19. *The Action of Sodium Nitrite on Michler's Hydrol in Hydrochloric Acid.*

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Sodium nitrite (4 mols.) reacted with Michler's hydrol (1 mol.) in excess of 4·8N-hydrochloric acid at 0° with production of 4-nitrophenylmethylnitrosoamine, 4-methylnitrosoaminobenzaldehyde, *p*-nitrodimethylaniline, *p*-nitrosodimethylaniline, and 3-nitro-4-dimethylaminobenzaldehyde. Nitric oxide and formaldehyde were liberated. In 1·2N-hydrochloric acid the reaction was fundamentally the same but the relative amounts of the products were altered. The yields of *p*-nitrodimethylaniline and *p*-nitrosodimethylaniline were increased and those of the nitrosoamines were diminished. Equations are put forward to interpret schematically the course of the reaction.

In a previous communication it has been shown that Michler's ketone and the methane base, bisdimethylaminodiphenylmethane, behaved very differently when treated with sodium nitrite in mineral acid solution. The ketone gave nitrosoamines by elimination of a methyl group from the dimethylamino-group of the amine without nuclear nitration or fission of the molecule, whereas the methane base underwent nitrosation at the nitrogen atom, nitration in the benzene nucleus, and simultaneous fission and nuclear nitration, the ratio of the yields of products from the three processes being governed to a large extent by the concentration of mineral acid employed (Donald and Reade, J., 1935, 52; Pinnow, *Ber.*, 1894, **27**, 3867). This study has been extended to bisdimethylaminobenzhydrol, Michler's hydrol, whose formula stands intermediate between those of Michler's ketone and the methane base.

From sodium nitrite (4 mols.) and Michler's hydrol (1 mol.) in excess of 4·8N-hydrochloric acid at 0° the following substances were isolated: 4-nitrophenylmethylnitrosoamine (I), 4-methylnitrosoaminobenzaldehyde (II), *p*-nitrodimethylaniline (III), *p*-nitrosodimethylaniline (IV), and 3-nitro-4-dimethylaminobenzaldehyde (V).

(I.) $NO_2{\cdot}C_6H_4{\cdot}NMe{\cdot}NO$ (II.) $NO{\cdot}NMe{\cdot}C_6H_4{\cdot}CHO$ (III.) $NO_2{\cdot}C_6H_4{\cdot}NMe_2$

(IV.) $NO{\cdot}C_6H_4{\cdot}NMe_2$ (V.) $NMe_2{\cdot}C_6H_3(NO_2){\cdot}CHO$

In 1·2N-hydrochloric acid the reaction was somewhat less vigorous. The yields of *p*-nitrodimethylaniline and *p*-nitrosodimethylaniline were increased and those of the nitrosoamines were diminished. To account for the production of these five substances, two modes of fission of the hydrol hydrochloride are required as suggested in the following schematic equations:

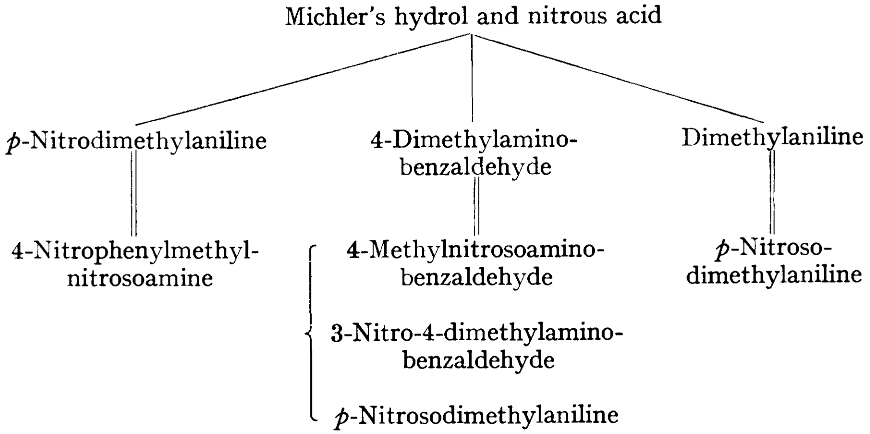
$$a.\ NMe_2{\cdot}C_6H_4{\cdot}CH(OH){\cdot}C_6H_4{\cdot}NMe_2 \longrightarrow NMe_2{\cdot}C_6H_4{\cdot}CHO + C_6H_5{\cdot}NMe_2$$

$$b.\ NMe_2{\cdot}C_6H_4{\cdot}CH(OH){\cdot}C_6H_4{\cdot}NMe_2 + 3HNO_2 \longrightarrow NMe_2{\cdot}C_6H_4{\cdot}CHO + NO_2{\cdot}C_6H_4{\cdot}NMe_2 + 2NO + 2H_2O$$

The products of these equations would then react further with the nitrous acid, according to known reactions, and so give the final substances isolated.

Fission of the hydrol as represented by equation *a* is not in itself an adequate explanation, because this does not account for the presence of *p*-nitrodimethylaniline, unless through the oxidation of *p*-nitrosodimethylaniline which is itself produced from the 4-dimethylaminobenzaldehyde and also from the dimethylaniline. Such oxidation is unlikely, because no *p*-nitrodimethylaniline was detected in experiments where sodium nitrite was added to *p*-nitrosodimethylaniline in 4·8N and in 1·2N-hydrochloric acid. Furthermore the experiments on the hydrol in 1·2N-hydrochloric acid showed that most of the *p*-nitrodimethylaniline was precipitated during the first 5 minutes, and the *p*-nitrosodimethylaniline was formed gradually during 2 hours. Equation *b* is likewise inadequate to represent the complete mode of fission of the hydrol molecule. If it were the only reaction taking place, the weights of 4-dimethylaminobenzaldehyde and of *p*-nitrodimethylaniline, expressed in gram-molecules, would be the same, and the weight of *p*-nitrosodimethylaniline would be less than either because it is one of the products formed from the aldehyde molecule. It was found, however, that the *p*-nitrosodimethylaniline was always in excess, particularly in the more concentrated acid (4·8N). The extent to which fission took place according to the mechanism shown in equation *b* was computed from the weight of *p*-nitrodimethylaniline obtained. Although the experiments do not lend themselves to quantitative estimations, it is evident from the yields obtained that in both acid concentrations fission according to equation *a* accounts for about $\frac{2}{5}$ of the original hydrol and is the main reaction, but that fission according to equation *b* is governed by the normality of the acid and accounts for about $\frac{1}{4}$ of the hydrol in 1·2N-acid and about $\frac{1}{40}$ of the hydrol in 4·8N-acid. Thus $\frac{2}{3}$ of the original hydrol was accounted for as fission products; non-fission products may not be entirely absent from the oils encountered. In the experiments in which nitrosoamines were isolated, formaldehyde was also present.

The following scheme shows the probable course of the reaction :



The double lines indicate reactions which have already been investigated by others (cf. Klaus and Baudisch, *Ber.*, 1918, **51**, 1046; Meldola, J., 1881, **39**, 37; Macmillan and Reade, J., 1929, 2863).

EXPERIMENTAL.

Michler's hydrol as supplied by Imperial Chemical Industries Ltd. was recrystallised twice from carbon tetrachloride and then from light petroleum (b. p. 50—60°) to give colourless needles, m. p. 102° alone and in admixture with a specimen prepared according to Mohlau and Heinze (*Ber.*, 1902, **35**, 359).

Michler's Hydrol and Sodium Nitrite in 4·8N-*Hydrochloric Acid.*—10 G. of Michler's hydrol were dissolved in 240 c.c. of 6N-hydrochloric acid, cooled in ice, and 10 g. of sodium nitrite in 20 c.c. of water were added slowly with continuous stirring. There was vigorous evolution of nitric oxide. (Allowing 1 mol. of hydrochloric acid for each mol. of hydrol and nitrite, the solution is 4·8N.) After 3 hours the solution was filtered, yielding 1·26 g. of a yellow precipitate and a dark red filtrate.

Ethereal extraction of this precipitate left 0·99 g. of *p*-nitrosodimethylaniline hydrochloride and yielded a mixture of two nitrosoamines, which when repeatedly crystallised from aqueous alcohol gave 4-nitrophenylmethylnitrosoamine (Found : C, 46·2; H, 3·7. Calc. : C, 46·2; H, 3·8%). The second nitrosoamine could not be isolated in the pure state by crystallisation. The nitrosoamine mixture was therefore heated with concentrated hydrochloric acid to remove the nitroso-groups, and after dilution was extracted with ether, thus removing *p*-nitromethylaniline and leaving in solution the base of the other nitrosoamine. When the solution was made alkaline, this base was precipitated, and after recrystallisation from light petroleum (b. p. 50—60°) was identified as 4-methylaminobenzaldehyde. The nitrosoamine prepared from this base was identical with the second constituent of the nitrosoamine mixture.

The dark red filtrate was extracted with ether, yielding 0·12 g. of *p*-nitrodimethylaniline. The aqueous remainder was diluted with an equal volume of water and subjected to continuous ether extraction, which yielded an orange-yellow oil. The oil was washed with cold 2N-hydrochloric acid, leaving behind a sticky yellow solid which after repeated crystallisations from aqueous alcohol and light petroleum was obtained from the latter solvent in long hair-like needles, m. p. 105°, identified as 3-nitro-4-dimethylaminobenzaldehyde (Found : C, 55·8; H, 5·1. Calc. : C, 55·7; H, 5·2%). The above method of removing the basic substances from solution by ethereal extraction from an acid medium was used because when the solution was made alkaline a tar resulted which could not be purified. It was, however, found to contain a little dimethylaniline.

Michler's Hydrol and Sodium Nitrite in 1·2N-*Hydrochloric Acid.*—4·5 G. of Michler's hydrol were dissolved in 120 c.c. of 2N-hydrochloric acid cooled in ice, and 4·5 g. of sodium nitrite in 10 c.c. of water added slowly with continuous stirring. There was immediate evolution of nitric oxide. (After allowing for the solution of the hydrol and the sodium nitrite the acid strength is 1·2N.) A yellow precipitate settled almost at once and after 10 minutes 0·55 g. of *p*-nitrodimethylaniline was filtered off. After 2 hours a further precipitate was obtained, which was separated, by washing with ether, into 1·26 g. of *p*-nitrosodimethylaniline hydrochloride and 0·1 g. of *p*-nitrodimethylaniline with a trace of nitrosoamine present. These substances were identified as before. The acid filtrate was repeatedly extracted with ether, yielding a small quantity of a yellow oil which was found to contain 3-nitro-4-dimethylaminobenzaldehyde as in the previous experiment.

The reaction between 4-dimethylaminobenzaldehyde and sodium nitrite was investigated in 4·8N- and in 1·2N-hydrochloric acid in order to determine the amount of *p*-nitrosodimethylaniline produced from a given weight of dimethylaminobenzaldehyde. The figures thus obtained were used in calculating the individual extent of the two modes of fission of the hydrol molecule. 4 G. of 4-dimethylaminobenzaldehyde were dissolved in 90 c.c. of 6N-hydrochloric acid, and 6 g. of sodium nitrite in 10 c.c. of water added. *p*-Nitrosodimethylaniline hydrochloride was precipitated, giving a total yield, including the solubility correction, of 2·34 g. In 1·2N-hydrochloric acid the yield was 3·2 g. The solubility of this hydrochloride in 4·8N- and in 1·2N-hydrochloric acid is 1·038 and 1·085 g. per 100 c.c. respectively.

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