

THE RESISTANCE TO HYDROLYSIS OF *N,N*-DIMETHYL-*N*-PHENYLAMMONIOMETHANESULFONATE AND THE  
 IMPROBABILITY OF A RECENTLY-PROPOSED MECHANISM OF HYDROLYSIS OF ANILINOMETHANESULFONATES

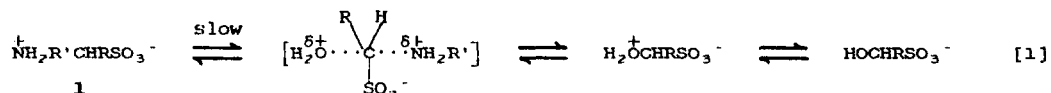
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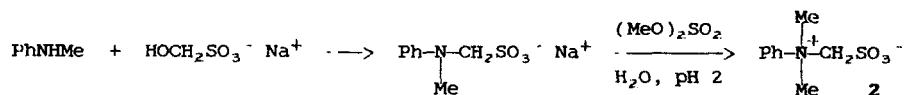
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**Summary:** The hydrolysis of  $\text{PhN}^+\text{Me}_2\text{CH}_2\text{SO}_3^-$  (2) is so slow that a proposed mechanism of hydrolysis of  $\text{PhNHCH}_2\text{SO}_3^- \text{Na}^+$  involving  $\text{S}_{\text{N}}2$  attack of  $\text{H}_2\text{O}$  on  $\text{PhNH}_2^+\text{CH}_2\text{SO}_3^-$  may be discounted.

The formation and hydrolysis of aminomethanesulfonate salts ("amine-formaldehyde-bisulfite adducts") and related species has long been thought to go via the carbinolamine, the iminium ion, and derived forms.<sup>1</sup> Recently, however, Senepeschi, *et al.*<sup>2</sup> have put forward "an alternative mechanism for the formation and hydrolysis of anilinomethanesulfonates", involving, in the hydrolysis direction, an  $\text{S}_{\text{N}}2$  attack of water on the conjugate acid of the substrate:



Such a bimolecular cleavage is not observed with simple amines under mild conditions, and, hence, to be regarded as even remotely possible, the suggestion would have to be supported by evidence that the attached sulfonato function has a strongly accelerating effect. In fact, quite the reverse has been observed, the displacement of halogen from an  $\alpha$ -halomethanesulfonate anion, for example, being an especially sluggish process.<sup>3</sup> As a model for a test of the new mechanism, we have accordingly prepared<sup>4</sup> 2, the *N,N*-dimethyl homologue of 1 ( $\text{R}' = \text{Ph}$ ,  $\text{R} = \text{H}$ ):



An aqueous solution of 2 was recovered largely (~95%) unchanged when refluxed for one week; by contrast, aqueous  $\text{PhNHCH}_2\text{SO}_3^- \text{Na}^+$  (3) hydrolyzed with a half-life of about 8 min at 25°C (at pH 2).<sup>5</sup> We noted also that the <sup>1</sup>Hmr and <sup>13</sup>Cmr spectra of the product of the hydrolysis of 3 showed no sign of  $\text{HOCH}_2\text{SO}_3^- \text{Na}^+$  as expected from eq. [1], but rather showed peaks appropriate to *N,N,N*-triphenylhexahydro-*s*-triazine (4); further experiments showed the sulfur to be present as  $\text{HSO}_3^-$ ; and also that a mixture of  $\text{PhNH}_3^+ \text{Cl}^-$  and  $\text{HOCH}_2\text{SO}_3^- \text{Na}^+$  was stable at pH 2 and 25°C.

We may therefore dismiss the mechanism of Senepeschi *et al.*<sup>2</sup> because (a) it does not account for the remarkable difference between 1 and 2 in ease of hydrolysis, and (b) predicts different products from those observed. A process leading to the iminium bisulfite<sup>1</sup> exactly analogous to that proposed by Young and Jencks<sup>6</sup> for the first step of the general acid catalyzed cleavage of  $\alpha$ -methoxysulfonic acids, would appear to suffice.

**Experimental:**  $\text{PhNHCH}_2\text{SO}_3^- \text{Na}^+$  (3):<sup>7</sup> mp >370°C,  $^1\text{Hmr}$  ( $\text{D}_2\text{O}$ )  $\delta$ : 4.40 (2H), 6.80-7.15 (m, 5H);  $^{13}\text{Cmr}$  ( $\text{D}_2\text{O}$ )  $\delta$ : 63.6, 116.2, 121.3, 131.9, 148.7;  $\text{PhNMeCH}_2\text{SO}_3^- \text{Na}^+$  (also via the general procedure<sup>7</sup>): mp >375°C;  $^1\text{Hmr}$  ( $\text{D}_2\text{O}$ )  $\delta$ : 3.08 (s, 3H), 4.58 (s, 2H), 6.8-7.2 (m, 5H);  $^{13}\text{Cmr}$  ( $\text{D}_2\text{O}$ )  $\delta$ : 40.9, 71.5, 115.5, 120.4, 131.7, 150.3. *N,N*-Dimethyl-*N*-phenylammoniummethanesulfonate (2):  $\text{PhNMeCH}_2\text{SO}_3^- \text{Na}^+$  (2.26 g, 10 mmol) in  $\text{H}_2\text{O}$  (6.5 mL) was stirred vigorously with dimethyl sulfate (7.5 g, 60 mmol) at pH 2.0 (pH-stat using 2 M NaOH) for 24 h, the solution was neutralized with NaOH, passed through Rexyn 300 (H-OH) deionizing resin, and the water evaporated to give a white solid (743 mg, 35%); needles from abs. EtOH, mp 251-252°C (dec.);  $^1\text{Hmr}$  ( $\text{D}_2\text{O}$ )  $\delta$ : 3.83 (s, 6H), 5.03 (s, 2H), 7.6-7.9 (m, 5H);  $^{13}\text{Cmr}$  ( $\text{D}_2\text{O}$ )  $\delta$ : 58.2, 79.7, 122.9, 132.7, 133.1, 146.8; ir (KBr)  $\nu_{\text{max}}$ : 3045 (m), 3010 (m), 1475(m), 1250-1205 (vs, br), 1045 (vs), 755 (s), 680 (s)  $\text{cm}^{-1}$ . Anal. calcd for  $\text{C}_9\text{H}_{13}\text{O}_3\text{NS}$ : C, 50.22; H, 6.09; N, 6.51; S, 14.89; found: C, 49.88; H, 5.93; N, 6.43; S, 14.87. A solution of 2 (30 mg) in  $\text{H}_2\text{O}$  (3 mL) and refluxed for 1 week, the water was evaporated to give a beige solid (28.5 mg, 95%), mp 250-252°C, with  $^1\text{Hmr}$ ,  $^{13}\text{Cmr}$  ( $\text{D}_2\text{O}$ ) and ir (KBr) spectra identical to those of 2 (as above).

Hydrolysis of 3 (25.0°C, pH 2.0, pH-stat) showed first-order uptake of 0.1 M NaOH with  $t_{1/2} = 8.4$  min ( $k_{\text{S}} = 1.4 \times 10^{-3} \text{ s}^{-1}$ ); the product of the hydrolysis precipitated from solution (0.1 M), mp. 143-145°C,  $^1\text{Hmr}$  and  $^{13}\text{Cmr}$  spectra ( $\text{D}_2\text{O} + \text{DCl}$ ) identical to those of *N,N,N*-triphenylhexahydro-*s*-triazine (4);<sup>8</sup> the filtrate with  $\text{BaCl}_2$  gave a precipitate identified (ir) as  $\text{BaSO}_3$ . In  $\text{D}_2\text{O}$  (pH reading initially 1.6, rising to 3.2 on reaction) the mixture from hydrolysis of 3 showed  $^1\text{Hmr}$  peaks at  $\delta$  84.84 (plus aromatic H signals) due to 4, and  $\delta$  84.40 (unreacted 3), and  $^{13}\text{Cmr}$  peaks at  $\delta$  68.0 due to 4,  $\delta$  63.7 due to 3, and no  $\text{HOCH}_2\text{SO}_3^- \text{Na}^+$  signal at  $\delta$  67.7.

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#### References and Notes:

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5. This corresponds to a rate difference of  $10^4$ , not taking into account either the temperature difference or the (probably) incomplete protonation of 3 to form 1. Senepeschi *et al.*<sup>2</sup> do not explicitly state either the temperature or the solvent used in their kinetic experiments and so no direct comparison with their results is possible.
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