SYNTHESIS AND TRANSFORMATIONS OF OXO- AND THIO-DERIVATIVES OF 1, 3-THIAZINE

IV. Interaction Between 4-Thiothiazanone-2 and Amino Compounds*

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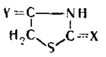
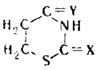
Substituted 4-iminothiazanes were obtained by the interaction between 4-thiothiazanone-2 with amino compounds. An examination was made of the difference in reactivity between thione groups in positions 2 and 4 in derivatives of thiazolidine and thiazane in relation to characteristics of the electron structure of the sulfur atom and the influence of the neighboring atoms.

It has previously been shown [1–5] that in reactions involving nucleophilic substitution in derivatives of thiazolidines and thiazanes, the reactivity of the thione group in position 4 is markedly greater than that in position 2. Thus, whereas 2-thiothiazolidone-4 (rhodanine, Ia) reacts with amines only on prolonged heating [6], 4-thiorhodanine (Ib) and 2-oxo-4-thiothiazolidone (isorhodanine, Ic) form condensation products with amines on mild heating in alcoholic medium within several minutes [2].



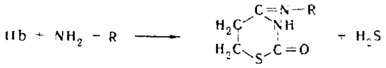
Ia X=S; Y=O
Ib X, Y=S
Ic X=O; Y=S

An analogous relationship concerning the reactivity of thione groups in positions 2 and 4 is found in thiazane derivatives [3, 4].



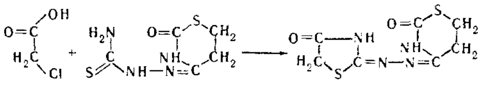
IIa X, Y=S
IIb X=O; Y=S
IIc X=S; Y=O

In the present work, a study was made of the condensation reaction between 4-thiothiazanone-2 (IIb) and the aromatic amines, n-nitrophenylhydrazine and thiosemicarbazide, in alcoholic medium. This reaction proceeds on mild heating with the intensive evolution of hydrogen sulfide and the formation of products according to the equation:



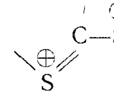
III

The characteristics of the substances obtained are presented in the table. The interaction of hydrazine or aliphatic diamines with compound IIb leads to the formation of compounds containing two thiazane residues. When monochloroacetic acid reacts with thiosemicarbazone IIb (IV) there is a closure of the five-membered ring with the formation of an azine which, by analogy with the compounds described earlier [7, 8], should have the structure V.



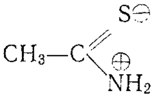
IV V

The difference in reactivity of the thione groups in positions 2 and 4 in derivatives of thiazolidine and thiazane may be attributed to the characteristics of the electron structure of the sulfur atom and the effect of neighboring atoms. It follows from formulas I and II that the thione groups in positions 2 and 4 are not equivalent. The decreased reactivity of the thione sulfur in position 2 is associated with the possibility of formation of structure A,



A

in which the carbon atom does not possess electron inefficiency essential for attack by the nucleophilic reagent. This proposal is supported by the increased reactivity of the thione group of 2-thionoxazolidone-4 (VI) in comparison with that in compound Ia [9]. It would be unlikely that compound VI could form structure A, as the oxygen atom possesses marked electronegativity and is characterized by a quantum number differing from that for the sulfur atom. The thione group in position 4 of compounds I and II is incorporated into the thioamide grouping, but, according to its properties, differs from the thione grouping of thioacetamide by its increased reactivity. It is probable that, in thioacetamide, owing to the expansion of the electron octet of sulfur due to the α-orbit [10, 11], the formation of the structure



$$CH_3-C\overset{S^{\ominus}}{\underset{NH_2}{\swarrow}}{}^{\oplus}$$

is possible, which decreases the reactivity of the thione group, whereas in compounds Ib, Ic, IIa, and IIb, due to the presence of the electrophilic group in position 2, the possibility of expansion of the electron octet of sulfur markedly decreases due to the p-electrons of the amine group, which leads to the great polarity of the thione bond and facilitates the attack on the carbon atom by the nucleophilic reagent. In aliphatic thioaldehydes and thioketones, similar elec-

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*For part III, see [5].

Products of Condensation of 4-Thione-1, 3-thiazanone-2 with Amino Compounds

Compound	Name	Time of heating, min	Mp, °C Solvent for crystallization	Empirical formula	Found, %		Calculated, %		Yield, %
					N	S	N	S	
IIIb	4-(n-Tolylimino)thiazanone-2	3	161.5 (decomp.), ethanol	$C_{11}H_{12}N_2OS$	12.97	14.25	12.71	14.56	76
IIIc	4-(n-Ethoxyphenylimino)thiazanone-2	15	148 (decomp.), ethanol	$C_{12}H_{14}N_2O_2S$	11.32	13.08	11.45	12.81	75
IIId	4-(o-Oxyphenylimino)thiazanone-2	10	141-142, acetic acid-water	$C_{10}H_{10}N_2O_2S$	12.85	14.59	12.60	14.43	71
IIIe	4-(n-Oxyphenylimino)thiazanone-2	10	187 (decomp.), ethanol	$C_{10}H_{10}N_2O_2S$	12.31	14.68	12.60	14.43	70
IIIf	4-(m-Br-phenylimino)thiazanone-2	60	168 (decomp.), methanol	$C_{10}H_9BrN_2O$	10.10	11.00	9.82	11.24	70
IIIg	4-(n-Carboxyphenylimino)thiazanone-2	120	196.5 (decomp.), dimethylformamide-water	$C_{11}H_{10}N_2O_3S$	10.75	13.30	11.19	12.82	53
IIIh	4-(β-Naphthylamino)thiazanone-2	10	162, ethanol-water	$C_{14}H_{12}N_2OS$	10.58	12.01	10.93	12.51	58
IIIi	4-n-Nitrophenylhydrazone of 4-thiothiazanone-2	15	218, acetic acid	$C_{10}H_{10}N_4O_3S$	20.20	11.25	21.03	12.04	84
IV	4-Thiosemicarbazone of 4-thiothiazanone-2	10	183.5, dimethylformamide-water	$C_5H_8N_4OS_2$	27.20	31.34	27.41	31.30	92

tronic displacements decreasing the polarity of the thione bond do not occur, and the reactivity of the thione group in these compounds is so great that they have a strong tendency to polymerize and essentially do not exist in the monomeric form.

EXPERIMENTAL

4-(n-Methoxyphenylimino)thiazanone-2 (IIIa). A 0.37 g quantity (3 mM) of n-anisole was dissolved in 5 ml methanol, and 0.44 g (3 mM) of compound IIb was added to the solution. On mild heating, hydrogen sulfide is evolved, and evolution of gas ceases after 1 hr 20 min. After cooling, a precipitate is formed. Yield, 0.52 g (73%). Colorless crystals with a mp of 152° C (with decomp. from ethanol). Found, %: N, 11.68; S, 13.32. Calculated for $C_{11}H_{12}N_2O_2S$ %: N, 11.85; S, 13.57.

The other products of the condensation between compound IIb and amino compounds were obtained in an analogous manner (see table).

Product of ring formation between compound IV and monochloroacetic acid (V). A 0.82 g quantity (4 mM) of compound IV was added to a mixture of 0.66 g of fused sodium and 7 ml glacial acetic acid, and then 0.38 g (4 mM) of monochloroacetic acid was added to the hot solution. After boiling for 4 hr the mixture was cooled and diluted with water. The precipitate was washed with water, acetic acid and dimethyl formamide. Yield, 0.15 g (15%). Colorless powder, readily soluble in conc. H_2SO_4, poorly soluble in alkalies. mp 213–214° C (with decomp.). Found, %: N, 22.51; S, 26.29. Calculated for $C_7H_8N_4O_2S_2$, %. N, 22.91; S, 26.21.

Bis(4,4-iminothiazanone-2)ethane (VII). Four ml methanol and 0.22 g (4 mM) KOH in 1 ml water were added to 0.26 g (2 mM) ethylene diamine hydrochloride. The KCl residue was removed and 0.59 g (4 mM) of compound IIb in 4 ml methanol was added to the filtrate. Immediately, hydrogen sulfide evolution and precipitation commenced. Within 15 min the precipitate had formed and it was subsequently washed with water, acetic acid, and pyridine. The compound was a colorless, finely crystalline powder, mp 271° C (with carbonization). Found, %: N, 19.18; S, 22.01. Calculated for $C_{10}H_{14}N_4O_2S_2$, %: N, 19.56; S, 22.39.

The azine of 4-thiothiazanone-2 was obtained in an analogous manner from hydrazine hydrochloride and compound IIb. The compound was purified by reprecipitation with water from dimethyl formamide. Colorless powder, mp 166° C. Found, %: N, 22.03, S, 25.65. Calculated for $C_8H_{10}N_4O_2S_2$, %: N, 21.68; S, 24.82.

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