

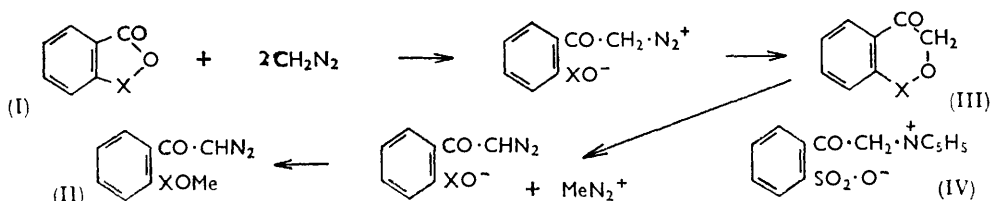
543. *Methyl o- and p-Diazoacetylbenzenesulphonate.*

By A. L. CROWTHER and G. HOLT.

Unlike phthalic and benzene-*o*-disulphonic anhydride, *o*-sulphobenzoic anhydride reacts almost instantaneously with diazomethane to provide an approximately equimolar mixture of *o*-glycolloylbenzenesulphonic acid sultone (III; X = SO₂) and a diazo-ketone, probably methyl *o*-diazoacetylbenzenesulphonate (II; X = SO₂). The latter was not obtained pure and attempts to synthesise it failed. *o*- and *p*-Diazoacetylbenzenesulphonyl chloride were synthesised; in aqueous dioxan the former provided the sultone (III; X = SO₂).

ACYCLIC carboxylic anhydrides react with diazomethane according to the scheme $(R \cdot CO)_2O + 2CH_2N_2 \longrightarrow R \cdot CO \cdot CHN_2 + R \cdot CO_2Me + N_2$, but few of the comparatively small number of intramolecular carboxylic anhydrides so far studied behave analogously.

Phthalic anhydride¹ (I; X = CO) reacts extremely slowly with diazomethane, to provide the diazo-ketone (II; X = CO) (25%) and 1,4-dioxoisochroman (III; X = CO); *o*-nitro-phthalic anhydride behaves similarly.²



We now report that, as expected, *o*-sulphobenzoic anhydride (I; X = SO_2) reacts almost instantaneously with diazomethane to provide the keto-sultone (III; X = SO_2) (~50%) and a diazo-ketone, probably methyl *o*-diazoacetylbenzenesulphonate. The latter was not obtained pure but the volumes of nitrogen evolved when the crude reaction mixture was treated with concentrated acid,⁴ with silver benzoate-triethylamine,⁵ or with silver oxide⁴ indicate that the diazo-ketone was present to the extent of some 30–40%, and the infrared spectrum of the crude reaction mixture showed strong absorption at 2101 and 1626 cm^{-1} .⁶ The hitherto unknown sultone (III; X = SO_2) dissolved slowly in water and more rapidly in dilute alkali, readily provided a 2,4-dinitrophenylhydrazone, and with pyridine yielded a betaine (IV); and infrared absorption band at 1698 cm^{-1} is also consistent with structure (III; X = SO_2). Since benzene-*o*-disulphonic anhydride is virtually unaffected by diazomethane, there is no doubt that the initial reaction involves nucleophilic attack by diazomethane at the carbonyl group of the mixed anhydride (I; X = SO_2). Subsequent reaction yields the diazo-ketone ester (II) or the keto-sultone (III) by differing routes.

Since diazoacylarenesulphonic acid derivatives are unknown, we synthesised the ester (VIII) and then tried to apply the method to the *ortho*-isomer.

p-Methoxysulphonylbenzoic acid (VI) has been reported by Wegscheider and Furcht⁷ to have m. p. 195–196°, being obtained by the action of methyl iodide on the silver salt of *p*-sulphobenzoic acid. A more attractive synthesis proved to be the oxidation of methyl toluene-*p*-sulphonate (V) with chromium trioxide and sulphuric acid in acetic acid at room temperature which gave excellent yields of a compound $\text{C}_8\text{H}_8\text{O}_5\text{S}$, m. p. 229–230°, having the properties expected for *p*-methoxysulphonylbenzoic acid (VI). The same ester was obtained (87%) by slow addition of ethereal diazomethane to *p*-sulphobenzoic acid, until a volume of nitrogen corresponding to the esterification of one acid group had been evolved. With boiling thionyl chloride *p*-methoxysulphonylbenzoic acid readily provided its acid chloride (VII), which with diazomethane gave the required diazo-ketone (VIII) in excellent yields. The latter was characterised as the toluene-*p*-sulphonate of the corresponding ketol.³ An alternative synthesis by the action of sodium methoxide on the sulphonyl chloride (IX) gave only an oil which, however, on treatment with toluene-*p*-sulphonic acid monohydrate gave the toluene-*p*-sulphonate just mentioned.

Attempts to oxidise methyl toluene-*o*-sulphonate were unsuccessful: Davies and Dick⁸ similarly found that oxidation of toluene-*p*-sulphonyl fluoride in non-aqueous media gave good yields of *p*-fluorosulphonylbenzoic acid, but that the *ortho*-isomer was either recovered or completely destroyed. Gradual addition of diazomethane to *o*-sulphobenzoic acid

¹ Duggleby and Holt, *J.*, 1962, 3579.

² Bahti, *J. Org. Chem.*, 1962, 27, 1183.

³ Crowther and Holt, unpublished work.

⁴ Wolff, *Annalen*, 1912, 394, 23.

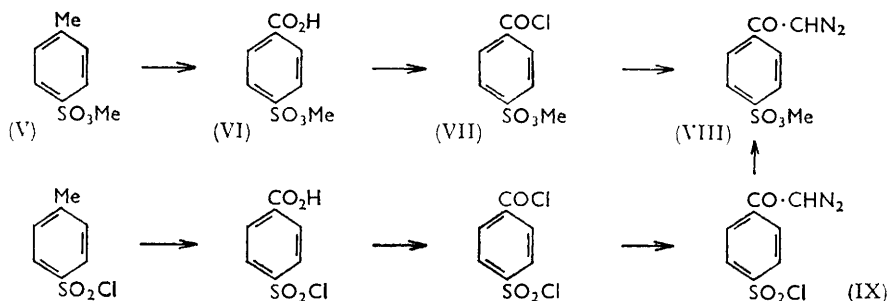
⁵ Newman and Beal, *J. Amer. Chem. Soc.*, 1950, 52, 5163.

⁶ Yates, Shapiro, Yoda, and Fugger, *J. Amer. Chem. Soc.*, 1957, 79, 5756.

⁷ Wegscheider and Furcht, *Monatsh.*, 1902, 23, 1129.

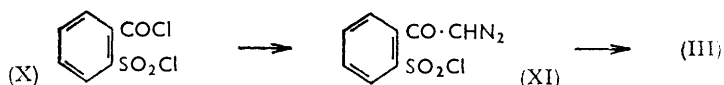
⁸ Davies and Dick, *J.*, 1932, 2042.

provided a mixture from which the desired *o*-methoxysulphonylbenzoic acid could not be obtained in a state of purity although, since a quaternary salt (40%) was obtained by the action of pyridine on the crude ester, some of this ester was probably present. Further work on these lines was discontinued when this crude product was found to react with cold



thionyl chloride to give a mixture from which *o*-methoxysulphonylbenzoyl chloride could not be isolated; the major product was *o*-sulphobenzoyl anhydride (I; X = SO₂) (30%), together with a chlorine-free oil. It seemed probable that *o*-methoxysulphonylbenzoyl chloride was formed as an unstable intermediate that readily eliminated methyl chloride.

Interaction of *o*-chlorosulphonylbenzoyl chloride (X) and ethereal diazomethane gave a diazo-ketone, probably (XI), which decomposed on removal of the ether. The presence



of the diazo-ketone in a freshly prepared solution was shown by evolution of nitrogen on addition of concentrated acid and by the presence of new, strong, sharp absorption at 2101, and 1645 cm.⁻¹ and absorption at 1389—1351 cm.⁻¹. The action of aqueous dioxan on a freshly prepared ethereal solution of the diazo-ketone rapidly brought about evolution of nitrogen and formation of the expected keto-sultone (III; X = SO₂).

EXPERIMENTAL

Gaseous volumes given below have been reduced to N.T.P.

o-Sulphobenzoyl Anhydride and Diazomethane.—*o*-Sulphobenzoyl anhydride (4.8 g.) in chloroform (33 ml.) was slowly added to diazomethane (2.31 g.) in ice-cold ether (270 ml.). Instantaneous and vigorous gas evolution occurred and nitrogen (620 ml.) was collected. The solvent was removed under reduced pressure and the semi-solid residue was filtered off, to provide cream-coloured crystals (2.8 g., 54%; m. p. 77—84°). Repeated recrystallisation from ethanol provided needles, m. p. 93—94°, of glycolloylbenzenesulphonic acid sultone (Found: C, 48.4; H, 3.1; S, 16.3. C₈H₆O₄S requires C, 48.5; H, 3.05; S, 16.2%). The 2,4-dinitrophenylhydrazone (85%), m. p. 268° (decomp.) (Found: N, 15.0. C₁₄H₁₀N₄O₇S requires N, 14.8%), formed yellow needles from ethyl acetate.

The keto-sultone, with pyridine at 90° for 2 min., provided 1-*o*-sulphophenacylpyridinium betaine (IV) (84%), needles, m. p. 281—282° (from ethanol) (Found: N, 5.1; S, 11.7. C₁₃H₁₁NO₄S requires N, 5.1; S, 11.6%).

The filtrate from which the crude keto-sultone had been separated failed to provide a solid diazo-ketone.

A solution of the crude product in methanol was treated with silver benzoate-triethylamine (1 : 10); nitrogen (250 ml., 43%) was evolved almost instantaneously.

When diazomethane was slowly added to the *o*-sulphobenzoyl anhydride solution, essentially the same results were obtained, 2 mol. of diazomethane being consumed.

Methyl p-Diazoacetylbenzenesulphonate.—To a stirred solution of methyl toluene-*p*-sulphonate (50 g.) in glacial acetic acid (300 ml.) was added chromium trioxide (140 g.) at such a rate that

the temperature did not exceed 20° (1 hr.). This temperature was maintained whilst concentrated sulphuric acid (10 ml.) was added during 30 min., and the resulting solution was left overnight at room temperature. It was then poured into water (750 ml.), and the solid (54.2 g., 93%; m. p. 223—226°) was collected and washed with water until colourless. Recrystallisation from methanol provided *p*-methoxysulphonylbenzoic acid, needles, m. p. 229—230° (Found: C, 44.6; H, 3.9; S, 14.8. C₈H₈O₅S requires C, 44.4; H, 3.7; S, 14.8%).

This acid ester was also obtained on addition of 1.5% ethereal diazomethane to anhydrous *p*-sulphobenzoic acid (4.76 g.) in dioxan (150 ml.), until nitrogen (540 ml.) corresponding to the esterification of one acid group had been evolved. The crude product, when stirred with water and recrystallised from methanol, provided needles (87%), m. p. and mixed m. p. 229—230° (Found: Equiv., 212, 214, 219. C₈H₈O₅S requires Equiv., 216).

The half-ester with pyridine at 80° for 5 min. gave quantitatively a salt, probably 1-methylpyridinium *p*-carboxybenzenesulphonate, m. p. 169—170°, as white needles (from ethanol) (Found: S, 10.9. C₁₃H₁₃NO₅S requires S, 10.85%), and with an excess of ethereal diazomethane gave methyl *p*-methoxysulphonylbenzoate⁷ (91%), m. p. 89—90°.

p-Methoxysulphonylbenzoyl chloride (87%), m. p. 83—84°, needles (from carbon tetrachloride) (Found: C, 41.0; H, 2.9; Cl, 15.2; S, 13.4. C₈H₇ClO₄S requires C, 40.95; H, 3.0; Cl, 15.1; S, 13.65%), obtained by the action of boiling thionyl chloride on *p*-methoxysulphonylbenzoic acid, was added to an excess of ice-cold, ethereal diazomethane; this provided methyl *p*-diazoacetylbenzenesulphonate (87%), m. p. 81—82°, as stout yellow needles from benzene-light petroleum (b. p. 60—80°) (Found: C, 45.5; H, 3.4; N, 11.8; S, 13.4. C₈H₈N₂O₄S requires C, 45.0; H, 3.1; N, 11.7; S, 13.3%). This diazo-ketone, on treatment with toluene-*p*-sulphonic acid monohydrate³ provided methyl *p*-(toluene-*p*-sulphonyloxyacetyl)benzenesulphonate (82%), m. p. 123—125° (Found: C, 50.0; H, 4.2; S, 16.7. C₁₆H₁₆O₇S₂ requires C, 50.0; H, 4.2; S, 16.7%).

p-Diazoacetylbenzenesulphonyl chloride, m. p. 108—109°, yellow needles (from benzene) (Found: C, 39.5; H, 1.9; Cl, 14.5; N, 11.6; S, 12.9. C₈H₆ClN₂O₃S requires C, 39.3; H, 2.05; Cl, 14.5; N, 11.6; S, 13.1%), was obtained (71%) by gradual addition of *p*-chlorosulphonylbenzoyl chloride⁹ to ethereal diazomethane (9.5 g.) at 0°. Evolution of nitrogen (184%) is consistent with the known¹⁰ catalytic action of sulphonyl chlorides in decomposing diazomethane into nitrogen and polymethylene. This diazo-ketone with toluene-*p*-sulphonic acid monohydrate provided *p*-(toluene-*p*-sulphonyloxyacetyl)benzenesulphonyl chloride, m. p. 140—142° (from chloroform) (Found: C, 46.1; H, 3.2; Cl, 9.4; S, 16.5. C₁₅H₁₅ClO₆S₂ requires C, 46.3; H, 3.4; Cl, 9.1; S, 16.5%).

Reaction of p-Diazoacetylbenzenesulphonyl Chloride and Sodium Methoxide.—To a stirred solution of the chloride (1.25 g.) in methanol (100 ml.) at 0° was added a solution of sodium (0.13 g.) in methanol (20 ml.) during 1 hr. The solution became orange, and nitrogen (20 ml., 17%) was evolved. The solution, on concentration under reduced pressure, provided a sticky residue (1.46 g.), which with toluene-*p*-sulphonic acid in acetic anhydride provided nitrogen (50 ml.; 43%) and methyl *p*-(toluene-*p*-sulphonyloxyacetyl)benzenesulphonate (0.88 g., 44%), m. p. and mixed m. p. 123—125°.

Reaction of o-Sulphobenzoic Acid and Diazomethane.—When ethereal diazomethane was added slowly to an ethereal solution of anhydrous *o*-sulphobenzoic acid, as described above for the *para*-isomer, the product was oily, and all attempts to obtain from it crystalline *o*-methoxysulphonylbenzoic acid were unsuccessful. With pyridine, under the conditions described above for the *para*-isomer, there resulted 1-methylpyridinium *o*-carboxybenzenesulphonate (25%), m. p. 142° (from acetone) (Found: C, 53.0; H, 4.6; N, 4.9. C₁₃H₁₃NO₅S requires C, 52.9; H, 4.4; N, 4.7%). Interaction of this crude methyl *o*-carboxybenzenesulphonate and thionyl chloride at room temperature provided *o*-sulphobenzoic anhydride as the only identifiable product.

c-Diazoacetylbenzenesulphonyl Chloride and *o*-Glycolloylbenzenesulphonic Acid Sultone.—When *o*-chlorosulphonylbenzoyl chloride (1 mol.) in ether was slowly added to diazomethane (5 mol.) in ether at 0°, an immediate evolution of nitrogen occurred. Attempts to isolate a solid diazo-ketone were unsuccessful, but a freshly prepared ethereal solution, from which the excess of diazomethane had been removed, gave a vigorous gas evolution on treatment with concentrated hydrochloric acid and its infrared spectrum showed strong absorption at 2123

⁹ Bungenberg de Jong, *Vers. Akad. Amst.*, 1923, **32**, 16.

¹⁰ Arndt and Scholz, *Ber.*, 1933, **66**, 1012.

and 1645 cm^{-1} . A second portion of freshly prepared solution from *o*-chlorosulphonylbenzoyl chloride (4.8 g.) and diazomethane (2.1 g.) in ether (150 ml.) was treated with water (6 ml.) and dioxan (94 ml.). Nitrogen evolution was complete in 15 min. and then the organic layer was separated from the small aqueous layer that had been formed. The latter was acid to litmus and gave a positive test for chloride ion. The dried (MgSO_4) organic layer provided a golden-brown oil (A) (6.85 g.). A sample (1.76 g.) of the latter, on trituration with methanol, gave a straw-coloured product (0.54 g., 58%), m. p. 82–85°, which, on crystallisation from benzene–light petroleum, provided the sultone, m. p. and mixed m. p. 94°. When the oil (A) was treated with pyridine, as described above for the sultone, 1-*o*-sulphophenacylpyridinium betaine was obtained in 51% yield.

Microanalyses were carried out by Mr. V. Manohin.

MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY,
MANCHESTER, I.

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