Synthesis of *N*-Halogeno-*N*-sodioalkanesulphonamides

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Contrary to earlier reports, aliphatic sulphonamides react readily with aqueous sodium hypochlorite and sodium hypobromite to give the corresponding *N*-halogeno-*N*-sodio-derivatives, which have been characterised by conversion into the crystalline *SS*-dimethylsulphimides.

AROMATIC *N*-halogeno-*N*-sodiosulphonamides have been known for many years and their chemistry has been thoroughly investigated.[1] Surprisingly, a search of the literature did not yield a description of their aliphatic counterparts. An early attempt [2] at the preparation of *N*-chloro-*N*-sodiomethanesulphonamide by treatment of methanesulphonamide with sodium hypochlorite was unsuccessful, unchanged sulphonamide being isolated in almost theoretical yield. This work seems to be the sole basis for later statements that aliphatic sulphonamides do not react with sodium hypochlorite.[1,3]

In the present work the action of sodium hypochlorite on four aliphatic derivatives: methane-, ethane-, hexane-, and dodecane-sulphonamides, has been examined. In each case a rapid and essentially quantitative conversion of an equimolar mixture to the corresponding *N*-chloro-*N*-sodio-derivative (2) was observed. Since the *N*-chloro-derivatives (2; R = Me, Et, or C_6H_{13}) are very water-soluble, they can only be isolated from aqueous solution by evaporation to dryness. Thus, to prevent contamination of the products by sodium chloride, it is essential that pure aqueous sodium hypochlorite (from neutralisation of redistilled hypochlorous acid) be used. In contrast, the surface-active *N*-chloro-compound (2; $R = C_{12}H_{25}$) readily crystallises from aqueous solution and so commercially available sodium hypochlorite solution may be used in its preparation. The lower homologues (2; R = Me or Et) have also been prepared by an alternative route:

$$RSO_2{\cdot}NH_2 + 2HOCl \longrightarrow \underset{(1)}{RSO_2{\cdot}NCl_2} + H_2O$$

$$RSO_2{\cdot}NCl_2 + RSO_2{\cdot}NH_2 + 2NaOH \longrightarrow \underset{(2)}{2RSO_2{\cdot}NClNa} + 2H_2O$$

The hypochlorous acid used in the first stage is generated by acidification of commercial sodium hypochlorite

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[1] C. M. Suter, Organic Chemistry of Sulphur, Wiley, New York, 1944, pp. 602—613.

[2] P. W. Clutterbuck and J. B. Cohen, *J. Chem. Soc.*, 1923, 2513.

[3] Sidgwick's 'Organic Chemistry of Nitrogen,' 3rd edn., Millar and Springhall, 1966, p. 252.

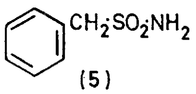
solution. The *NN*-dichloro-sulphonamides (1) are insoluble in water and can be readily isolated for use in the second stage.

It has also been established that aliphatic sulphonamides react smoothly with aqueous sodium hypobromite to give *N*-bromo-*N*-sodio-derivatives. Thus addition of the theoretical amount of redistilled hypobromous acid to an equimolar aqueous mixture of dodecanesulphonamide and sodium hydroxide gave the surface-active *N*-bromo-derivative $C_{12}H_{25}\cdot SO_2\cdot NBrNa$ (3).

The stability of the aliphatic *N*-chloro-compounds in the solid state approaches that of their aromatic counterparts; no significant loss of available chlorine was noted even on prolonged storage at room temperature. They are generally more difficult to crystallise than the aromatic materials and *N*-bromo-*N*-sodiododecanesulphonamide is amorphous. Both the aromatic and aliphatic species crystallise in a hydrated form but, whereas hydrates of the former required very severe conditions for dehydration, the aliphatic materials could be obtained in the anhydrous form by desiccation over phosphorus pentoxide. On treatment with dimethyl sulphide the aliphatic materials were converted into the corresponding *SS*-dimethylsulphimides (4); these crystalline derivatives are useful in the characterisation of the *N*-halogeno-compounds.

$$RSO_2\cdot NHalNa + Me_2S \longrightarrow \underset{(4)}{RSO_2\cdot N{=}SMe_2}$$

Clutterbuck and Cohen [2] were also unable to isolate *N*-chloro-*N*-sodio-derivatives from the reaction of sodium hypochlorite with 3-phenylpropanesulphonamide (6) and cyclohexanesulphonamide (7), although the reaction with toluene-α-sulphonamide (5) proceeded smoothly.



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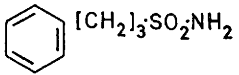
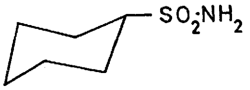


(6)



(7)

The two unsuccessful reactions have now been repeated: the *N*-chloro-*N*-sodio-derivatives of sulphonamides (6) and (7) were isolated in good yield. Their inability to prepare the former is especially surprising since it crystallises so readily from aqueous solution. Possibly the material they attempted to chlorinate was not the sulphonamide (6), since a low m.p. was quoted. The formation of *N*-chloro-*N*-sodio-derivatives on treatment with sodium hypochlorite seems to be a general property of sulphonamides.

EXPERIMENTAL

Pure aqueous sodium hypochlorite was prepared by adding excess of boric acid to the commercially available solution (10—14% available chlorine), distilling the mixture at 30—40° under reduced pressure, and neutralising the distillate with sodium hydroxide. Hypobromous acid was prepared by stirring bromine water with excess of yellow mercuric oxide, filtering, and distilling the filtrate under reduced pressure. These pure solutions, assayed iodometrically, were freshly prepared before each halogenation in which they were required.

N-*Chloro*-N-*sodioethanesulphonamide*.— Ethanesulphonamide (2·72 g., 0·025 mole) was dissolved in pure aqueous sodium hypochlorite (0·2M; 125 ml.) and the solution was evaporated to dryness under reduced pressure. The crystalline residue was washed with cold acetone and filtered with use of the same solvent. Prolonged drying (P_2O_5) gave the N-*chloro-compound* (3·6 g., 87%) in an anhydrous state (Found: C, 14·6; H, 3·2; N, 8·35; av. Cl, 42·3. $C_2H_5ClNNaO_2S$ requires C, 14·5; H, 3·05; N, 8·45; av. Cl, 42·8%); $\nu_{max.}$ (KBr) 8·3, 8·95, and 10·5 μm.

N-*Chloro*-N-*sodiohexanesulphonamide* was prepared by the same method in 85% yield (Found: av. Cl, 31·8. $C_6H_{13}ClNNaO_2S$ requires av. Cl, 32·0%).

N-*Chloro*-N-*sodiomethanesulphonamide*.—To methanesulphonamide (19 g.) dissolved in ice-cold sulphuric acid (1·6N; 230 ml.), commercial sodium hypochlorite solution (3·27N; 260 ml.) was added dropwise with stirring. *NN*-Dichloromethanesulphonamide (27·3 g.) was filtered off, washed with ice-cold water, and dried; it had m.p. 84° (lit.,[4] 84—86°). This material (10 g.) was suspended in a solution of methanesulphonamide (5·8 g.; 1 mol.) in water (100 ml.). Aqueous N-sodium hydroxide (122 ml.) was added dropwise with stirring and cooling, and the resultant clear solution was evaporated to dryness. The crystalline residue was filtered with use of acetone and dried (P_2O_5) to give N-*chloro*-N-*sodiomethanesulphonamide* (16·8 g., 90%) (Found: av. Cl, 46·5. $CH_3ClNNaO_2S$ requires av. Cl, 46·75%).

N-*Chloro*-N-*sodiododecanesulphonamide*.—A mixture of dodecanesulphonamide (10 g.) and aqueous N-sodium hydroxide (40 ml.) was heated to boiling and then cooled to 50°. Commercial sodium hypochlorite solution (1·32M; 35 ml.) was added with stirring and the resultant clear solution was allowed to cool slowly. The crystalline N-*chloro-compound* (10·5 g., 85%) was filtered off, washed with a little ice-water and cold acetone, and dried. It could be recrystallised from 0·01N-sodium hydroxide (Found: C, 47·25; H, 8·3; N, 4·4; av. Cl, 23·5. $C_{12}H_{25}ClNNaO_2S$ requires C, 47·1; H, 8·25; N, 4·6; av. Cl, 23·2%).

N-*Bromo*-N-*sodiododecanesulphonamide*.—A mixture of dodecanesulphonamide (5 g., 0·02 mole), sodium hydroxide (0·8 g., 0·02 mole), and water (50 ml.) was heated to boiling and then cooled to room temperature. Hypobromous acid (0·35M; 58 ml.) was added and the solution was stirred until it became clear. The N-*bromo-compound* was isolated by lyophilisation as a pale yellow powder (6·3 g., 90%) (Found: av. Br, 45·3. $C_{12}H_{25}BrNNaO_2S$ requires av. Br, 45·6%); $\nu_{max.}$ (KBr) 3·45—4·5, 8·3, 9·0, and 10·43 μm.

Reaction of N-*Halogeno*-N-*sodioalkanesulphonamides with Dimethyl Sulphide*.—Mixtures of each *N*-chloro-compound and anhydrous acetone containing a two-fold excess of dimethyl sulphide were shaken overnight at room temperature. After filtration, the solutions were evaporated to dryness and the residues were recrystallised from the appropriate solvents. The following SS-*dimethylsulphimides* ($RSO_2\cdot N$

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[4] A. G. Newcombe, *Canad. J. Chem.*, 1955, **33**, 1250.

= SMe$_2$) were prepared in this way: R = Me, m.p. 121—122° (from acetone–light petroleum) (Found: C, 22·9; H, 5·9; N, 8·75. $C_3H_9NO_2S_2$ requires C, 23·2; H, 5·85; N, 9·0%) (lit.,[5] m.p. 122—123°); R = Et, m.p. 58—59° (from butan-2-one) (Found: C, 28·6; H, 6·45; N, 8·35. $C_4H_{11}NO_2S_2$ requires C, 28·4; H, 6·55; N, 8·3%); R = C_6H_{13}, m.p. 70—72° (from carbon tetrachloride) (Found: C, 42·5; H, 8·4; N, 6·3. $C_8H_{19}NO_2S_2$ requires C, 42·65; H, 8·5; N, 6·2%); R = $C_{12}H_{25}$, m.p. 86—87° (from acetone) (Found: C, 54·45; H, 10·3; N, 4·7. $C_{14}H_{31}NO_2S_2$ requires C, 54·3; H, 10·1; N, 4·55%).

A similar reaction with *N*-bromo-*N*-sodiododecanesulphonamide and with carbon tetrachloride as solvent gave an *SS*-dimethylsulphimide of m.p. 87°.

Reactions of 3-*Phenylpropanesulphonamide and Cyclohexanesulphonamide with Sodium Hypochlorite.*—3-Phenylpropanesulphonamide,[6] m.p. 60—61° (lit., 35°), was *N*-chlorinated by the method described for the chlorination of dodecanesulphonamide. The recrystallised N-*chloro*-N-*sodio-derivative* (Found: C, 42·25; H, 4·4; N, 5·5; av. Cl, 27·3. $C_9H_{11}ClNNaO_2S$ requires C, 42·3; H, 4·35; N, 5·5; av. Cl, 27·75%) gave an *SS*-dimethylsulphimide, m.p. 117—118° (from carbon tetrachloride–chloroform).

Cyclohexanesulphonamide was *N*-chlorinated by the method described for ethanesulphonamide. Evaporation to dryness and filtration with use of ether–acetone (1 : 1) gave N-*chloro*-N-*sodiocyclohexanesulphonamide* (Found: C, 32·8; H, 4·95; N, 6·4; av. Cl, 31·9. $C_6H_{11}ClNNaO_2S$ requires C, 32·8; H, 5·05; N, 6·4; av. Cl, 32·3%). Treatment with dimethyl sulphide gave an *SS*-dimethylsulphimide, m.p. 130—132° (from carbon tetrachloride–butan-2-one).

[0/540 *Received, April* 6*th*, 1970]

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[5] G. Schulz and G. Kresze, *Angew. Chem.*, 1963, **75**, 1022.

[6] W. E. Truce and J. P. Milionis, *J. Amer. Chem. Soc.*, 1952, **74**, 974.