

152. *Aminobenzthiazoles. Part XIII. The Nature of the Bromo-addition Compounds of the 5-Bromo-1-alkylaminobenzthiazoles obtained from s-p-Bromophenylalkylthioureas and Bromine.*

By M. ALIAZAM, R. F. HUNTER, and NOOR AHMAD KHAN.

THE bromo-addition compounds of 5-bromo-1-alkylaminobenzthiazoles obtained by bromination of *s-p*-bromophenylalkylthioureas and assumed to be nitrogen bromides of the type >NBr_2 (Hunter and Soyka, J., 1926, 2958) were later shown to be hydroperbromides (Dyson, Hunter, and Soyka, J., 1929, 458; Hunter, J., 1930, 125; Hunter and Jones, *ibid.*, p. 2190). The alleged dibromides of the 5-bromo-1-alkylaminobenzthiazoles are actually *hydrodibromides*, analogous to the hydrodibromide of 1-aminobenzthiazole for which a formula containing a $[\text{Br}_2]^\ominus$ anion, involving a singlet link, was suggested (Hunter, *loc. cit.*). 1-Aminobenzthiazole hydrodibromide, examined in Professor Bhatnagar's laboratory at Lahore, failed, however, to exhibit the paramagnetism to be anticipated on the basis of an odd-electron structure. The hydrodibromides of the

1-aminobenzthiazoles are therefore probably complexes of the type $[\text{Base}, \text{H}]_2 \overbrace{\text{Br}^\ominus \text{Br}_2^\oplus \text{Br}^\ominus}$.

Two forms of a dibromide of the 5-bromobenzthiazole obtained from *s-p*-bromophenyl-

ethylthiourea were described in 1926, to which formulæ of the type $\cdot\text{NBr}_2\cdot\dot{\text{C}}\cdot\text{NHEt}$ and $\cdot\text{N}[\text{H}]\text{Br}_2\cdot\dot{\text{C}}\cdot\text{NEt}$ were assigned. Since the dibromides are now known to be bromine complexes of amidine salts, and the anions of triad systems of this type are electromeric (Burtles and Pyman, J., 1923, 123, 362), the original explanation of the phenomenon and the related deductions in connexion with the addition of bromine to nascent tautomeric systems are invalid. A reinvestigation of the bromination of the ethylthiourea under a variety of conditions has shown that there are several hydroperbromides of the 5-bromo-1-ethylamino-derivative. The product usually isolated without precautions is the original and more difficultly fusible hydrodibromide, which is also obtained by bromination of the hydrobromide of the base. When the bromination mixture is suddenly cooled, however, a labile *hydrotribromide* separates, which decomposes into bromine and the hydrodibromide on being heated just below its melting point in a vacuum, or when kept in an evacuated desiccator over potassium hydroxide. On the other hand, if the warm solution is concentrated under reduced pressure, a more stable *hydrotribromide* is obtained whose properties correspond closely to those of the alleged second dibromide described in 1926, which differs from the labile hydrotribromide in that it does not yield the hydrodibromide on pyrolysis. In the presence of a large excess of the halogen, an unstable *hydropentabromide* of 5-bromo-1-ethylaminobenzthiazole is also isolable.

EXPERIMENTAL.

5-Bromo-1-ethylaminobenzthiazole Hydrodibromide.—(i) 0.5 G. of *s-p*-bromophenylethylthiourea (m. p. 135°) in chloroform (4 c.c.) was treated with bromine (0.6 c.c. in 1 c.c. of chloroform), and the mixture heated under reflux on a water-bath for 10 minutes. The solution was kept in a desiccator over-night; the *hydrodibromide*, which crystallised in small yellow prisms, was crushed on porous earthenware and dried in a vacuum over potassium hydroxide, paraffin wax, and anhydrous calcium chloride; m. p. 240—245° (decomp., sintering at 200—220°) [Found: Br (total), 57.4; Br (labile), 19.0. $\text{C}_9\text{H}_9\text{N}_2\text{BrS}\cdot\text{HBr}(\text{Br})$ requires Br (total), 57.3; Br (labile), 19.1%].* This is the most stable bromo-addition compound of the series, although it shows appreciable decomposition on being kept over potassium hydroxide in a desiccator for some days. This is attributable to hydrolysis by traces of moisture, since no decomposition occurred when the desiccator contained fresh phosphoric oxide in addition to potassium hydroxide. (ii) Excess of dry hydrogen bromide was passed through a solution of 5-bromo-1-ethylaminobenzthiazole (m. p. 159°) (1 g.) in chloroform (10 c.c.), which was thereafter treated with bromine and concentrated in a vacuum [Found: Br (total), 57.4; Br (labile), 19.0%].

Labile 5-Bromo-1-ethylaminobenzthiazole Hydrotribromide.—The ethylthiourea (1 g.) in chloroform (8 c.c.) was treated with bromine (1 c.c. in 2 c.c. of the same solvent), the mixture heated for 10 minutes and then suddenly cooled in ice; the *hydrotribromide* crystallised in small orange-yellow prisms, m. p. 105° (sintering at 100°) [Found: Br (total), 63.7; Br (labile), 32.0. $\text{C}_9\text{H}_9\text{N}_2\text{BrS}\cdot\text{HBr}(\text{Br}_2)$ requires Br (total), 64.3; Br (labile), 32.1%]. When kept over potassium hydroxide in a desiccator for 50 hours, it lost bromine, yielding the hydrodibromide, m. p. 243° [Found: Br (labile), 19.0%]. *Thermal dissociation.* Freshly prepared hydrotribromide, whose purity was checked by m. p. and analysis, was placed in a dry flask in series with a closed mercury manometer and an oil pump, and heated in an oil-bath at 90°. The apparatus was then exhausted to 15 mm.; bromine was rapidly evolved during 2 minutes. The product consisted of a fine crystalline specimen of the hydrodibromide, m. p. 250° [Found: Br (labile), 18.9%].

Stable 5-Bromo-1-ethylaminobenzthiazole Hydrotribromide.—The experiment was carried out as in the case of the labile isomeride with the exception that the warm bromination mixture was concentrated in a vacuum instead of being cooled; the hydrotribromide crystallised in large orange-red rhombic crystals, m. p. 140° (decomp.) [Found: Br (total), 64.1; Br (labile), 32.2%].

5-Bromo-1-ethylaminobenzthiazole hydropentabromide, isolated in an experiment similar to the preceding in which a larger quantity of bromine was used (1.3 c.c.) and heating was continued for 12 minutes, formed small, unstable, deep red crystals, m. p. 65° [Found: Br (total), 72.3; Br (labile), 48.2. $\text{C}_9\text{H}_9\text{N}_2\text{BrS}\cdot\text{HBr}(\text{Br}_4)$ requires Br (total), 72.9; Br (labile), 48.6%].

* Labile bromine was estimated by iodometric titration of the bromides in chloroform with *N*/20-sodium thiosulphate. The curious results obtained earlier (*loc. cit.*) were due to the use of acetic acid as solvent, which itself liberates iodine from aqueous potassium iodide in amounts varying with the speed of determination and the intensity of the light in the laboratory.

Bromination of 5-Bromo-1-ethylaminobenzthiazole.—Owing to the closeness of the m. p. of the product of bromination of 5-bromo-1-ethylaminobenzthiazole with that of the hydrodibromide, it was originally supposed by Hunter and Soyka (*loc. cit.*) that the thiazole base gave rise to this "dibromide," since no analysis was made of the product. Actually the orange bromo-addition compound, m. p. 190° (decomp.), obtained by treatment of a solution of 5-bromo-1-ethylaminobenzthiazole in chloroform (0.5 g. in 7 c.c.) with bromine (0.6 c.c.) at 0° consisted of a *hydrotribromide* of 3(?) : 5-dibromo-1-ethylaminobenzthiazole, contaminated by a small amount of a bromo-addition compound of the 5-bromo-1-ethylamino-base [Found : Br (total), 69.9; Br (labile), 30.0. $C_9H_8N_2Br_2S \cdot HBr(Br_2)$ requires Br (total), 69.6; Br (labile), 27.9%]. On reduction with sulphurous acid and sulphur dioxide, basification with ammonia, and recrystallisation from methyl alcohol it yielded the *dibromoethylaminobenzthiazole*, m. p. 156—157° (Found : Br, 47.1. $C_9H_8N_2Br_2S$ requires Br, 47.6%).

5-Bromo-1-n-propylaminobenzthiazole Hydrodibromide.—(i) The specimen prepared from *s-p*-bromophenyl-*n*-propylthiourea as in the case of the ethyl derivative had m. p. 146—147° [Found : Br (total), 56.0; Br (labile), 17.7. $C_{10}H_{11}N_2BrS \cdot HBr(Br)$ requires Br (total), 55.6; Br (labile), 18.4%], and its composition was not appreciably altered by recrystallisation from dry chloroform under reduced pressure at laboratory temperature [Found : Br (total), 55.8; Br (labile), 17.6%]. (ii) *5-Bromo-1-n-propylaminobenzthiazole hydrobromide*, m. p. 224°, was prepared by treating a solution of the base in absolute alcohol (1 g. in 15 c.c.) with hydrobromic acid (66%, 3 c.c.), the solution being concentrated in a vacuum after being boiled for 1 minute (Found : Br', 22.5. $C_{10}H_{11}N_2BrS \cdot HBr$ requires Br', 22.3%). A suspension of this salt in warm chloroform (1.2 g. in 8 c.c.) was treated with bromine (1 c.c. of a 10% solution in the same solvent) and the clear solution was boiled for a minute and concentrated under reduced pressure at laboratory temperature; the hydrodibromide then crystallised, m. p. 146° [Found : Br (total), 55.8; Br (labile), 17.5%].

5-Bromo-1-n-butylaminobenzthiazole Hydrodibromide.—(i) The specimen obtained from *s-p*-bromophenyl-*n*-butylthiourea crystallised in yellow needles, m. p. 150° [Found : Br (total), 54.1; Br (labile), 16.9. $C_{11}H_{13}N_2BrS \cdot HBr(Br)$ requires Br (total), 53.8; Br (labile), 17.9%], whose composition was unaltered by recrystallisation from cold dry chloroform [Found : Br (total), 54.1; Br (labile), 16.9%]. (ii) *5-Bromo-1-n-butylaminobenzthiazole hydrobromide* crystallised in small needles, m. p. 194° (Found : Br', 21.6. $C_{11}H_{13}N_2BrS \cdot HBr$ requires Br', 21.9%). The hydrodibromide obtained from the bromination of this salt had m. p. 150° [Found : Br (total), 54.1; Br (labile), 17.0%].

5-Bromo-1-isobutylaminobenzthiazole Hydrodibromide.—*s-p*-Bromophenylisobutylthiourea (1 g.) in chloroform (8 c.c.) was treated with bromine (1 c.c. in 1 c.c. of chloroform) and the solution was heated for 10 minutes and concentrated under reduced pressure. The crystals which first separated probably consisted of a labile form, since they redissolved on being stirred in the mother-liquor (compare Dyson, Hunter, Jones, and Styles, *J. Indian Chem. Soc.*, 1931, 8, 165), giving a solution which on further concentration yielded an orange *hydrotribromide* of 5-bromo-1-isobutylaminobenzthiazole, m. p. 80° [Found : Br (total), 59.5; Br (labile), 28.3. $C_{11}H_{13}N_2BrS \cdot HBr(Br_2)$ requires Br (total), 60.1; Br (labile), 30.05%]. This compound was also obtained in an experiment in which the bromination mixture was allowed to crystallise in a basin without any precautions [Found : Br (labile), 28.2%]. When kept over potassium hydroxide for 2 days, it lost bromine, yielding the stable "dibromide" of Hunter and Soyka, m. p. 126—127° [Found : Br (total), 53.2; Br (labile), 17.2%]. The 5-bromo-1-isobutylamino-base obtained by reduction of this was finally obtained from methyl alcohol in small crystals, m. p. 147° (previously recorded as 137°).

5-Bromo-1-isoamylaminobenzthiazole hydrodibromide, obtained as in the case of the isobutyl derivative from the decomposition of an unstable hydroperbromide (m. p. 66—67°) which was not investigated, had m. p. 111—112° [Found : Br (total), 51.8; Br (labile), 16.2. $C_{12}H_{15}N_2BrS \cdot HBr(Br)$ requires Br (total), 52.2; Br (labile), 17.4%].

5-Bromo-1-isoamylaminobenzthiazole.—The product previously obtained by decomposition of the impure hydrodibromide was contaminated with resinous matter and obviously impure (*loc. cit.*). By careful and complete reduction of the hydrodibromide with sulphurous acid, and recrystallisation from methyl alcohol, the *isoamylamino*-base was obtained in small needles, m. p. 131—132° (Found : Br, 27.0. Calc. : Br, 26.7%).