STUDIES IN THE FIELD OF 2,1,3-THIA- AND SELENADIAZOLES

LIII. Amination of Benzo-2, 1, 3-Thiadiazole with Hydroxylamine Sulfate in Concentrated Sulfuric Acid*

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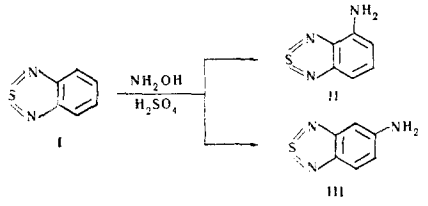
The reaction of benzo-2,1,3-thiadiazole with hydroxylamine sulfate in concentrated sulfuric acid at 150° C for 1–10 hr has been studied. It has been shown that under these conditions mixtures of different amounts of 4- and 5-aminobenzo-2,1,3-thiadiazoles are formed.

According to the literature [2–5], the amino group can be introduced directly into aromatic or heterocyclic compounds by the action on the latter of alkali-metal amides or hydroxylamine. In an alkaline medium, hydroxylamine readily reacts under the usual conditions with 1,3-dinitro- and 1,3,5-trinitrobenzenes [6] and with α- and β-nitronaphthalenes [7, 8] with the formation of the corresponding aminonitro derivatives in high yield. This reaction takes place readily with the isomeric 4- and 5-nitrobenzo-2,1,3-thia- and -selenadiazoles and their methyl-substituted derivatives [9, 10].

Graebe and Gaubert [11, 12] have established that the action of hydroxylamine hydrochloride on benzene, toluene, o-, m-, and p-xylenes, mesitylene, and naphthalene in the presence of anhydrous aluminum chloride can give low yields of the corresponding amino derivatives. Turskii [13, 14] proposed to carry out the amination of aromatic compounds with hydroxylamine in concentrated sulfuric acid. In this way the corresponding amino derivatives are obtained in high yields. Japanese workers [15–17] have studied the reaction of hydroxylamine salts with aromatic compounds in concentrated sulfuric acid or in the presence of anhydrous aluminum chloride. Kovacic and Bennett [18] have studied the amination of aromatic compounds with hydroxylamine O-sulfonic acid in the presence of anhydrous aluminum chloride.

The present paper gives the results of a study of the behavior of benzo-2,1,3-thiadiazole (I) under the conditions of Turskii's reaction.

The amination of compound I was carried out with hydroxylamine sulfate in concentrated sulfuric acid at 150° C, and the formation of the isomeric 4-amino- (II) and 5-aminobenzo-2,1,3-thiadiazoles (III) was observed.



I II III

*For part LII, see [1].

The yield of the final products depends on the time for which the reaction is carried out, and increases with time (see table).

Amination of Benzo-2, 1, 3-thiadiazole

Duration of the experiment, hours	Total yield of the amines II and III, g and %
1	0.02 (1.32)
2	0.02 (1.32)
3	0.04 (2.64)
4	0.04 (2.64)
5	0.04 (2.64)
6	0.06 (3.96)
7	0.10 (6.60)
8	0.16 (10.56)
9	0.18 (11.88)
10	0.20 (13.20)

The formation of approximately equal amounts of the isomers II and III shows the similar activities, under the particular experimental conditions, of positions 4 and 5. Nevertheless, position 4 is more active than position 5 in electrophilic substitution reactions. These results may serve as an indication than the process probably takes place by a radical mechanism.

EXPERIMENTAL

The initial benzo-2,1,3-thiadiazole and 4- and 5-aminobenzo-2,1,3-thiadiazoles were obtained as described in the literature [19, 20], and [21], respectively.

Amination. A mixture of 1.36 g (0.01 mole) of I, 4.1 g (0.05 mole) of hydroxylamine sulfate ($NH_2OH \cdot 0.5\ H_2SO_4$), and 10 ml of concentrated sulfuric acid (d 1.835) was heated at 150° C for a predetermined time (see table). After cooling, the reaction mixture was poured onto ice and the precipitate that deposited was filtered off, washed with water, and dried (residue A)*. The filtrate was made alkaline in the cold with 30% caustic soda solution and extracted with chloroform. The chloroform layer was separated off and dried with anhydrous sodium sulfate; the solvent was distilled off and the residue B** was chromatographed in a column of alumina (250 × 15 mm) (solvent–benzene). The differently colored zones of the chromatogram (the lower yellow zone and the light yellow upper zone) were separated and extracted with acetone. The extracts were evaporated. The residues were identified from their melting points and mixed melting points with the authentic amino derivatives, and also by their conversion into various acyl derivatives—4- and 5-acylaminobenzo-2,1,3-thiadiazoles.

The lower zone yielded II, mp 68° C and the upper zone III, mp 114°–116° C.

*Residue A–unchanged starting material (sometimes partially resinified).

**Residue B–a mixture of the isomeric amines II and III.

4-Benzoylaminobenzo-2,1,3-thiadiazole. A mixture of 1.5 g of II, 20 ml of water, and 2.4 g of benzoyl chloride was heated to a boil with stirring, cooled, and made alkaline with 10% caustic soda solution the precipitate was filtered off and washed with water. Yield 2.3 g (90%). Silvery plates, mp 123°–124° C (from 50% propanol). Found, %: N 16.95; S 12.13. Calculated for $C_{13}H_9N_3OS$, %: N 16.47; S 12.55.

5-Benzoylaminobenzo-2,1,3-thiadiazole. This was obtained from III in a similar manner (see above). Yield 90%; mp 166°–168° C (from 50% propanol). Found, %; N 16.82; S 12.12. Calculated for $C_{13}H_9N_3OS$, %: N 16.47; S 12.55.

4-(p-Toluenesulfonamido)benzo-2,1,3-thiadiazole. A mixture of 1.5 g of II and 2 g of p-toluenesulfonyl chloride was heated at 100° C until it solidified (~2 min) and was cooled. The yield was quantitative. Silvery plates, mp 145°–147° C (from propanol). Found, %: N 14.16; S 20.41. Calculated for $C_{13}H_{11}N_3O_2S_2$, %: N 13.77; S 20.98.

5-(p-Toluenesulfonamido)benzo-2,1,3-thiadiazole. Obtained from III in a similar manner (see above). The yield was quantitative. Mp 156°–158° C (from 30% propanol). Found, %: N 14.41; S 20.46. Calculated for $C_{13}H_{11}N_3O_2S_2$, %: N 13.77; S 20.98.

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