INVESTIGATIONS IN THE FIELD OF PYRAZOLIDINE CHEMISTRY

XIX.* REACTION OF 4-BUTYL-1,2-BIS(p-CHLOROSULFONYLPHENYL)-3,5-DIOXOPYRAZOLIDINE WITH HYDRAZINE HYDRATE

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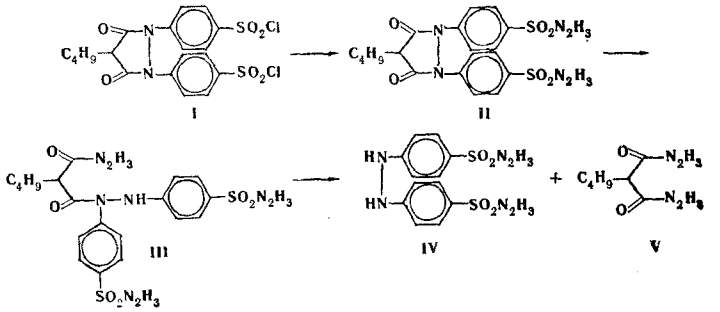
The reaction of 4-butyl-1,2-bis(p-chlorosulfonylphenyl)-3,5-dioxopyrazolidine with hydrazine hydrate readily gives the p,p'-disulfonylhydrazine of 1,2-diphenyl-4-butyl-3,5-dioxopyrazolidine, which undergoes hydrazinolysis at the C–N bond. The butylmalonic acid N,N'-bis(p-sulfonylhydrazinophenyl)hydrazide formed is in turn cleaved at the C–N bond under the influence of hydrazine hydrate in aqueous alcohol to form p,p'-bis(sulfonylhydrazino)-hydrazobenzene and butylmalonic acid dihydrazide.

It is known [1-3] that 1,2-diphenyl-3,5-dioxopyrazolidines (DDP) readily undergo hydrazolinolysis at the C–N bond of the heterocycle to form the correspondingly substituted hydrazides of malonic acid N,N'-diphenylhydrazide. Cleavage of the heterocycle therefore occurs along with replacement of the chlorine in the reaction of the disulfonyl chloride of 4-butyl-DDP (I) (previously described by us in [4]) with hydrazine hydrate, which complicates the preparation of 4-butyl-DDP p,p'-disulfonylhydrazine (II).

However, we have found that chlorosulfonyl groups have high reactivities, and this enables one to obtain II. Treatment of sulfonyl chloride I with excess hydrazine hydrate at room temperature results in complete replacement of the chlorine by a hydrazine residue in only 10 min after dissolution of the sulfonyl chloride, and acidification of the reaction solution gives a high yield of 4-butyl-DDP p,p'-disulfonylhydrazine (II). However, if the reaction is not interrupted, the C–N bond also undergoes rapid hydrazinolysis to form butylmalonic acid N,N'-bis(p-sulfonylhydrazinophenyl)hydrazide (III). The same product (III) is obtained in 67% yield by the reaction of disulfonyl chloride I with excess hydrazine hydrate in dichloroethane.



On treatment with a fivefold excess of hydrazine hydrate in aqueous alcohol at 60°, III in turn undergoes hydrazinolysis to form p,p'-bis(sulfonylhydrazino)hydrazobenzene (IV) in 23% yield and malonic acid

*See [6] for communication XVIII.

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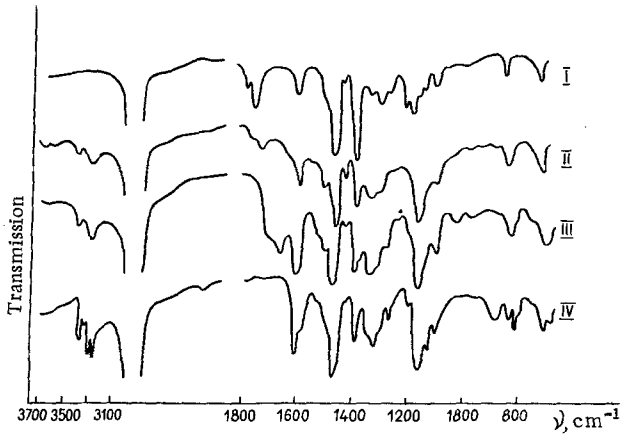

Fig. 1. IR spectra of I-IV.

dihydrazide (V). The yield of IV is doubled when this reaction is carried out with a 25-fold excess of hydrazine hydrate.

Like all enolized DDP, 4-butyl-DDP p,p'-disulfonylhydrazine (II) dissolves in the calculated amount of aqueous alcoholic alkali to form neutral solutions. The doublet characteristic for the β-diketone form of DDP, somewhat shifted to the low-frequency regions as compared with the position of the doublet in the spectrum of the starting disulfonyl chloride (I), is displayed in the IR spectrum recorded from a mineral oil suspension (Fig. 1).

The IR spectrum of III contains bands with maxima of ~1700 and 1660 cm^{-1}, which can be ascribed to vibrations of the secondary and tertiary amide (hydrazide) groups. The structure of of III was additionally confirmed by the preparation from it of IV and V by hydrazinolysis.

The IR spectrum of IV does not contain the carbonyl absorption but does contain a band with a maximum at 1600 cm^{-1} ($\nu_{C=C}$ of the benzene ring). Also characteristic for all of the compounds (I-IV) are absorption bands with maxima at 1330-1341 and 1167-1179 cm^{-1}, which confirm the presence of SO_2 groups.

The structure of p,p'-bis(sulfonylhydrazino)hydrazobenzene (IV) was also confirmed by the preparation from it of a dihydrazone (VIa) from p-dimethylaminobenzaldehyde and of a dihydrazone (VIIb) from salicylaldehyde. After alkaline hydrolysis, eight equivalents of iodine were expended in the iodometric titration of IV. Ammonia and p-aminobenzenesulfamide are formed by catalytic hydrogenation in the prescense of a Raney nickel catalyst.

EXPERIMENTAL

p,p'-Disulfonylhydrazine of 1,2-Diphenyl-4-butyl-3,5-dioxopyrazolidine (II). A 1.65-g (0.0033 mole) sample of 1,2-bis(p-chlorosulfonylphenyl)-4-butyl-3,5-dioxopyrazolidine (I) was ground thoroughly and stirred in a flask with 10 ml of water and 2 ml (0.04 mole) of freshly distilled hydrazine hydrate until it dissolved completely. A sample of the reaction solution was then withdrawn without discontinuing the stirring, and the percentage of chloride ions in it was determined by the Volhard method. After the percentage of the latter ceased to increase (~10-20 min after complete dissolution of the solid), the solution was filtered rapidly, and the filtrate was acidified with 3% hydrochloric acid to pH 2. The resulting precipitate was washed on the filter with water to give 1.21 g (55%) of a white, finely crystalline substance with mp 156-157°, which was dried in vacuo over phosphoric anhydride. Found: N 16.38, 16.80; S 12.78, 12.90%. $C_{19}H_{24}N_6O_6S_2$. Calculated: N 16.93; S 12.90%.

Hydrazide of Butylmalonic Acid N,N'-Bis(p-sulfonylhydrazinophenyl)hydrazide (III). A solution of 7.21 g (0.144 mole) of hydrazine hydrate in 30 ml of water was added with stirring to a solution of 10.0 g (0.032 mole) of 4-butyl-1,2-bis(chlorosulfonylphenyl)-3,5-dioxopyrazolidine (I) in 70 ml of dichloroethane. After stirring continuously for 5 h, the emulsion was allowed to separate into layers; to accelerate this, saturated sodium chloride solution was added. The precipitate was removed by filtration, washed with water, and dried at 60-70° to give 6.06 g (57.9%) of a yellowish-tinged white substance with mp 158-159° that was slightly soluble in water (1:5000) and ethanol. Found: N 20.62; S 12.17%. $C_{19}H_{28}N_8O_6S_2$. Calculated: N 21.22; S 12.12%.

One spot with R_f 0.56 and an insignificant spot at the start were detected by chromatography on Filtrpack paper in an acetone–carbon tetrachloride system (1:2) at a path length of 104 mm in UV light in an iodine chamber.

p,p'-Bis(sulfonylhydrazino)hydrazobenzene (IV). A mixture of 1.0 g (0.0019 mole) of III in 40 ml of 60% aqueous ethanol and 5.15 g [5 ml (0.102 mole)] of hydrazine hydrate was stirred at 60° for 6 h. The reaction mixture was cooled, and the precipitate was removed by filtration, washed with water and ethanol, and dried to give 0.327 g (43.9%) of a white substance with mp 192-193° (with foaming). Found: N 22.29;

S 16.89%. $C_{12}H_{16}N_6O_4S_2$. Calculated: N 22.58%; S 17.20%. One spot with R_f 0.60 was detected during chromatography on Filtrpack paper in an acetone–carbon tetrachloride system (1: 2) at a path length of 104 mm in UV light in an iodine chamber. The catalyzate from the hydrogenation of this substance in aqueous alcohol solution in the presence of a W-5 Raney nickel catalyst yielded a white crystalline substance with mp 159-160° that was identified as p-aminobenzenesulfamide from its qualitative reactions, the form of the crystals, and the absence of a depression of the melting point of a genuine sample of p-aminobenzenesulfamide. Ammonia was also detected in the catalyzate.

The reaction with excess p-dimethylaminobenzaldehyde in alcohol gave 88% of the dihydrazone (VIa) as a light-orange substance with mp 185-190°. Found: S 10.20%. $C_{30}H_{34}N_8O_4S_2$. Calculated: S 10.09%. The reaction with excess salicylaldehyde in alcohol gave 84% of the dihydrazone (VIb) as an orange-yellow substance with mp 118°. Found: S 11.17%. $C_{24}H_{26}N_6O_6S_2$. Calculated: S 11.03%. An iodometric determination carried out as in the analysis of isoniazid [5], showed that an analytically pure sample contained 99.1% of p,p'-bis(sulfonylhydrazino)hydrazobenzene. The mother liquor after removal of IV was concentrated in vacuo to a small volume and cooled to precipitate needle-shaped crystals. Treatment of these crystals with excess p-dimethylaminobenzaldehyde in ethanol gave an orange-red, crystalline substance with mp 241-243° (from ethanol) (VII). Found: N 18.68%. $C_{25}H_{34}N_6O_2$. Calculated: N 18.66%. One spot with R_f 0.55 was detected by chromatography in a thin layer of activity III aluminum oxide containing 2% acetic acid in an acetone–carbon tetrachloride system (1: 1) in UV light.

The IR spectra of mineral oil pastes were recorded with an IKS-14 spectrometer with NaCl and KCl prisms.

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