol 〔3〕.** 〔3〕 was prepared by the method of Hass and Bender.9)

2-Dimethylaminocyclohexylmethanol 〔4〕. 〔1〕 was reduced in the presence of Adams platinum oxide catalyst10) under atmospheric pressure in an ethanol solution. Bp 125—127°C/17 mmHg, n_D^{17} 1.4990, Found: N, 8.50%. Calcd for $C_9H_{19}NO$: N, 8.92%.

***N,N*-Dimethyl-*o*-toluidine 〔6〕 and *N,N*-Dimethyl-*p*-toluidine 〔7〕.** 〔6〕 and 〔7〕 were prepared by the method of Hunig.11)

***N,N*-Dimethyl-*o*-cumidine 〔8〕 and *N,N*-dimethyl-*p*-cumidine 〔9〕.** 〔8〕 and 〔9〕 were prepared by the nitration of cumene,12) the reduction of the *o*- and *p*-nitrocumenes thus obtained13) and the methylation of the *o*- and *p*-aminocumenes.11)

〔9〕: bp 123—125°C/21 mmHg, n_D^{20} 1.5255, Found: N, 8.37%. Calcd for $C_{11}H_{18}N$: N, 8.54%.

The Schotten-Baumann Reaction. The general procedure was carried out as has been described in a previous paper,2) and 〔A〕 and 〔C〕 were separated from the reaction mixtures by an extraction method using ether. The characteristics of 〔A〕 are summarized in Table 3.

TABLE 3. CHARACTERS OF ESTERS 〔A〕

Ester	Bp °C/mmHg	n_D (°C)	Analysis, N%	
			Found	Calcd
〔1A〕	176—177/3	1.5700 (22.5)	5.45	5.49
〔2A〕	196—197/3	1.5852 (20)	5.44	5.49
〔3A〕	86— 87[a]	—	5.81	5.49
〔4A〕	155—157/2	1.5401 (15)	5.37	5.36

a) melting point

Reaction of Tertiary Amines 〔5〕—〔9〕 with Benzoyl Chloride. Benzoyl chloride (0.25 mol) was added to the *t*-amine in a 10% aqueous sodium hydroxide (0.35 mol) solution under the same conditions as in the abovementioned Schotten-Baumann reaction.

The Measurement of the Twist-angle (φ) between the Planes of the Benzene Ring and the *t*-Amino Group. φ was calculated6) from $\varepsilon_{\max}$ near 250 mμ (K-band) in the UV spectrum in isooctane.

Measurement of pK_a. The pK_a values of the amines were measured in methanol by the back-titration method described in a preceeding paper.3)

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