

Reaction of Benzofurazan Oxides with Sodium Azide; a New Synthesis of Benzofurazans

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Benzofurazans can be synthesised, either from the corresponding benzofuroxans or from appropriately substituted *o*-dinitrobenzenes, by treatment with sodium azide in ethylene glycol or in dimethyl sulphoxide, at 120–150 °C.

MANY syntheses of benzofurazan derivatives are known. Direct routes from *o*-disubstituted benzenes involve heating *o*-nitrosahalogenobenzenes with sodium azide in dimethyl sulphoxide (DMSO),¹ pyrolysis of methyl *o*-nitrophenylcarbamates,² or thermolytic rearrangement of 1-*o*-nitroarylimino-1,2,5-triphenylphospholes.³ Other routes proceed *via* benzofurazan *N*-oxide derivatives which are reduced with trialkyl phosphites, tributyl- or triphenyl-phosphine, methanolic potassium hydroxide, alkaline hydroxylamine, or hydrazine.⁴ Some thermal reductions of benzofurazan *N*-oxides have been also reported.⁵

Recently we have investigated the synthesis of new benzofurazan derivatives,⁶ and have found that benzofurazan *N*-oxides, when heated with sodium azide in ethylene glycol (or DMSO) at 120–150°, give the corresponding benzofurazans with evolution of nitrogen and nitrous oxide. However, sodium azide and benzofurazan *N*-oxides, when heated separately under the

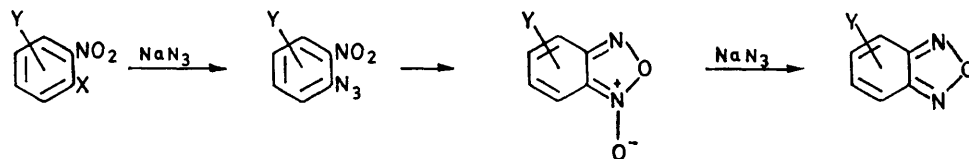
we consider our route to be an improvement over that¹ from the corresponding *o*-nitroso-derivatives, since the *o*-*X*-nitrobenzenes are more readily available.

With lower temperatures and shorter times of reaction *o*-nitrophenyl azides and benzofurazan *N*-oxides were also isolated, so we consider the probable mechanism to be as shown in the Scheme. This Scheme is similar to that reported¹ for the synthesis of benzofurazans from *o*-nitrosahalogenobenzenes.

EXPERIMENTAL

M.p.s were taken with a Kofler apparatus. Micro-analyses were carried out by Mrs. R. De Leonadis, Institute of Pharmaceutical Chemistry, Bari, and by the Institute of Intermediate Chemistry, Bologna.

Reactions of Benzofurazan N-Oxides with Sodium Azide.—Benzofurazans (ca. 2 g) were heated with sodium azide (molar ratio 1 : 1) in ethylene glycol (40 ml) (some experiments were carried out satisfactorily in DMSO) at 120–



SCHEME

same conditions, are unchanged. This simple route often gives satisfactory yields, but failed with nitrobenzofuroxans. 5-Nitrobenzofuroxan⁷ afforded only traces of 5-nitrobenzofurazan⁸ (g.l.c.), while 4-nitrobenzofuroxan⁹ did not give 4-nitrobenzofurazan,^{8,10} but 2,6-dinitroaniline¹¹ (ca. 20%), together with other unidentified products. Further investigations are in progress on this point and on the mechanism of the reduction.

Benzofurazans are also obtained by heating *o*-*X*-nitrobenzenes (where X is a good leaving group in nucleophilic substitution; in this work X = NO₂) with an excess of sodium azide in ethylene glycol (or DMSO):

150 ° until evolution of gas [N₂ (g.l.c.) and N₂O (i.r.); some production of alkali in the solution was also found] had ceased (1–2 h). The solution was poured in water (ca. 0.5 l) and extracted with ether or chloroform. The combined extracts were dried (Na₂SO₄) and evaporated under vacuum, and the residues were recrystallised from ethanol.

By this procedure, the following benzofurazans were prepared: benzofurazan (40%), m.p. and mixed m.p. 53° (lit.^{9,12} 53°) (reaction temperature 140°); 5-bromobenzofurazan (65%), m.p. and mixed m.p. 74° (lit.¹³ 75°) (reaction temperature 120°); 5-chlorobenzofurazan (55%), m.p. and mixed m.p. 43–44° (lit.^{9,12} 44°) reaction temperature

⁶ L. Di Nunno, S. Florio, and P. E. Todesco, unpublished results.

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⁹ R. J. Gaughran, J. P. Picard, and J. V. R. Kaufman, *J. Amer. Chem. Soc.*, 1954, **76**, 2233.

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¹² T. Zincke and P. Schwarz, *Annalen*, 1899, **307**, 40.

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⁴ A. J. Boulton and P. B. Ghosh, *Adv. Heterocyclic Chem.*, 1969, **10**, 21.

⁵ R. C. Perera, R. K. Smalley, and L. G. Rogerson, *J. Chem. Soc. (C)*, 1971, 1348.

(120°); and 5-methoxybenzofurazan (70%), m.p. and mixed m.p. 98° (lit.,¹⁴ 98°) (reaction temperature 140°).

Reactions of Substituted o-Dinitrobenzenes with Sodium Azide.—These reactions were carried out in ethylene glycol as described above, with a molar ratio of *o*-dinitrobenzene derivative to sodium azide of *ca.* 1 : 2. The residues were recrystallised from ethanol either directly or after chromatography on a silica gel column [hexane (for 4-iodobenzofurazan) or hexane-ether, 9 : 1 (for 5-iodobenzofurazan) as eluant].

The following benzofurazans were synthesised by this procedure: 4,7-dimethoxybenzofurazan (78%), m.p. 155—156° (Found: C, 53.5; H, 4.4; N, 15.5. $C_8H_8N_2O_3$ re-

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¹⁵ J. Habermann, *Ber.*, 1878, **11**, 1037; C. A. Howe, V. J. Pecore, and P. M. Clinton, *J. Org. Chem.*, 1962, **27**, 1923; S. Kawai, J. Kosaka, and M. Hatano, *Proc. Japan Acad.*, 1954, **30**, 774.

quires C, 53.3; H, 4.4; N, 15.5%), from 1,4-dimethoxy-2,3-dinitrobenzene¹⁵ at 150°; 5-methoxybenzofurazan (70%), m.p. and mixed m.p. 98° (lit.,¹⁴ 98°), from 3,4-dinitroanisole¹⁶ at 150°; 4-iodobenzofurazan (24%), m.p. 94.5—95.5° (Found: C, 29.4; H, 1.5; I, 51.4; N, 11.3. $C_6H_3IN_2O$ requires C, 29.3; H, 1.2; I, 51.6; N, 11.3%), from iodo-2,3-dinitrobenzene¹⁷ at 130°; and 5-iodobenzofurazan (55%), m.p. 93.5—94.5° (Found: C, 29.4; H, 1.1; I, 52.0; N, 11.3. $C_6H_3IN_2O$ requires C, 29.3; H, 1.2; I, 51.6; N, 11.4%), from iodo-3,4-dinitrobenzene¹⁸ at 130°.

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