OXIDATION OF HALOHYDROXYBENZO-2,1,3-THIADIAZOLES WITH NITRIC ACID

I. A. Belen'kaya, G. P. Krokhina,
and S. A. Andronati

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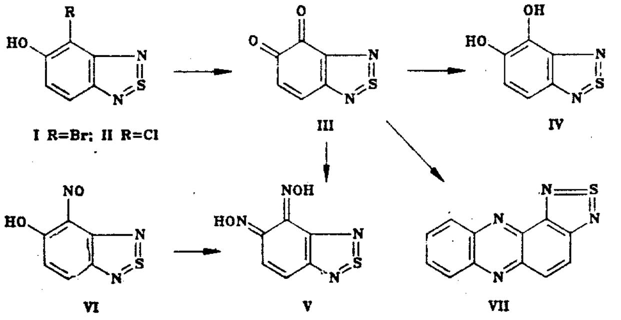
4,5-Dioxobenzo-2,1,3-thiadiazole has been synthesized. Its structure was proven by conversion to the known 4,5-dioximinobenzo-2,1,3-thiadiazole and to 2,1,3-thiadiazolo[4,5-a]phenazine, and by reduction to 4,5-dihydroxybenzo-2,1,3-thiadiazole. Oxidation of 5,6-dichloro-4,7-dihydroxy- and 5,7-dichloro-4-hydroxybenzo-2,1,3-thiadiazoles forms 5,6-dichloro-4,7-dihydroxybenzo-2,1,3-thiadiazole, of known structure, and 7-chloro-4,5-dioxobenzo-2,1,3-thiadiazole; the latter by reaction with ortho-phenylene diamine is converted to 4-chloro-2,1,3-thiadiazolo[4,5-a]phenazine.

We have previously reported [1-3] the synthesis and chemical reactions of 4,7-dioxobenzo-2,1,3-thiadiazole and its methyl and chloro derivatives. The present work is a continuation of those studies and is devoted to the oxidation of halohydroxybenzo-2,1,3-thiadiazoles with nitric acid.

When 4-bromo-5-hydroxy- or 4-chloro-5-hydroxybenzo-2,1,3-thiadiazoles (I or II) are oxidized with nitric acid ($d = 1.35$ g/cm^3) in toluene, and nitrosyl bromide or chloride is distilled off, 4,5-dioxobenzo-2,1,3-thiadiazole (III) is formed in 96.9 and 54.8% yield, respectively; III is reduced by sodium hydrosulfite to 4,5-dihydroxybenzo-2,1,3-thiadiazole (IV).

The IR spectrum of the quinone III contains C=O absorption bands at 1680 and 1740 cm^{-1}, which are absent in the spectrum of compound IV, while an absorption band at 3350 cm^{-1}, corresponding to the stretching vibrations of OH, appears in the latter.



The reaction of ortho-quinone III with hydroxylamine hydrochloride forms 4,5-dioximinobenzo-2,1,3-thiadiazole (V), which is identical with the compound obtained according to [4] from 4-nitroso-5-hydroxybenzo-2,1,3-thiadiazole (VI) the structure of which is known [5, 6]. Addition of an alcoholic solution of ortho-phenylene diamine to quinone III forms 2,1,3-thiadiazolo[4,5-a]phenazine (VII).

The reaction of 5,7-dichloro-4-hydroxybenzo-2,1,3-thiadiazole (VIII) with nitric acid in toluene gives 7-chloro-4,5-dioxobenzo-2,1,3-thiadiazole (IX), which could not be brought to a state of analytical purity. With the alcoholic solution of ortho-phenylene diamine this product gives 4-chloro-2,1,3-thiadiazolo[4,5-a]phenazine (X). (See scheme below).

We established that when 5,6-dichloro-4,7-dihydroxybenzo-2,1,3-thiadiazole (XI) is oxidized with nitric acid in toluene, 4,5,6,7-tetraoxobenzo-2,1,3-thiadiazole (XII) is not formed. 5,6-Dichloro-4,7-dioxobenzo-2,1,3-thiadiazole (XIII) was isolated in high yield; previously it has been synthesized according to [3].

A. V. Bogatskii Physicochemical Institute, Academy of Sciences of the Ukrainian SSR, Odessa 270080. Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 6, pp. 850-852, June, 1987. Original article submitted July 15, 1985; revision submitted November 17, 1985.

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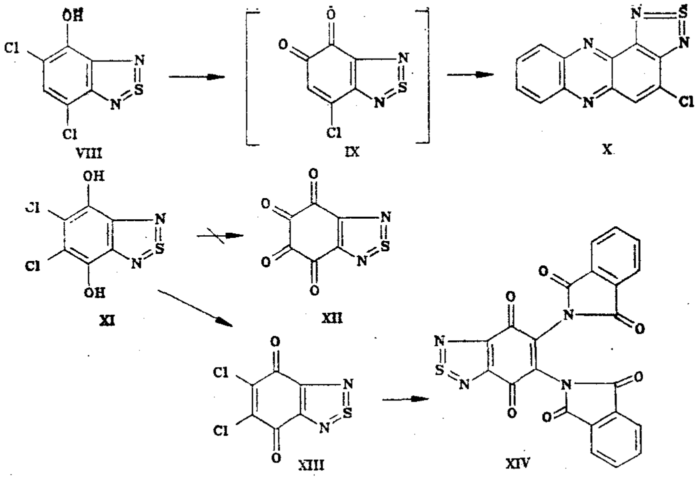

Quinone XIII reacts with potassium phthalimide to form 5,6-phthalimido-4,7-dioxobenzo-2,1,3-thiadiazole (XIV), which could not be converted to 5,6-diamino-4,7-dioxobenzo-2,1,3-thiadiazole.

The compounds I, II, and VIII required for syntheses were obtained according to [5]; compound XI, according to [3]; and compound VI, according to [6].

EXPERIMENTAL

The course of reactions and the individuality of substances was monitored by TLC on Silufol UV-254 plates in 1:1 acetone–toluene (system A), or 2:1:2 acetone–chloroform–hexane (system B). IR spectra were obtained with a Perkin–Elmer 577 spectrophotometer in chloroform or in KBr tablets. Mass spectra were obtained with a Varian MAT-112 mass spectrometer at 70 eV ionization energy.

4,5-Dioxobenzo-2,1,3-thiadiazole (III). A) Compound I, 10 g (43 mmole) was suspended in 80 ml of toluene, 5 ml of nitric acid (d = 1.35 g/cm^3) was added, and the mixture was stirred for 30 min at 20°C, then filtered. Water, 60 ml, was added and the layers were separated. The organic layer was washed with water to pH 7, dried with $MgSO_4$ for 30 min, and filtered. Toluene and nitroxyl bromide were distilled off in vacuum at 65° bath temperature. There was obtained 6.92 g (96.9%) of compound III, which after washing with petroleum ether and drying had mp 164-165° (with dec.). Rf 0.66 (system A, development with ammonia vapor). Found, %: N 16.7, S 19.2. $C_6H_2N_2O_2S$. Calculated, %: N 16.9, S 19.3.

B) Compound II, 3.3 g (18 mmole), was suspended in 30 ml of toluene, 3 ml of nitric acid (d = 1.35 g/cm^3) was added, and the mixture was stirred for 1 h at 25° and then filtered. Water, 25 ml, was added. Thereafter workup was according to method A. There was obtained 1.6 g (54.8%) of compound III, which after washing with petroleum ether and drying had mp 164-166° (with dec.). Rf 0.66 (system A, development with ammonia vapor). Found, %: N 17.0, S 19.2. $C_6H_2N_2O_2S$. Calculated, %: N 16.9, S 19.3.

4,5-Dioxobenzo-2,1,3-thiadiazole (IV). A mixture of 0.23 g (1.37 mmole) of compound III and 2.3 g (13.2 mmole) of sodium hydrosulfite was added to 20 ml of water at 90°. The mixture was boiled 1-2 min, then filtered hot. The filtrate was cooled and extracted with ether. Removal of ether from the extract gave 0.1 g (42.9%) of compound IV, mp 210° (with decomp., from ethyl alcohol), Rf 0.57 (system B, development with iodine vapor). Found, %: C 42.7, N 16.9. $C_6H_4N_2O_2S$. Calculated, %: C 42.8, N 16.7.

4,5-Dioximinobenzo-2,1,3-thiadiazole (V). A mixture of 1.66 g (10 mmole) of compound III and 1.4 g (20 mmole) of hydroxylamine hydrochloride in 40 ml of methyl alcohol was boiled for 3 h, then cooled, and the precipitate was filtered off. The filtrate was evaporated to give 1.81 g (92.5%) of compound V, mp 215-216° (with decomp., from aqueous ethanol), Rf 0.56 (system B). IR spectrum: 3200 cm^{-1} (OH). The IR spectrum of compound V was identical with that of 4,5-dioximinobenzo-2,1,3-thiadiazole obtained according to [4]. Found, %: N 28.5, S 16.2. $C_6H_4N_4O_2S$. Calculated, %: N 28.6, S 16.3.

2,1,3-Thiadiazolo[4,5-a]phenazine (VII). To a solution of 1.08 g (10 mmole) of ortho-phenylidene diamine in 40 ml of ethyl alcohol was added 1.66 g (10 mmole) of compound III. The mixture was stirred for 5 min and left for 2 h at 20°. The precipitate was filtered off, washed with ethyl alcohol, and dried. There was obtained 0.67 g (28.2%) of compound VII, which did not melt but blackened and charred at 294-295°, Rf 0.63 (system B). Mass spectrum, m/z: 238. Found, %: N 23.4, S 13.3. $C_{12}H_6N_4S$. Calculated, %: N 23.5, S 13.4.

4-Chloro-2,1,3-thiadiazolo[4,5-a]phenazine (X). To 1.2 g (5.11 mole) of compound VIII in 13 ml of toluene was added 1,25 ml of nitric acid (d = 1.35 g/cm³). The mixture was stirred for 30 min at 50°, then filtered. To the filtrate was added 20 ml of water and the layers were separated. The organic layer was washed with water to pH 7, dried with $MgSO_4$ for 30 min, and filtered. Toluene and nitrosyl bromide were distilled off in vacuum at 65° bath temperature. The residue was dissolved in 30 ml of ethyl alcohol and 0.27 g (2.5 mmole) of ortho-phenylene diamine in 30 ml of ethyl alcohol was added. The reaction mixture was let stand for an hour, and the precipitate was filtered off, washed with ethyl alcohol, and dried to give 0.57 g (38.8% calculated on compound VIII) of compound X, mp 233-234°, Rf 0.58 (system B). Mass spectrum, m/z: 272. Found, %: Cl 13.2, S 11.9. $C_{12}H_5ClN_4S$. Calculated, %: Cl 13.0, S 11.7.

5,6-Dichloro-4,7-dioxobenzo-2,1,3-thiadiazole (XIII). To 0.65 g (2.74 mmole) of compound XI in 10 ml of toluene was added 1.8 ml of nitric acid (d = 1.35 g/cm³) at 25°. The mixture was heated and stirred for 30 min at 70°; then 30 ml of water was added and the layers were separated. The organic layer was washed with water to pH 7, dried with $MgSO_4$ for 30 min, and filtered. Toluene was distilled off to give 0.37 g (57.4%) of compound XIII, which was crystallized from dichloroethane; sublimes at 188-190°, Rf 0.8 (system B, development with ammonia vapor). IR spectrum: 1705 cm^{-1} (C=O). Found, %: Cl 30.2, N 10.7. $C_6Cl_2N_2O_2S$. Calculated, %: Cl 30.2, N 10.9.

5,6-Phthalimido-4,7-dioxobenzo-2,1,3-thiadiazole (XIV). To a suspension of 0.471 g (2.54 mmole) of potassioum phthalimide in 11 ml of dimethylformamide at 120° was added 0.3 g (1.28 mmole) of compound XIII in 6 ml of dimethylformamide, and the mixture was held at 145° for 30 min. Then the mixture was cooled, the precipitate was filtered off, and the filtrate was poured onto ice. The precipitate was filtered off to give 0.2 g (21.9%) of compound XIV, Rf 0.71 (system B, development with iodine vapor). Mass spectrum, m/z: 456. IR spectrum: 1720 cm^{-1} (C=O). Found, %: N 12.1. $C_{22}H_8N_4O_6S$. Calculated, N 12.3.

LITERATURE CITED

1. V. G. Pesin and I. A. Belen'kaya-Lotsmanenko, Khim. Geterotsikl. Soedin., No. 3, 354 (1965).
2. I. A. Belen'kaya, N. S. Tsepova, Ya. L. Kostyukovskii, and V. G. Pesin, Khim. Geterotsikl. Soedin., No. 7, 926 (1973).
3. I. A. Belen'kaya, G. P. Krokhina, and S. A. Andronati, Khim. Geterotsikl. Soedin., No. 10, 1344 (1982).
4. A. S. Angeloni, D. Dal Monte, E. Sandri, and G. Scapini, Tetrahedron, 30, 3849 (1974).
5. V. G. Pesin, A. M. Khaletskii, and I. A. Lotsmanenko, Zh. Obshch. Khim., 33, 1752 (1963).
6. V. G. Pesin, I. A. Belen'kaya-Lotsmanenko, and A. M. Khaletskii, Zh. Obshch. Khim., 34, 3763 (1964).