XVII.—*The Constitution of the Supposed* N-*Methylenesulphurous Acid Derivative of Amines. Part I. Oxidation by an Alkaline Solution of Iodine.*

By GEORGE NEWBERY and MONTAGUE ALEXANDRA PHILLIPS.

DISODIUM 3 : 3′-diamino-4 : 4′-dihydroxyarsenobenzene-*NN′*-dimethylenesulphite prepared by the action of excess of formaldehyde and sodium bisulphite on 3 : 3′-diamino-4 : 4′-dihydroxyarsenobenzene (salvarsan) is known by American chemists as " sulpharsphenamine " and its preparation and properties together with those of the corresponding acid have been described by Voegtlin and Johnson (*J. Amer. Chem. Soc.*, 1922, **44**, 2573) and by Christiansen (*ibid.*, 1923, **45**, 2182). The corresponding disodium 3 : 3′-diamino-4 : 4′-dihydroxyarsenobenzene-*NN′*-dimethylenesulphoxylate is said (D.R.-P. 245756) to result on heating an aqueous suspension of salvarsan base with excess of sodium formaldehydesulphoxylate (rongalite) on the water-bath. When a similar method is applied with the replacement of rongalite by sodium formaldehydebisulphite, it appears that mono- or di-*N*-methylenesulphurous acid substitution products, or a mixture of these, result according to conditions of temperature and to the amount of the reagent present in excess. A reaction mixture so prepared at 60° with an excess of sodium formaldehydebisulphite, when filtered and poured into alcohol, yields a sodium salt which in its chemical behaviour as well as in its pharmacological action differs from that described by Voegtlin and Johnson (*loc. cit.*). A characteristic qualitative distinction is afforded by the action of 2*N*-hydrochloric acid, which causes the immediate precipitation of the corresponding acid in the first case, but not in the latter, the alleged acid * described by these authors as precipitated from the sodium salt by glacial acetic acid being soluble both in water and in 2*N*-hydrochloric acid.

A chemical method for distinguishing substances of the type of neosalvarsan from sulpharsphenamine has recently been described by Elvove (*U.S. Public Health Reports*, June 12, 1925), and is based on the observation that the sulphur in the former is oxidised by iodine in alkaline solution to sulphate and can be precipitated quantitatively as barium sulphate, whereas the combined sulphur in products of the latter type is not so oxidised. It is now shown that the same distinction holds between the two sodium salts above mentioned, the whole of the sulphur in the product of the action of sodium formaldehydebisulphite on salvarsan base being oxidisable by iodine in alkaline solution.

It was found that although 4 : 4′-diaminoarsenobenzene yields analogous products by similar methods, the sulphur in both is completely oxidised and is precipitated quantitatively as barium sulphate under the conditions laid down by Elvove.

These observations have led to the investigation of a number of amino-derivatives from this point of view. In each case the hydrochloride of the base was treated with two molecular proportions of formaldehyde and of sodium bisulphite for each amino-group and the total sulphur and the amount of sulphur oxidised under the Elvove conditions were determined in aliquot portions of the reaction mixture. In the case of those bases which gave positive results the arsenic content (or in the case of 2-aminophenol, the nitrogen content) of the solution was checked by estimation in a further aliquot part. The results obtained are tabulated below.

Total S (g.) calculated from total S determination in aliquot portion = *a*.
Oxidised S (g.) calculated from S found in aliquot portion after oxidation under Elvove conditions = *b*.

Substance (0·001 g.-mol.).	*a*.	*b*.	Non-oxidised S, *a*—*b*.	Atomic ratio, Non-oxidised S : As.
Aniline	0·063	0·065	—	—
2-Aminophenol	0·065	0·046	0·019	—
3-Aminophenol	0·061	0·061	—	—
4-Aminophenol	0·060	0·061	—	—
2-Anisidine	0·064	0·062	—	—

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* In our opinion the product precipitated was the sodium salt and not the acid. The acid is apparently a strong one and its sodium salt is not decomposed by acetic acid.

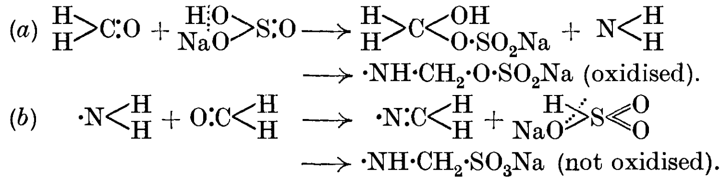
Substance (0·001 g.-mol.).	*a.*	*b.*	Non-oxidised S, *a*—*b*.	Atomic ratio, Non-oxidised S : As.
4-Aminophenylarsinic acid	0·064	0·064	—	—
3 - Amino - 4 - hydroxyphenylarsinic acid	0·064	0·034	0·030	0·95
4 - Amino - 3 - hydroxyphenylarsinic acid	0·063	0·030	0·033	1·03
4 - Amino - 2 - hydroxyphenylarsinic acid	0·056	0·055	—	—
5 - Amino - 2 - hydroxyphenylarsinic acid	0·059	0·059	—	—
2 - Amino - 4 - hydroxyphenylarsinic acid	0·063	0·064	—	—
3 -Amino - 4 - methoxyphenylarsinic acid	0·062	0·061	—	—
4-Aminoarsenobenzene	0·062	0·059	—	—
4 : 4′-Diaminoarsenobenzene *	0·128	0·135	—	—
3-Amino - 4 - hydroxyarsenobenzene	0·051	0·021	0·030	0·47
3 : 3′ - Diamino - 4 : 4′ - dihydroxy-arsenobenzene	*0·135	0·067	0·068	1·06
	†0·202	0·131	0·071	1·11
	‡0·283	0·215	0·068	1·06
4 : 4′ - Diamino-3 : 3′ - dihydroxy-arsenobenzene *	0·128	0·060	0·066	1·03
5 : 5′ - Diamino - 2 : 2′ - dihydroxy-arsenobenzene *	0·127	0·127	—	—
3 : 3′ - Diamino - 4 : 4′ - dimethoxy-arsenobenzene *	0·127	0·125	—	—

Two mol. proportions of formaldehyde were used in all cases except those marked * (4 mols.), † (6 mols.), and ‡ (8 mols.).

It will be seen that the combined sulphur is unoxidised by iodine in alkaline solution under the Elvove conditions only in the compounds that contain an *o*-aminophenol group. Except in the case of *o*-aminophenol, the atomic ratio of combined sulphur, so determined, to nitrogen approximates to unity. In confirmation of this, experiments with salvarsan were made not only with four molecular proportions each of formaldehyde and sodium bisulphite but with six and with eight proportions of each reagent. The ratio of combined sulphur to nitrogen remained unaffected.

The conclusion is thus forced upon us that, at least from those bases which contain the *o*-aminophenol group, different and apparently isomeric sulphur acids are capable of being formed according to whether the addition of sodium bisulphite is made to the $:CH_2$ complex before or after condensation with the amino-group of the base.

A common type of sulphur linkage which is not readily susceptible to oxidation (and is not, indeed, affected by oxidation under the Elvove conditions) is that of the sulphonic and sulphinic acids, *i.e.*, a direct linkage of carbon with sulphur. It might therefore be assumed that sodium bisulphite reacts in a tautomeric manner in the two cases, thus :



$$(a)\quad {}^{H}_{H}\!>\!C{:}O + {}^{H\,\vdots\,O}_{NaO}\!>\!S{:}O \longrightarrow {}^{H}_{H}\!>\!C\!<\!{}^{OH}_{O\cdot SO_2Na} + N\!<\!{}^{H}_{H}$$
$$\longrightarrow \cdot NH\cdot CH_2\cdot O\cdot SO_2Na \text{ (oxidised).}$$
$$(b)\quad \cdot N\!<\!{}^{H}_{H} + O{:}C\!<\!{}^{H}_{H} \longrightarrow \cdot N{:}C\!<\!{}^{H}_{H} + {}^{H}_{NaO}\!>\!S\!\leqslant\!{}^{O}_{O}$$
$$\longrightarrow \cdot NH\cdot CH_2\cdot SO_3Na \text{ (not oxidised).}$$

It would appear, however, that more than this is involved in the problem, since, unlike compounds of the sulphonic or sulphinic acid type, the sulphur derivatives here described as being resistant to oxidation are very susceptible to the action of hydrolytic agents. Indeed the isolation in a state of purity of either di-sulphur acid in question presents difficulties which have so far proved insurmountable, so that direct proof of isomerism is at present lacking.

The evidence afforded by oxidation by alkaline iodine shows, we think conclusively, the disubstituted nature of the sulpharsphenamine type of product. That the product of the action of two molecules of sodium formaldehydebisulphite on salvarsan base is not merely a mixture of the monosubstituted product with the excess of the reagent is readily demonstrated by marked qualitative differences from such a mixture, differences which, however, disappear after very mild acid hydrolysis.

Moreover, mild acid hydrolysis of a disubstituted product of the type of sulpharsphenamine leads to the formation of a monosubstituted derivative of apparently the same type as that obtained by the action of sodium formaldehydebisulphite on the corresponding base. In no case is such a product of hydrolysis found to contain any appreciable amount of sulphur which remains unoxidised under the Elvove conditions.

Further, there seems no obvious reason why the proximity of the hydroxy-group should have such an effect on the mechanism of combination. Ring formation of some kind would consequently appear to be involved.

We have also to bear in mind that the commonly accepted view of the constitution of sodium formaldehydebisulphite and of sodium formaldehydesulphoxylate as substances containing sulphur linked to carbon through oxygen has recently been called into question by Raschig (*Ber.*, 1926, **59**, 859). Binz (*ibid.*, p. 1695), on the other hand, points out that many of the chemical properties of sodium formaldehydesulphoxylate are better explained by assuming the ${:}C{-}O{-}S{:}$ formula. There appears to be good grounds for considering both these compounds to be tautomeric in their chemical behaviour.

We have thus at present no completely satisfactory explanation to offer for these observations, but it is hoped in future communications to examine more closely some individual cases of this apparent isomerism.

EXPERIMENTAL.

The methods used for the preparation of the following compounds call for some note.

4-*Aminoarsenobenzene.*—A solution of 4-aminophenylarsinic acid (4·4 g.) and phenylarsinic acid (4·0 g.) in saturated sodium carbonate solution (20 c.c.) was added to an ice-cold solution of magnesium chloride hexahydrate (10 g.) and sodium hyposulphite (40 g.) in water (600 c.c.). The solution was treated with charcoal, filtered, and heated for 2 hours at 30—40° (yield, 4 g.; 62%) (Found: As, 46·8; N, 4·4. $C_{12}H_{11}NAs_2$ requires As, 47·0; N, 4·4%).

4-*Aminoarsenobenzene* was a light yellow powder insoluble in dilute acids and alkalis and in methyl alcohol and the usual organic solvents. It was converted by grinding with methyl-alcoholic hydrochloric acid into a *monohydrochloride*, which was insoluble in water (Found: As, 38·4; Cl, 9·5. $C_{12}H_{11}NAs_2,HCl,2H_2O$ requires As, 38·4; Cl, 9·1%). That this hydrochloride was not a mixture of 4 : 4′-diaminoarsenobenzene and arsenobenzene was shown by the fact that complete solution was obtained by suspension in water and treatment with formaldehyde and sodium bisulphite. No such solution could be obtained with arsenobenzene prepared by the reduction of phenylarsinic acid.

4 : 4′-Diaminoarsenobenzene was prepared in a similar manner (4-aminophenylarsinic acid, 9·2 g., in a slight excess of 2*N*-sodium carbonate; magnesium chloride hexahydrate, 5 g.; sodium hyposulphite, 40 g.; ice-water, 500 c.c.), the solution being finally heated for 1½ hours at 55—60° (yield, 4 g.; 56%) (Found: As, 44·9; N, 8·6%). The product was insoluble in the theoretical amount of very dilute hydrochloric acid. On the other hand, the base prepared by hypophosphorous acid reduction (Kashima, *J. Amer. Chem. Soc.*, 1925, **47**, 2207) was readily soluble in dilute hydrochloric acid, and the hydrochloride precipitated by the addition of 2*N*-hydrochloric acid in excess was still soluble in water after being dried in a vacuum (Found: As, 33·7; Cl, 15·9; N, 6·4. Calc. for dihydrate: As, 33·9; Cl, 16·0; N, 6·3%).

3-Amino-4-hydroxyarsenobenzene was prepared from 3-amino-4-hydroxyphenylarsinic acid (5·8 g.) and phenylarsinic acid (5 g.) by reduction with sodium hyposulphite (50 g.) and magnesium chloride hexahydrate (10 g.) in 500 c.c. of water for 2 hours at 60° (yield, 5 g.; 60%) (Found: As, 44·6; N, 4·1%). The yellow base was soluble in 2*N*-sodium hydroxide and, although not readily soluble in 2*N*-hydrochloric acid, was converted by suspension in methyl alcohol, addition of alcoholic hydrochloric acid and finally of ether into a soluble hydrochloride (Found: As, 36·6; Cl, 8·8. Calc. for the monohydrochloride dihydrate: As, 36·8; Cl, 8·7%).

4-Amino-2-hydroxyphenylarsinic acid was prepared by a method essentially that since described by Hewitt and King (J., 1926, 822). No difficulty, however, was experienced in the isolation of the crude mixture of nitroethenyl-*o*-aminophenols when the nitration of ethenyl-*o*-aminophenol was carried out as follows: 100 g. of the fraction, b. p. 190—210°, from the preparation of ethenyl-*o*-aminophenol (Ladenburg, *Ber.*, 1876, **9**, 1524) were added to sulphuric acid (*d* 1·84; 500 c.c.), the temperature being allowed to rise to 60—70°. The cooled mixture was then nitrated at 10—20° by the slow addition (2½—3 hours) of a mixture of nitric acid (*d* 1·42; 60 c.c.) and sulphuric acid (*d* 1·84; 60 c.c.) with mechanical stirring. Completion of nitration was shown by the absence of the characteristic smell of the unchanged material on dilution with water. The bulk was poured on ice, washed free from acid, and dried at 90°.

The crude 5-*nitroethenyl*-o-*aminophenol* (111 g. = 90%; m. p. 145°) was very susceptible to hydrolytic agents and was not readily purified, repeated crystallisation from organic solvents such as acetic anhydride, alcohol, or acetone giving colourless, ill-defined needles of m. p. 150—151°, which was not raised by further crystallisation (Found: N, 15·8. $C_8H_6O_3N_2$ requires N, 15·7%). The product was not quite free from 4-nitroethenyl-*o*-aminophenol, since on hydrolysis as outlined below some 4-nitro-2-aminophenol always accompanied the main product.

The crude moist product from the above nitration was boiled with 400 c.c. of hydrochloric acid (*d* 1·16) until dissolved, sodium acetate was then added, and the precipitate thus formed was washed thoroughly with water, which removed the bulk of the 4-nitro-2-aminophenol. The residue of 5-nitro-2-aminophenol (m. p. 202° after crystallisation from hot water) was converted into 4-nitro-2-hydroxyphenylarsinic acid by the Bart method according to the details given by Lewis and Cheetham (*J. Amer. Chem. Soc.*, 1921, **43**, 2119) for *p*-carboxyphenylarsinic acid (yield, 62%) (Found: As, 28·4%). Reduction by the method of Jacobs, Heidelberger, and Rolf (*J. Amer. Chem. Soc.*, 1918, **40**, 1580) using ferrous sulphate then gave the same yield (84%) of 4-amino-2-hydroxyphenylarsinic acid as that recorded by Hewitt and King (*loc. cit.*) (Found: As, 32·2; N, 6·1%).

The corresponding arseno-base could not be obtained by the usual hyposulphite or hypophosphorous acid method owing to extremely ready de-arsenication with the production of polyarseno-compounds (compare Hewitt and King, *loc. cit.*).

5-*Amino-2-hydroxyphenylarsinic Acid.*—5-Nitro-2-hydroxyphenylarsinic acid prepared by Bart's method (*Annalen*, 1922, **429**, 97) from technical 4-nitro-2-aminophenol or by nitration of 2-hydroxyphenylarsinic acid (Keimatsu and Kakinuma, *J. Pharm. Soc. Japan*, 1925, No. 520, 2) was reduced according to the following details : To a solution of the acid (100 g.) in water (250 c.c.) and 2*N*-caustic soda (200 c.c.), ice (200 g.) was added, followed by sodium hyposulphite (240 g.), the temperature being below 10°. After 30 minutes' stirring, the solid was filtered off, washed, and purified as described by Christiansen for 3-amino-4-hydroxyphenylarsinic acid (*J. Amer. Chem. Soc.*, 1920, **42**, 2403). Yield, 50 g. (60%) (Found : As, 32·0%).

3-Hydroxy-4-aminophenylarsinic acid could not be readily obtained by Benda's method (*Ber.*, 1911, **44**, 3579) and was prepared as follows : 5-Nitroethenyl-*o*-aminophenol (10 g.) was slowly dusted into a boiling mixture of glacial acetic acid (5 c.c.), fine iron powder (12 g.), and water (30 c.c.). The hot mixture was made alkaline to phenolphthalein with 2*N*-sodium carbonate and diluted to 100 c.c. with boiling water. The combined filtrate and washings from the iron oxides were concentrated to 50 c.c. under reduced pressure; on cooling, 5-*aminoethenyl*-o-*aminophenol* (4 g.; 50% yield) crystallised in diamond-shaped plates, moderately easily soluble in cold water and readily soluble in dilute mineral acids. Purified by reprecipitation by sodium acetate from hydrochloric acid solution, it had m. p. 147° (Found : N, 18·8. $C_8H_8ON_2$ requires N, 18·9%). Its orientation was confirmed by the fact that hydrolysis by boiling 2*N*-hydrochloric acid, followed by acetylation, led quantitatively to an acetyl derivative, m. p. 260° (Found : N, 13·7%), identical with 2 : 5-diacetamidophenol prepared by the reduction of pure 5-nitro-2-aminophenol, followed by acetylation (Kehrmann and Betsch, *Ber.*, 1897, **30**, 2099).

4-Acetamido-3-hydroxyphenylarsinic acid was made from the foregoing aminoethenyl derivative by the Bart method; the yield was poor (10%). The compound crystallises in characteristic needles, and is insoluble in cold water and in dilute mineral acids (Found : As, 27·2; N, 5·1%). On hydrolysis with hot 20% sodium hydroxide solution, followed by acidification with acetic acid, it gave 4-amino-3-hydroxyphenylarsinic acid in 90% yield; this, purified by the Christiansen method (*loc. cit.*), crystallised in short, stout prisms (Found : As, 32·4; N, 6·0%). It differed from 3-amino-4-hydroxyphenylarsinic acid in giving a green instead of a red coloration with chromic acid and in its lower basicity. Thus at comparable dilutions 1 mol. of 3-amino-4-hydroxy-, 2-amino-4-hydroxy-, and 4 amino-3-hydroxy-phenylarsinic acids respectively required approximately 4, 8, and 12 mols. of hydrochloric acid for complete solution. The same properties were shown by the product obtained from 5-aminobenzoxazolone by the Bart method, followed by alkaline hydrolysis (Amer. Patent 1539799/1924).

4 : 4′-Diamino-3 : 3′-dihydroxyarsenobenzene was prepared by a slight modification of the method suggested by Benda (*loc. cit.*). The alkaline solution of the purified β-naphthol dye was treated at 0—5° with sufficient sodium hyposulphite to discharge the colour of the solution, which was then saturated with carbon dioxide. After removal of 1-amino-2-naphthol, the filtrate was reduced with a 50% excess of sodium hyposulphite for 2 hours at 60°.

The arseno-compound was converted into its hydrochloride in methyl alcohol and precipitated by ether. It was readily soluble in water (Found : As, 31·0 ; N, 5·7 ; Cl, 14·0. Calc. for dihydrate : As, 31·6 ; N, 5·9 ; Cl, 14·9%).

2-Amino-4-hydroxyphenylarsinic acid was prepared according to the scheme outlined by Fourneau (*Ann. Inst. Pasteur*, 1923, **37**, 576). 3-Nitro-4-aminophenol gave by the Bart method 2-nitro-4-hydroxyphenylarsinic acid (50%), which on reduction (Jacobs, Heidelberger, and Rolf, *loc. cit.*) gave the required amino-acid (yield, 80%) (Found: As, 32·4 ; N, 6·1%).

The corresponding arseno-base, like that from 2-hydroxy-4-aminophenylarsinic acid above, was not readily obtained by the ordinary methods of reduction, owing to the readiness with which de-arsenication occurred.

General Method of Examination.—The hydrochloride (0·001 g.-mol.) of the base under examination was dissolved in water (5 c.c.) or alternatively an equivalent amount of the base dissolved in the minimum of hydrochloric acid was made up to about 5 c.c. 4% Formalin solution (1·5 c.c., *i.e.*, 2 mols. per 1 at. of amino-nitrogen) was added and then after the lapse of 60 seconds * a solution of sodium bisulphite (0·208 g. ; 2 mols. per 1 at. of amino-nitrogen). In certain cases, particularly those of arseno-compounds, precipitation of a yellow product ensued which rapidly re-dissolved on shaking. After 30 minutes, the solution so obtained was diluted to 100 c.c. and aliquot portions were taken for the determinations detailed below.

The above amounts are those for mono-acid bases ; the quantities of the reagents were doubled for the di-acid bases. For 3 : 3′-diamino-4 : 4′-dihydroxyarsenobenzene, the proportions of the reagents were varied, 4, 6, and 8 mols. each of formaldehyde and of

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* In the case of 3-amino-4-hydroxyarsenobenzene only 15 seconds were allowed, as otherwise the subsequent dissolution of the solid precipitated on the addition of the sodium bisulphite was difficult to accomplish.

sodium bisulphite being employed in three separate experiments. As the ratio of arsenic to non-oxidisable sulphur remained approximately constant, it was assumed that 2 mols. of the reagents per 1 at. of amino-nitrogen was a sufficient excess in all cases for the completion of the reaction.

Nitrogen was determined, in the case of the examination of 2-aminophenol, by the Kjeldahl method, 25 c.c. of the solution being employed.

Arsenic was estimated in 25 c.c. of the solution by the ammonium persulphate method described by one of us (J., 1925, **127**, 1751).

Total sulphur was determined in 25 c.c. by evaporation and fusion with a eutectic mixture of sodium and potassium carbonates (4 parts) and potassium nitrate (1 part), followed by precipitation of the sulphur as barium sulphate. An experimental correction for adsorbed salts was applied (compare Christiansen, *J. Amer. Chem. Soc.*, 1922, **44**, 853). This determination was made as a check on the amount of sulphur introduced as sodium bisulphite.

Oxidised sulphur. 50 C.c. of the solution were estimated by Elvove's method (*loc. cit.*), excess of 0·1*N*-iodine (75 c.c.) being added, followed by 10 c.c. of 2*N*-sodium hydroxide. After 5 minutes 11 c.c. of 2*N*-hydrochloric acid were added and the excess of iodine was removed by the addition of a 0·05*M*-sodium arsenite solution (50 c.c.). When the solution was completely decolorised, it was further acidified by addition of 2*N*-hydrochloric acid (10 c.c.), and the sulphate in the solution estimated in the usual manner as barium sulphate.

Sodium 4 : 4′-*Diaminoarsenobenzenedimethylenesulphite* (*A*).—Difficulty was experienced in attempts to repeat the details of the method of Kashima (*J. Amer. Chem. Soc.*, 1925, **47**, 2208), the product of the action of formalin upon 4 : 4′-diaminoarsenobenzene after isolation being incompletely soluble on the addition of sodium bisulphite. It was found preferable to use a method similar to that of Christiansen (*loc. cit.*). 4 : 4′-Diaminoarsenobenzene (4 g.) made according to Kashima (*loc. cit.*) was suspended in water (30 c.c.) and dissolved by the cautious addition of 2*N*-hydrochloric acid. Formalin (40%, 2·5 c.c.) and, after the lapse of 60 seconds, sodium bisulphite (3·25 g.) in water (5 c.c.) were then added to the suspension of the formaldehyde compound. Solution was quickly effected, and the mixture was then shaken with charcoal, filtered, and precipitated in 500 c.c. of spirit. The product, after being washed with spirit and dried in a vacuum over sulphuric acid (yield, 5 g.), was dark yellow and soluble in water. A 10% solution was not precipitated by an equal volume of 2*N*-hydrochloric acid even after some hours' standing, nor did it decolorise a hot solution of indigo-carmine (Found : As, 25·3 ; N, 4·0 ; total S, 12·8 ; S by the Elvove oxidation method, 13·1%. As : N : S=1 : 0·87 : 1·19).

Sodium 4 : 4′-*Diaminoarsenobenzenedimethylenesulphite* (*B*).—The moist base obtained by hypophosphorous acid reduction of 4-aminophenylarsinic acid (8 g.) was ground with sodium formaldehydebisulphite (5 g.) and water (25 c.c.). The mixture was heated at 60° for 2½ hours, and the turbid solution filtered through kieselguhr and precipitated by pouring into spirit (500 c.c.). The light yellow product was filtered off, washed, and dried as before (3 g.). (Found : As, 25·2 ; N, 4·7 ; total S, 10·1 ; S by the Elvove oxidation method, 10·3%. As : N : S = 1 : 1·0 : 0·94). It was readily soluble in water. A 10% solution did not decolorise hot indigo-carmine solution, but was precipitated after a just perceptible delay by the addition of an equal volume of 2*N*-hydrochloric acid.

The acid obtained was readily soluble in dilute alkali hydroxide or carbonate : its gelatinous character and ready oxidation in air precluded satisfactory analysis.

Sodium 3 : 3′-*Diamino*-4 : 4′-*dihydroxyarsenobenzene*-NN′-*dimethylenesulphite* (*A*).—A specimen prepared according to Christiansen (*loc. cit.*) gave the following figures : As, 18·0 ; N, 3·3 ; total S, 13·9 ; S by the Elvove oxidation method, 5·3 ; unoxidised S by difference, 8·6%. Atomic ratio, As : N : unoxidised S = 1 : 0·98 : 1·12.

Hydrolysis of the sodium salt. In a solution of 5·0 g. in water (15 c.c.) 2*N*-hydrochloric acid (10 c.c.) caused no precipitation (compare preparation B described below). The mixture was warmed at 60—70° until a sample on cooling deposited a yellow, amorphous solid (5—7 minutes). The whole was cooled and the solid was filtered off after 10 minutes, washed with water, and dried in a vacuum over sulphuric acid (yield, 2·5 g.). The product was freely soluble in alkali hydroxide or carbonate and the solution so obtained was readily precipitated by 2*N*-acetic acid or 2*N*-hydrochloric acid (Found in three preparations : As, 31·0, 31·1, 31·4 ; N, 5·55, 5·95, 5·4 ; total S, 8·0, 7·65, 7·7 ; S by the Elvove oxidation method, 7·2, 6·85, 7·5 ; unoxidised S by difference, 0·8, 0·7, 0·2%. Mean atomic ratio, As : N : total S = 2 : 1·92 : 1·16. $C_{13}H_{14}O_5N_2SAs_2$ requires As, 32·6 ; N, 6·1 ; S, 7·0%).

Sodium 3 : 3′-*Diamino*-4 : 4′-*dihydroxyarsenobenzene*-NN′-*dimethylenesulphite* (*B*).—3 : 3′-Diamino-4 : 4′-dihydroxyarsenobenzene obtained from 3-amino-4-hydroxyphenylarsinic acid (50 g.) by the usual hyposulphite reduction method was, without being dried, ground to a paste with a solution of sodium formaldehydebisulphite (30 g.) in water (250 c.c.). The mixture was heated at 60° until solution was effected (about 3 hours), filtered, and precipitated by pouring it into 3 litres of spirit. The product was washed and dried in a vacuum (yield, 37 g.) (Found : As, 25·2; N, 4·7; total S, 10·1; S by the alkaline oxidation method, 10·3%. As:N:S = 1:1·0:0·91). A solution in water was not precipitated by an equal volume of 2*N*-acetic acid and did not decolorise a hot indigo-carmine solution.

A similar solution, treated with 2*N*-hydrochloric acid (2 parts), gave after a few seconds' delay a voluminous, light yellow precipitate which remained soluble in water (as shown by dilution) for a period of some minutes at the ordinary temperature and for 30—60 minutes at 0°. The insoluble acid formed on standing was apparently identical with that described below under the heading of hydrolysis. All attempts to isolate the soluble acid for analysis proved abortive, even when precipitation, filtration, and washing with *N*-hydrochloric acid were carried out at 0°, the product becoming insoluble when dry. Figures obtained for the insoluble acid in all cases indicated a monosubstituted product.

Hydrolysis of sodium salt. The above product (7 g.) was dissolved in water (20 c.c.), 2*N*-hydrochloric acid added, and the mixture heated in the water-bath. The acid which separated quickly redissolved and sulphur dioxide was evolved. On cooling, a dark yellow product separated which was washed and dried to constant weight in a vacuum (yield, 3 g.) (Found : As, 33·0; N, 5·6; total S, 7·1; S by the Elvove oxidation method, 6·5. Calc. : As, 32·6; N, 6·1; S, 7·0%).

The product was readily soluble in dilute caustic alkali or carbonate solution and the solution so obtained was readily precipitated by 2*N*-acetic acid or hydrochloric acid and did not decolorise hot indigo-carmine solution.

Sodium 3 : 3′-*diamino*-4 : 4′-*dihydroxyarsenobenzene*-N-*monomethylenesulphite* was prepared from 3 : 3′-diamino-4 : 4′-dihydroxyarsenobenzene (6·8 g.) which was heated with a solution of sodium formaldehydebisulphite (2·5 g.) in water (30 c.c.) at 60° with mechanical stirring until solution was almost complete (1—2 hours). After filtration through a kieselguhr bed, the product was precipitated in an excess of alcohol, filtered, washed, and dried in a vacuum. It was readily soluble in water, and the corresponding acid was precipitated by dilute acetic acid, even in presence of excess of sodium formaldehydebisulphite, and by dilute mineral acids. The solution did not decolorise a hot indigo-carmine solution (Found : As, 31·2; N, 5·3; total S, 7·1; S by the alkaline iodine method, 7·0%. As : N : S = 2 : 1·84 : 1·06).

RESEARCH LABORATORY, MESSRS. MAY & BAKER, LTD.
LONDON, S.W. 18.
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