

CXLV.—*Non-aromatic Diazonium Salts. Part IV.*
Thiazole-2-diazonium Salts.

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THE aminothiazoles are among the heterocyclic bases which have manifested a certain degree of diazotisability, although stable salts of these bases have not hitherto been isolated. The difficulty experienced in preparing normal diazonium compounds of the thiazole series is due, in part, to the method of diazotisation adopted, namely, treatment with alkali or alkyl nitrites in the presence of hydrochloric or hydrobromic acids. The use of these halogen acids leads to the formation of unstable diazonium haloids, which speedily decompose, with elimination of diazo-nitrogen and substitution of halogen in the thiazole ring. In feebly acid solutions, aqueous sodium nitrite furnishes thiazole-2-diazohydroxide, an unstable, orange-red, insoluble powder, transformed by concentrated hydrochloric acid into 2-chlorothiazole (Hantzsch, *Annalen*, 1888, **249**, 1; Traumann, *ibid.*, 1888, **249**, 35; Schatzmann, *ibid.*, 1891, **261**, 9; compare Nef, *ibid.*, 1891, **265**, 110).

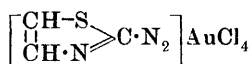
Diazotisation of ethyl 5-amino-2-methylthiazole-3-carboxylate

(Wohlmann, *Annalen*, 1890, **259**, 279) also gives rise to an insoluble diazohydroxide, converted by hydrochloric acid into ethyl 5-chloro-2-methylthiazole-3-carboxylate.

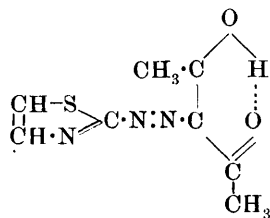
The similarly constituted aminothiazinones, containing a heterocyclic ring with one sulphur and two nitrogen atoms, are also diazotisable, but their diazo-derivatives are anomalous, inasmuch as the diazo-group is not removed by alcohol (Harries and Klamt, *Ber.*, 1900, **33**, 1158). This substitution of hydrogen for the diazonium complex by the reducing action of alcohol occurs quite readily in the thiazole series (Hantzsch and Popp, *Annalen*, 1889, **250**, 274).

The following experiments confirm the earlier researches in regard to diazotisation in the presence of hydrochloric acid. The soluble product is unstable, the solution becoming successively yellow and brown. The amorphous precipitate, which then separates, contains in all probability the insoluble diazohydroxide already examined (Schatzmann, *loc. cit.*; Nef, *loc. cit.*).

In the presence of oxy-acids, diazotisation proceeds more smoothly, especially in the case of sulphuric acid. The colourless diazo-solution, when treated with sodium aurichloride, yields the sparingly soluble, yellow, crystalline *thiazole-2-diazonium aurichloride* (formula I).



(I.)



(II.)

Although stable at the ordinary temperature when dry, this salt is readily hydrolysed by cold water, giving rise to an orange-brown substance, which consists partly of the insoluble thiazole-2-diazohydroxide.

Diazotisation in perchloric acid leads to the formation of a diazonium perchlorate without by-products. This salt is, however, extremely explosive, even in ice-cold solution, in this respect resembling benzenediazonium perchlorate (*Ber.*, 1906, **39**, 2715, 3146). Diazotisation takes place equally readily with sulphuric acid, but with nitric acid the reaction proceeds less smoothly (Nef, *loc. cit.*), owing to the sparing solubility of 2-aminothiazole nitrate.

These thiazole-2-diazonium oxy-salts couple readily and quantitatively with phenols and the more reactive aromatic amines, such

as β -naphthylamine, giving rise to intensely coloured derivatives, which, however, are not very crystallisable. Coupling also occurs between the thiazole-2-diazonium salts and the β -diketones, such as acetylacetones, with the production of yellow thiazole-2-azo- β -diketones (formula II) (compare Morgan and Reilly, T., 1913, **103**, 1498).

Hantzsch (*loc. cit.*) has already directed attention to the great similarity subsisting between the thiazole and pyridine bases. This similarity is distinctly manifested in the behaviour of the amino-derivatives of the thiazole and pyridine series towards diazotising agents. In presence of hydrochloric acid, there is the same tendency for the replacement of the diazo-complex by chlorine. 2-Aminopyridine yields 2-chloropyridine (H. Meyer, *Monatsh.*, 1894, **15**, 173), and 4-amino-2:6-dimethylpyridine gives rise to 4-chloro-2:6-dimethylpyridine (Marckwald, *Ber.*, 1894, **27**, 1325).

Although pyridinediazonium salts have not been isolated, the foregoing reactions point to transient diazotisation, and accordingly it can scarcely be doubted that a suitable modification of experimental conditions would lead to the separation of stable diazonium compounds.

The case of the aminoquinolines is quite analogous. It is sometimes stated that 4-aminoquinoline is not diazotisable, but this interpretation of the result obtained by Claus and Howitz is not justifiable, for these investigators showed that, in the presence of hydrochloric acid, nitrous acid induces the replacement of the amino-group by chlorine, a substitution which points to the transitory existence of quinoline-4-diazonium chloride (*J. pr. Chem.*, 1894, [ii], **50**, 23). This explanation is supported by the fact that 3-aminoquinoline is readily diazotisable (Mills and Watson, T., 1910, **97**, 743).

EXPERIMENTAL.*

2-Aminothiazole was prepared by the method described by Traumann (*loc. cit.*). Thiocarbamide (5 grams) and chloroacetaldehyde alcoholate (10 grams) were suspended in 50 c.c. of water, and boiled in a reflux apparatus until the oily layer was no longer turbid. The mixture, rendered strongly alkaline with sodium hydroxide, was extracted with ether, and 2-aminothiazole isolated by the spontaneous evaporation of the ethereal extract.

Diazotisation in Hydrochloric Acid.—2-Aminothiazole dissolved readily in cold dilute hydrochloric acid, but addition of sodium nitrite led to the formation of an unstable diazonium chloride; the

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solution became yellow, then brown, and deposited tarry, amorphous products. When treated with ethyl nitrite in alcoholic solution, 2-aminothiazole hydrochloride showed little tendency to diazotise. Addition of gold chloride to the diazonium chloride solution gave a crystalline, orange precipitate of diazonium aurichloride. This was collected, but on washing with cold water to remove sodium salts, the aurichloride turned brown, and lost its crystalline character. In view of this readiness to decompose hydrolytically, it seemed desirable to prepare the aurichloride in the absence of non-volatile inorganic salts.

Diazotisation in the Presence of Oxy-acids.—2-Aminothiazole formed a sparingly soluble nitrate, which did not diazotise at all readily when treated in aqueous suspension with sodium nitrite or ethyl nitrite. Only the dissolved portion of the salt underwent diazotisation, as shown by the reaction with alcoholic β -naphthol; the white, insoluble, crystalline portion resisted the attack of these diazotising agents for a considerable time. Meanwhile, the diazonium nitrate already formed underwent decomposition, as was manifested by a darkening of the solution, first to yellow and then to brown. On concentrating the orange solution of thiazole-2-diazonium nitrate at the ordinary temperature, merely a viscous residue was obtained, and the addition of sodium azide to the solution of diazonium nitrate gave rise only to tarry products.

Gold chloride, when added to the orange-brown solution, led to the deposition of a heavy, reddish-brown precipitate, which was collected and dried, when a nitrogen estimation showed that a considerable loss of diazo-nitrogen had occurred.

Aminothiazole (0.5 gram) added to 6.6 c.c. of 20 per cent. perchloric acid (D 1.14) gave a colourless, crystalline perchlorate, which dissolved readily on adding a few c.c. of cold water. The solution, cooled to 0°, was treated with ethyl nitrite, and speedily gave the azo-reaction with alcoholic β -naphthol. When the solution was stirred, a sharp explosion occurred, and this crackling detonation was repeated at short intervals, even when the solution was allowed to remain unstirred in contact with fragments of ice. On this account, and also because of its great solubility, no further attempt was made to isolate the diazonium perchlorate. The solution, apart from its explosive character, showed very little tendency to yield secondary by-products; it remained almost colourless, and when gold chloride was cautiously added, an orange-coloured precipitate was obtained, which was collected, washed with a little ice-water, and dried on porous tile in a desiccator over potassium hydroxide. The partly dried aurichloride was still somewhat ex-

plosive, owing either to co-precipitated diazonium perchlorate or to adherent perchloric acid.

Thiazole-2-diazonium Aurichloride. (Formula I.)

It was ultimately found that aminothiazole could be readily dissolved and diazotised in 20 per cent. sulphuric acid; 0.35 gram of base was dissolved in a solution of 0.6 c.c. of concentrated sulphuric acid diluted with water to 3.3 c.c., and the solution, cooled with ice, was treated with 3.5 c.c. of *N*-sodium nitrite. Diazotisation was rapid; the solution remained colourless, and no tarry products were set free. The addition of a concentrated solution of sodium aurichloride determined the formation of a heavy, crystalline, yellow precipitate. As the diazonium aurichloride was decomposed by water and soluble in alcohol, it was washed four times with dilute hydrochloric acid, and dried on porous tile over potassium hydroxide:

0.0621 gave 0.0271 Au. Au=43.64.

0.1805 „ 14.3 N₂ (moist) at 14.5° and 779.5 mm. N=9.46.

0.1398 „ 0.1800 AgCl. Cl=31.85.

0.3245 „ 0.1614 BaSO₄. S=6.83.

C₃H₂N₃Cl₄SAu requires Au=43.68; N=9.31; Cl=31.48; S=7.09 per cent.

When quite dry, thiazole-2-diazonium chloride was stable at the ordinary temperature. It melted and decomposed at 122°.

Thiazoleazo-β-naphthol.—Solutions of thiazolediazonium salts when added to β-naphthol dissolved in ethyl alcohol gave a dull, orange coloration, and after a short time a terra-cotta precipitate, which was readily soluble in alcohol, ether, chloroform, glacial acetic acid, ethyl acetate, or benzene. The product was not easily crystallisable, but was finally obtained in well-defined, dark, brownish-red plates by the slow evaporation of its benzene solution. When treated with cold dilute aqueous sodium hydroxide, the substance partly dissolved, leaving a residue of coppery-red flakes (m. p. 105°); the solution when acidified gave a pale red substance (m. p. 126°). Both fractions gave the same intense lilac coloration with cold concentrated sulphuric acid.

Thiazole-2-azo-β-naphthylamine, prepared by coupling the thiazolediazonium salts with alcoholic β-naphthylamine, is a somewhat uncrystallisable, dark, bluish-red substance (m. p. 135–140°), readily soluble in the ordinary organic media, giving with concentrated sulphuric acid an orange coloration, which assumes an intense magenta colour on dilution.

Thiazole-2-azoacetylacetone. (Formula II.)

The aqueous solution of thiazolediazonium nitrate was added to acetylacetone, and then neutralised with ammonium carbonate, when the compound separated in dull, golden-yellow plates, readily soluble in alcohol or ether, and melting at 120° :

0.0440 gave 7.5 c.c. N_2 (dry) at 16° and 760 mm. $N = 20.01$.

$C_8H_9O_2N_3S$ requires $N = 19.90$ per cent.

The substance was practically insoluble in water, and was partly decomposed on prolonged boiling with organic solvents.

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