354. *A Rearrangement of* o-*Acetamido-sulphoxides.*

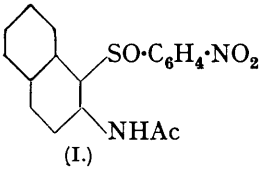
By Alfred Levi, Leonard A. Warren, and Samuel Smiles.

In the course of previous experiments dealing with the behaviour of *o*-amino-sulphones (J., 1932, 2774) it was found that in presence of alkali one of the corresponding sulphoxides (I) underwent a rearrangement of the same type as that observed with the sulphone; the 2-nitrophenyl was displaced from thionyl by the acetamido-group and the sulphenic acid was liberated. Other *o*-acetamido-sulphoxides of similar structure have now been examined and it appears that this rearrangement is of general occurrence, provided that a suitably positive group is attached to thionyl. Two examples are now described.

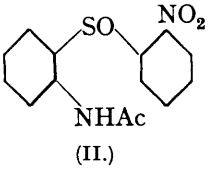
The *sulphoxide* (II) with two molecular proportions of alkali yielded a solution of the salt of the sulphenic acid (III). This was not obtained in the pure condition, but after

methylation it was isolated in good yield as the *methyl-sulphoxide* (IV). This product gave methylthiol with hydriodic acid and was converted by oxidation into the *methyl-sulphone*, which was identical with the methylation product of the corresponding sulphinic acid obtained from another source. The sulphenic acid (III) showed greater stability than expected; as in the case of anthraquinone-1-sulphenic acid (Fries, *Ber.*, 1912, **45**, 2965), it did not yield the disulphide in warm alkaline solution like other less stable acids of this type, but instead absorbed atmospheric oxygen, forming the sulphinic acid. The latter was not isolated from the product, but its presence was inferred from the formation of the *disulphide* (V) with dilute hydrogen iodide; freshly prepared material did not yield the disulphide in this manner.

The rearrangement of the *chloronitro-sulphoxide* (VI) was effected in the same way and gave analogous products (compare III and IV). The sulphenic acid formed gave on immediate methylation in alkali the *methyl-sulphoxide*, but after prolonged exposure to air before methylation the *methyl-sulphone* was obtained.



(I.)



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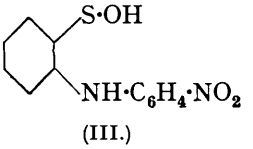

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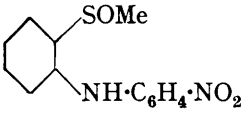

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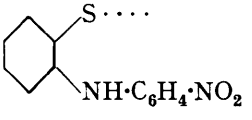

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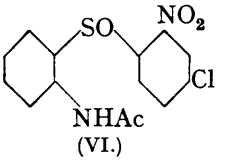
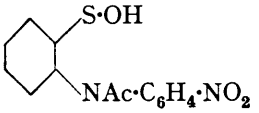


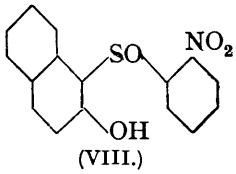
(VI.)

The rearrangement of these sulphoxides takes place very readily and it is important to notice that with one molecular proportion of sodium hydroxide the acetylated sulphenic acid (VII) is formed: this was isolated in good yield as the N-*acetyl-methyl-sulphoxide*, which gave methylthiol with hydrogen iodide and was de-acetylated by alkaline media, yielding (IV). The de-acetylated amine was not observed in the product of rearrangement under this condition. This result is interesting, since it shows that rearrangement takes place before de-acetylation and that the process must be regarded as a displacement of thionyl by the acetamido-group. A similar displacement of the sulphonyl by the acetamido-group has already been recorded (*loc. cit.*) and further investigation has since revealed other examples. In the case of the sulphone the rearrangement of the corresponding amine was also effected (*loc. cit.*) and, although no exact comparison was possible, the general conditions required appeared to indicate that this proceeded less readily than with the acetyl derivative.

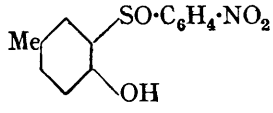
The relative activity of the amino- and the acetamido-group in these rearrangements has been further examined by a study of the amine derived from (VI) by de-acetylation. Under conditions which easily effect the rearrangement of (VI), the amine was partly recovered unaltered. Thus from data hitherto obtained it appears that under the alkaline conditions used the acetamido-derivative is more active in these rearrangements than



(VII.)



(VIII.)



(IX.)

the amine. From the rearrangements observed with sulphoxides and sulphones of this series it is now clear that in presence of alkali the acetamido-group is capable of displacing both thionyl and sulphonyl from the 2-nitrophenyl group; further experiments now in progress will determine whether it is also able to displace the thio-group.

It is common knowledge that the corresponding *o*-hydroxy-sulphides (*e.g.*, VIII and IX, where SO is S) are, apart from a tendency to lose 2-nitrophenyl by hydrolysis, stable in alkaline solution; they are, indeed, formed in that medium by rearrangement of the *o*-thiol oxides (J., 1931, 3264). On the other hand, the sulphones (*e.g.*, VIII and IX, where SO is SO_2) undergo rearrangement (*loc. cit.*); it is therefore of interest to consider the case of the *sulphoxides* (VIII and IX). These substances have now been examined and no evidence of their rearrangement has been found under the usual conditions. Evidently aromatic hydroxyl is less active than the acetamido-group in these intramolecular displacements.

Experimental.

2-*Nitro*-2′-*aminodiphenyl Sulphide*.—When a solution of bis-2-aminophenyl disulphide (10 g.) in acetic acid (150 c.c.) containing zinc dust (6 g.) was boiled (2 hours), the zinc salt of 2-aminophenylthiol separated. Concentrated hydrochloric acid was added to dissolve this, the clear solution diluted (1 l.), and the zinc salt reprecipitated by addition of excess of sodium acetate. After being washed until free from acid, the salt was dried and suspended in alcohol (100 c.c.) containing sufficient sodium ethoxide to yield the sodium salt of the thiol. A concentrated solution of *o*-chloronitrobenzene (13 g.) in alcohol was then added and the mixture was boiled (4 hours), more alcohol being added to dissolve any oil which separated. The required product (17 g.) crystallised from the cooled solution after zinc oxide had been removed. It was purer (m. p. 85°) than that obtained by Hodgson and Rosenberg (*J. Soc. Dyers and Colourists*, 1930, 267). The acetyl derivative formed yellow needles, m. p. 136°, from alcohol. 4-*Chloro*-2-*nitro*-2′-*aminodiphenyl sulphide* was prepared in a similar manner, 2 : 5-dichloronitrobenzene being used instead of 2-chloronitrobenzene. It formed deep yellow prisms from alcohol, m. p. 130° (Found : N, 9·8; S, 11·5. $C_{12}H_9O_2N_2ClS$ requires N, 10·0; S, 11·4%). The *acetyl* derivative, obtained with acetic anhydride and pyridine (100°), formed yellow needles, m. p. 150°, from acetic acid (Found : C, 52·2; H, 3·7; N, 9·0. $C_{14}H_{11}O_3N_2ClS$ requires C, 52·1; H, 3·4; N, 8·7%).

2-*Nitro*-2′-*acetamidodiphenyl Sulphoxide* (II).—A solution of the corresponding sulphide (14·4 g.) in acetic acid (35 c.c.) containing " hyperol " (6 g.) was kept at 100° (2 hours). After dilution (400 c.c.) the *product* slowly separated; it was recrystallised from alcohol (charcoal) and formed pale yellow needles, m. p. 160° (Found : C, 55·3; H, 4·0; N, 9·4. $C_{14}H_{12}O_4N_2S$ requires C, 55·3; H, 3·9; N, 9·2%). The substance liberated iodine from hydrogen iodide in acetic acid and was soluble in concentrated hydrochloric acid and was hydrolysed by the hot reagent. Further oxidation yielded the sulphone.

4-*Chloro*-2-*nitro*-2′-*acetamidodiphenyl Sulphoxide* (VI).—Warm acetic acid (6 c.c.) containing " hyperol " (1·1 g.) and the corresponding sulphide (3·2 g.) were kept at 100° (1·5 hours). Dilution of the mixture then yielded the *sulphoxide* (3·1 g.), which formed pale yellow prisms, m. p. 179—180°, from alcohol (Found : C, 49·6; H, 3·3; Cl, 10·4; S, 9·7. $C_{14}H_{11}O_4N_2ClS$ requires C, 49·6; H, 3·2; Cl, 10·5; S, 9·5%).

4-*Chloro*-2-*nitro*-2′-*aminodiphenyl Sulphoxide* (compare VI).—Alcohol (50 c.c.) which contained sulphuric acid (10%) and the acetamido-sulphoxide (VI) (3·5 g.) was kept at 70—80° (2 hours). Dilution gave the required *product* (3 g.), which separated from alcohol in orange prisms, m. p. 162° (Found : C, 48·6; H, 3·2. $C_{12}H_9O_3N_2ClS$ requires C, 48·6; H, 3·0%). When the substance was reacetylated, (VI) was obtained.

Rearrangement of the Sulphoxides (II) *and* (VI).—(a) 2-o-*Nitrophenylaminophenyl methyl sulphoxide* (IV). Alcohol (10 c.c.) which contained the sulphoxide (II) (1 g.) was warmed (50°) before *N*-sodium hydroxide (2 mols.) and excess of methyl iodide were consecutively added. When the red colour had faded to pale orange, the mixture was diluted, and alcohol removed; the required *methyl-sulphoxide*, which separated (0·7 g.), crystallised from alcohol in orange plates, m. p. 149—151°, which gave a purple solution in sulphuric acid and liberated methylthiol when warmed with hydriodic acid (*d* 1·7) (Found : C, 56·7; H, 4·5; N, 10·3; S, 11·6. $C_{13}H_{12}O_3N_2S$ requires C, 56·5; H, 4·3; N, 10·2; S, 11·6%).

Oxidation of this substance (0·6 g.) in acetic acid (3 c.c.) with " hyperol " (0·6 g.) at 100° gave 2-o-*nitrophenylaminophenylmethylsulphone*, which formed yellow needles, m. p. 130—131° (Found : C, 53·4; H, 4·3. $C_{13}H_{12}O_4N_2S$ requires C, 53·4; H, 4·1%).

(b) The sulphoxide (II) readily dissolved in *N*-sodium hydroxide (3 mols.) at 50°; the solution was kept at 100° (½ hour) with free access of air. Addition of dilute sulphuric acid to the cold solution yielded an orange material which could not be resolved into pure components

but evidently contained sulphinic acid, since, in warm acetone with dilute hydriodic acid and sulphur dioxide, it gave a red crystalline precipitate of *bis*-2-o-*nitrophenylaminophenyl disulphide* (V). This formed plates from acetic acid, m. p. 149—151°, which were also obtained from the pure sulphinic acid of different origin (Found : C, 58·6; H, 3·7; S, 13·2. $C_{28}H_{18}O_4N_4S_2$ requires C, 58·8; H, 3·7; S, 13·1%).

(c) 2-o-*Nitrophenylacetamidophenyl methyl sulphoxide* (compare VII). The sulphoxide (II) (1 g.) was treated as in (a) with methyl iodide and *N*-sodium hydroxide (1 mol.); after dilution and removal of alcohol the *acetyl* derivative of (IV) separated (0·9 g.). This formed yellow prisms from alcohol, m. p. 160—161°, which gave methylthiol with hot hydriodic acid (*d* 1·7) and were converted into (IV) by warm aqueous alcohol containing sodium hydroxide (Found : C, 56·6; H, 4·6; N, 8·9. $C_{15}H_{14}O_4N_2S$ requires C, 56·6; H, 4·4; N, 8·8%).

(d) 2-p-*Chloro*-o-*nitrophenylaminophenyl methyl sulphoxide*. The acetamido-sulphoxide (VI) (1 g.) was treated in alcohol with *N*-sodium hydroxide (2 mols.) and methyl iodide as described in (a). The deep red colour of the solution faded as methylation proceeded, and subsequently the required *product* separated (0·65 g.). This formed orange prisms, m. p. 152°, from alcohol, which gave methylthiol with hot hydriodic acid (Found : C, 50·3; H, 3·6; N, 9·3; S, 10·3. $C_{13}H_{11}O_3N_2ClS$ requires C, 50·2; H, 3·5; N, 9·0; S, 10·3%).

When the preceding sulphoxide was oxidised by " hyperol " in acetic acid, it yielded 2-p-*chloro*-o-*nitrophenylaminophenylmethylsulphone*. This, purified from acetic acid, had m. p. 187° and was identical with a sample obtained from the sulphinic acid (Found : C, 47·7; H, 3·3; N, 8·7; S, 10·0. $C_{13}H_{11}O_4N_2ClS$ requires C, 47·8; H, 3·4; N, 8·6; S, 9·8%). The amine derived from (VI) was partly recovered after it had been treated (2 hours) at 90—100° with 2*N*-sodium hydroxide [compare (b)].

2-*Nitrophenyl* 4-*Hydroxy*-m-*tolyl Sulphoxide* (IX).—A solution of the sulphide (5 g.) in acetic acid (25 c.c.) which contained " hyperol " (3 g.) was heated (90—100°; 3 hours). The *product* separated (3 g.) from the cooled solution; it formed yellow prisms, m. p. 206—207°, from acetic acid (Found : C, 55·9; H, 4·0. $C_{13}H_{11}O_4NS$ requires C, 56·3; H, 4·0%). The substance was recovered after a solution in 2*N*-sodium hydroxide had been heated (100°; 15 mins.); *o*-nitrophenol, formed by hydrolysis of the sulphoxide, was also isolated.

2-*Nitrophenyl* 2-*Hydroxy*-1-*naphthyl Sulphoxide* (VIII).—Acetic acid (100 c.c.) which contained the acetyl derivative of the sulphide (10 g.) and " hyperol " (3 g.) was warmed (100°; 2 hours). When the cold solution was diluted, a yellow mass separated; this was treated with a little hot alcohol, and the residue (5 g.) was purified from acetic acid (charcoal). The *acetyl* derivative of the sulphoxide (VIII) thus obtained formed pale yellow prisms, m. p. 169° (Found : C, 60·9; H, 3·9. $C_{18}H_{13}O_5NS$ requires C, 60·8; H, 3·7%). It was hydrolysed by boiling (5 mins.) 2*N*-sodium hydroxide which contained a little alcohol. When the solution was cooled, the sodium salt separated; the required *hydroxy-sulphoxide* was liberated from this and formed yellow plates, m. p. 144° (decomp.), from acetic acid; they gave a green solution in sulphuric acid (Found : C, 61·5; H, 3·5. $C_{16}H_{11}O_4NS$ requires C, 61·3; H, 3·5%). Treatment with acetic anhydride and pyridine converted the substance into the acetyl derivative described above. It was recovered unaltered from hot aqueous sodium hydroxide (2*N*), but prolonged heating with the reagent led to the formation of *o*-nitrophenol and other products of hydrolysis.

We wish to thank Dr. Hodgson for information concerning the amino-sulphides and Mr. W. J. Evans for details of the method of preparing those now described and for samples of the methyl-sulphones obtained from the sulphinic acids.

KING'S COLLEGE, LONDON. [*Received, September 9th*, 1933.]