The alkaline decomposition of o-phthalaldehyde di-p-toluenesulfonylhydrazone

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The Bamford-Stevens reaction of o-phthalaldehyde di-p-toluenesulfonylhydrazone gives N-(3,4-dihydrophthalazinyl)p-tolysulfone. The product is synthesized by an independent method.

The alkaline decomposition of tosylhydrazones³ of aldehydes and ketones has been extensively used for the synthesis of olefins (1) and some novel cyclic compounds (2).

The Bamford-Stevens reaction of benzaldehyde tosylhydrazone (1a, 1c) under aprotic conditions (3) yields an aryl carbene which dimerizes to trans-stilbene in high yield. Very little is known about the alkaline decomposition of ditosylhydrazones (1a) under aprotic conditions. The ditosylhydrazone of o-phthalaldehyde (1) could yield a dicarbenoid (4) species (2) and hence benzocyclobutadiene (3) (5) or some interesting unsaturated macrocyclic compounds.

o-Phthalaldehyde ditosylhydrazone (1) was prepared by mixing o-phthalaldehyde and p-toluenesulfonylhydrazone in a 1:2 ratio in ethanol. The use of acetic acid as solvent (6) gave a colored solution. Heating a solution of 1 in dimethyl formamide at 120°, or in diethyl Carbitol at 160°, with either sodium methoxide or sodium hydride gave N-(3,4-dihydrophthalazinyl)p-tolysulfone (4) in 5-30% yield, as the only new substance isolated.⁴ No products derived from benzocyclobutadiene (3) (5) could be detected in the reaction product. Cava and Stein (7) have obtained a similar product by the reaction of phthalaldehydic acid tosylhydrazone with excess acetyl chloride in methanol.

The product 4 was also synthesized by the method of Lemal and Fry (8). Phthalazine (5) was reduced with lithium aluminium hydride to 3,4-dihydrophthalazine (6), and the crude product was treated directly with p-toluenesulfonyl chloride in freshly distilled sulfolane and triethylamine.

Dornow and Bartsch (16) have reported the formation of sulfones from diazoalkanes and aldehyde tosylhydrazones and hence the conversion of 1 to 4 is not surprising. A likely precursor of 4 may involve a monocarbene resulting from loss of one tosylhydrazone group.

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³Tosyl = Ts = p-toluenesulfonyl.
⁴Ditolyldisulfide and sodium p-tolysulfinate were also formed as side products (see refs. 1c, 9).
from 1 with subsequent carbene insertion to the N-H bond of the remaining tosylhydrazone. The intervention of a protonated diazo compound even under "aprotic" conditions (8, 9) cannot be excluded.

Experimental

Melting points were taken on a Kofler microscope hot-stage and are corrected. Infrared spectra were obtained as KBr discs on a Unicam SP-300 spectrophotometer. Infrared values (v) are given in cm⁻¹. Nuclear magnetic resonance (n.m.r.) spectra were recorded on a Varian Associates HA-100 spectrometer with tetramethylsilane as an internal standard and deuterochloroform as solvent. Ultraviolet spectra were obtained in ethanol on a Cary model 14 spectrophotometer. The mass spectra were taken on an A.E.I. MS9 double-focusing mass spectrometer. Woelm alumina (activity II-III) was used for column chromatography.

o-Phthalaldehyde Ditosylhydrazone (1)

To 2.3 g of p-toluenesulfonylhydrazone in 10 ml of warm absolute ethanol was added 0.8 g of o-phenaldehyde in 3 ml of absolute ethanol. The solution was heated to reflux for a few minutes and allowed to stand at room temperature for 3 h. The solid was filtered off to give 2.7 g (96%) of I, m.p. 151-152° (decomp.). The mass spectrum did not give a parent ion (the usual splitting pattern of tosylhydrazones is well known (10); n.m.r. (17), 7.58 s (six protons, Ar-CH), 1.8-3.0 m (complex multiplet which includes aromatic H, CH=N, and NH protons); v 3300; 3100 (NH), 1640 (C=N), 1595, 1560 (aromatic), 1335, 1165 (SO₂); mₓ 225 mp (28 800), 290 (8500).


Alkaline Decomposition of o-Phthalaldehyde Ditosylhydrazone (1)

A solution of I (2.35 g, 5 mmoles) in 20 ml of dimethyl formamide was added to 0.24 g (10 mmoles) of sodium hydride in 5 ml of dimethyl formamide at 5°. After being stirred for 1 h, the solution was immersed in an oil bath at 120°. After 5 min at this temperature, nitrogen evolution had ceased. The reaction mixture was filtered, the filtrate was extracted into ether, and washed six times with water. The semi-crystalline residue was chromatographed to give 300 mg (21%) of a crystalline compound m.p. 169-171° in the 1:1 pentane:ether fraction. Recrystallization from ether-pentane gave product 4, m.p. 171-173°. The mass spectrum gave a parent ion at m/e 286, as well as large peaks at m/e 285, 155, and 130, which would be consistent with structure 4; n.m.r. (17) 7.56 s (Ar-CH), 5.54 s (CH₃-N), 2.0-3.0 (eight aromatic protons); v 3450 br (NH), 1600 (aromatic), 1370, 1180 s (SO₂); mₓ 222 mp (22 100), 290 (9030).


In a similar reaction in which only one equivalent of sodium hydride was used, the product 4 was obtained in 14% yield. When the reaction was carried out in dry dioctylcarbitol at 160° with two equivalents of sodium methoxide, only a 6% yield of 4 was obtained. All the reactions were carefully examined by thin-layer chromatography for hydrocarbon components, but none could be detected.

Alternative Synthesis of N-[3,4-Dihydrophthalalyl]p-tosylhydrazine (4)

To a stirred slurry of lithium aluminium hydride (0.38 g, 10 mmoles) in 10 ml of ether under nitrogen, was added dropwise a solution of 1.3 g (10 mmoles) of phthalazine (5) in 20 ml of tetrahydrofuran. The mixture was then refluxed for 3 h. Water (1 ml) was added and the mixture was filtered through a filter cel-magnesium sulfate pad. The solvent was removed under reduced pressure. Thin-layer chromatography and elution of the product with ether showed mainly one spot (Rₖ 0.8; phthalazine Rₖ 0.05). The solid obtained was dried in 17.5 ml of freshly distilled sulfolane, and 0.8 ml (5 mmoles) of triethylamine and 950 mg (5 mmoles) of p-toluenesulfonylchloride were added. The solution was heated at 140-150° for 1.5 h, cooled, and then extracted with ether. The resulting oil on chromatography in the 1:1 pentane-ether fractions gave 100 mg of 4, m.p. 172-174°, undepressed upon admixture with the product obtained above; mass spectrum was identical to that obtained previously.


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