LXVII.—The Nitration of 2- and 6-Methoxy-*m*-Tolualdehydes and *m*-Toluic Acids.

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For synthetical experiments in the anthraquinone group, the author was desirous of preparing 3-methoxy-4-methylphthalic acid, and it appeared probable that the simplest method would be by nitrating 2-methoxy-*m*-tolualdehyde (I), when it was expected that the nitro-group would enter the ortho-position with respect to the aldehyde group with the formation of 4-nitro-2-methoxy-*m*-tolualdehyde (II), which could then be readily converted into the required acid, for it has been shown that *o*-veratraldehyde (III) and 5:6-methylenedioxy-*o*-tolualdehyde (IV), on nitration, yield nitro-derivatives containing the nitro-group in the ortho-position with respect to the aldehyde group (Perkin and Robinson, T., 1914, 105, 2389; Perkin, T., 1916, 109, 910).

This expectation was not, however, realised, for when 2-methoxy-*m*-tolualdehyde was treated with nitric acid under the conditions described in the experimental part of this paper (see p. 778), an almost quantitative yield of 5-nitro-2-methoxy-*m*-tolualdehyde (V) was obtained.

The constitution of this aldehyde was readily proved by the fact that on oxidation it was converted into 5-nitro-2-methoxy-*m*-toluic acid (VI), an acid which was readily obtained by the methylation of 5-nitro-2-hydroxy-*m*-toluic acid (VII) (Einhorn and Pfyl, *Annalen*, 1900, **311**, 47; Fortner, *Monatsh.*, 1901, **22**, 939).

5-Nitro-2-methoxy-*m*-toluic acid was also prepared by the nitration of 2-methoxy-*m*-toluic acid (VIII), which was obtained by the oxidation of the aldehyde.

During the preparation of the 2-hydroxy-aldehyde, a considerable quantity of the 6-hydroxy-aldehyde was obtained, and it appeared, therefore, to be of some interest to investigate the nitration of 6-methoxy-*m*-tolualdehyde (IX) and 6-methoxy-*m*-toluic acid (X). The aldehyde on nitration gave an excellent yield of the 5-nitro-derivative (XI), the constitution of which was proved by the fact that on treatment with acetone and alkali it yielded the corresponding derivative of distyryl ketone, no formation of indigotin taking place, which would have been the case if the nitro-group had entered either of the positions ortho to the aldehyde group. The nitro-aldehyde yielded on oxidation the corresponding acid (XII), which acid was also formed by the nitration of 6-methoxy-*m*-toluic acid.

At the same time, there was obtained a considerable quantity of a neutral substance melting at 69°, which would appear to be 6-nitro-*o*-tolyl methyl ether (XIII). As was to be expected of a substance possessing this constitution, some difficulty was experienced in converting the methyl group into a carboxyl group. This was ultimately accomplished by oxidation with chromic acid in concentrated sulphuric acid solution, when an acid was obtained crystallising in prismatic needles and melting at 161°. Simonsen and

Rau (T., 1916, **111**, 223 *et seq.*) have described three of the four possible isomeric nitro-2-methoxybenzoic acids; this acid was found not to be identical with any of the three, and it is in all probability 6-nitro-2-methoxybenzoic acid (XIV). Unfortunately, it was not obtained in sufficient quantity for a detailed examination to be made.

The results described above are of some interest in illustrating the difference in orientating effect of methyl and methoxy-groups. It has been suggested (Simonsen and Rau, *loc. cit.*) that a negative group in the ortho-position with respect to a positive group tends to neutralise such a grouping, and the orientating effect is then in the main exercised by the remaining positive group in the molecule. Whilst this appears to be the case in the nitration of acetyl-amino-methoxy-derivatives and also of other methoxy-derivatives, the rule is evidently not of any general application.

EXPERIMENTAL.

2-Methoxy-m-tolualdehyde (I).

The phenolic aldehyde (10 grams) was dissolved in sodium methoxide (2 grams of sodium) and treated with methyl sulphate (15 grams), the addition of the same quantities of alkali and methyl sulphate being repeated three times. The solution was then heated on the water-bath for fifteen minutes to complete the decomposition of the methyl sulphate, water added, the methoxy-aldehyde extracted with ether, and the ethereal solution dried and evaporated.

2-Methoxy-m-tolualdehyde was obtained as a viscid, pleasant-smelling oil which boiled at about $120^{\circ}/6$ mm. With concentrated sulphuric acid it gave a cherry-red coloration.

The *oxime* was best prepared by dissolving the aldehyde (1.3 grams) in alcohol, and, after the addition of hydroxylamine hydrochloride (2 grams) and sodium acetate (2 grams), the mixture was heated on the water-bath for half an hour. On pouring into water, the oxime separated in silky needles, which were purified by crystallisation from methyl alcohol. It melted at 118° :

0.1558 gave 12.9 c.c. N_2 at 33° and 759 mm. $N=8.7$.

$C_9H_{11}O_2N$ requires $N=8.5$ per cent.

The *semicarbazone*, prepared in the usual manner, crystallised from alcohol, in which it was somewhat sparingly soluble, in white, microscopic needles melting at 224° :

0.0906 gave 16.8 c.c. N_2 at 30° and 760 mm. $N=20.0$.

$C_{10}H_{13}O_2N_3$ requires $N=20.2$ per cent.

Nitration of 2-Methoxy-m-tolualdehyde. 5-Nitro-2-methoxy-m-tolualdehyde (V).

In one experiment, the aldehyde (2 grams) was added gradually to nitric acid (D 1.52:10 grams), which was kept well cooled in ice. The reaction proceeded smoothly, and, after remaining for fifteen minutes, the mixture was poured on ice, when an oil separated which rapidly solidified. This was collected, triturated with dilute sodium carbonate solution* to remove a trace of acid, dried on porous porcelain, and purified by crystallisation from a mixture of ether and light petroleum (yield, 2.2 grams):

0.1634 gave 10.7 c.c. N_2 at 30° and 759 mm. $N=7.0$.

$C_9H_9O_4N$ requires $N=7.2$ per cent.

5-Nitro-2-methoxy-m-tolualdehyde crystallises in balls of needles melting at $61-62^\circ$. It is readily soluble in the ordinary organic solvents with the exception of light petroleum, in which it is somewhat sparingly soluble. The 5-nitro-aldehyde was found to be the sole product of the reaction, since no trace of an isomeride could be isolated from the mother liquors.

The *semicarbazone* crystallised from alcohol in fine, woolly needles which decomposed at 233° :

0.0948 gave 19.4 c.c. N_2 at 32° and 758 mm. $N=22.0$.

$C_{10}H_{12}O_4N_4$ requires $N=22.2$ per cent.

5:5'-Dinitro-2:2'-dimethoxydi-3-m-methylstyryl Ketone,
 $NO_2 \cdot C_6H_2Me(OMe) \cdot CH:CH \cdot CO \cdot CH:CH \cdot C_6H_2Me(OMe) \cdot NO_2$.

This substance was readily prepared under the following conditions: the aldehyde (0.5 gram), dissolved in warm methyl alcohol (5 c.c.), was mixed with acetone (0.5 gram), and, after the addition of potassium hydroxide (50 per cent.:two drops), the yellow mixture was heated to boiling for a few minutes. The liquid rapidly clouded and a voluminous mass of yellow needles separated. These were collected, well washed with methyl alcohol, and the residue recrystallised from acetic acid, in which it was only very sparingly soluble, when it was obtained in fine, yellow needles decomposing at 252° :

0.094 gave 6 c.c. N_2 at 32° and 758 mm. $N=6.8$.

$C_{21}H_{20}O_7N_2$ requires $N=6.8$ per cent.

* The acid (0.05 gram) which separated from the sodium carbonate solution on acidification was found to be 5-nitro-2-methoxy-*m*-toluic acid.

Oxidation of 5-Nitro-2-methoxy-m-tolualdehyde. 5-Nitro-2-methoxy-m-toluic Acid (VI).

The nitro-aldehyde (1.2 grams) was dissolved in acetone (30 c.c.) and finely powdered potassium permanganate (0.65 gram) was gradually added. The oxidation proceeded readily, and, after the reaction was complete, water was added, the solution boiled, and the manganese dioxide filtered off. The filtrate was concentrated on the water-bath until free from acetone, a trace of unchanged aldehyde removed, and the aqueous solution acidified, when the nitro-acid separated in fine needles. These were collected and crystallised from hot water:

0.2036 gave 12 c.c. N_2 at 30° and 759 mm. $N=6.3$.

$C_9H_9O_5N$ requires $N=6.6$ per cent.

5-Nitro-2-methoxy-m-toluic acid crystallises from hot water in glistening, silky needles melting at 154° . It is readily soluble in the ordinary organic solvents with the exception of light petroleum.

The *silver* salt separated in pale yellow needles, which were somewhat soluble in hot water:

0.2974 gave 0.1007 Ag. $Ag=33.8$.

$C_9H_8O_5NaAg$ requires $Ag=34.0$ per cent.

For the purposes of comparison, a specimen of 5-nitro-2-methoxy-*m*-toluic acid was prepared by the methylation of the corresponding hydroxy-acid obtained by the nitration of 2-hydroxy-*m*-toluic acid (Einhorn and Pfyl, *loc. cit.*). The acid isolated from the methylation melted at 154° , and was identical in every way with the acid prepared by the method described above.

2-Methoxy-m-toluic Acid (VIII).

This acid was readily obtained by the oxidation of the corresponding aldehyde by means of potassium permanganate in acetone solution. It separated from hot water in hair-like needles which melted at 83° . It was readily soluble in hot water and in the ordinary organic solvents, somewhat readily so in cold water:

0.0952 gave 0.2266 CO_2 and 0.053 H_2O . $C=64.9$; $H=6.2$.

$C_9H_{10}O_3$ requires $C=65.1$; $H=6.1$ per cent.

The *silver* salt was obtained as a caseous, white precipitate which was dried at 100° for analysis:

0.37 gave 0.1475 Ag. $Ag=39.9$.

$C_9H_9O_3Ag$ requires $Ag=39.6$ per cent.

Nitration of 2-Methoxy-m-toluic Acid.

The acid (0.3 gram) was gradually added to nitric acid (D 1.52: 1 gram), the temperature being kept at about 30°. After remaining for ten minutes, the clear solution was poured into water, when the nitro-acid separated and was collected (yield, 0.3 gram). After crystallisation from hot water, it melted at 154°, and this melting point was unaltered on admixture with a specimen of the 5-nitro-acid prepared by the oxidation of the nitro-aldehyde as described above. The 5-nitro-acid appeared to be the sole product of the reaction, since the mother liquors yielded no trace of an isomeride.

Nitration of 6-Methoxy-m-tolualdehyde (IX). 5-Nitro-6-methoxy-m-tolualdehyde (XI).

The aldehyde (3 grams) was added slowly to nitric acid (D 1.52: 9 grams), which was kept well cooled in a mixture of salt and ice. The aldehyde dissolved with considerable evolution of gas, and, after remaining for ten minutes, the mixture was poured on ice, when the nitro-aldehyde separated and was collected (yield, 4.2 grams).

5-Nitro-6-methoxy-m-tolualdehyde crystallises from dilute alcohol in small needles melting at 77°. It is readily soluble in all the ordinary organic solvents:

0.1093 gave 7.2 c.c. N_2 at 31° and 760 mm. $N=7.1$.

$C_9H_9O_4N$ requires $N=7.2$ per cent.

The semicarbazone crystallised from alcohol in needles which decomposed at 235°:

0.0849 gave 17.4 c.c. N_2 at 31° and 760 mm. $N=22.0$.

$C_{10}H_{12}O_4N_4$ requires $N=22.2$ per cent.

5:5'-Dinitro-4:4'-dimethoxydi-3-methylstyryl Ketone.

This substance was prepared in a similar manner to the isomeride described on p. 778. It crystallises from acetic acid in yellow needles melting at 214°:

0.0526 gave 3.4 c.c. N_2 at 30° and 759 mm. $N=6.9$.

$C_{21}H_{20}O_7N_2$ requires $N=6.8$ per cent.

5-Nitro-6-methoxy-m-toluic Acid (XII).

This acid was readily obtained when the nitro-aldehyde was oxidised with potassium permanganate in acetone solution. For analysis, it was crystallised from dilute alcohol:

0.1752 gave 11.2 c.c. N_2 at 31° and 760 mm. $N=6.8$.

$C_9H_9O_5N$ requires $N=6.6$ per cent.

5-Nitro-6-methoxy-m-toluic acid crystallises in colourless, felted needles melting at $180-181^\circ$, and softening slightly at 175° . It is very sparingly soluble in cold water, somewhat more readily so in hot; it is very readily soluble in chloroform, acetic acid, or ethyl acetate, more sparingly so in benzene.

The *barium* salt crystallised in sparingly soluble, curious nodular masses of needles; the *calcium* salt was obtained in stellate clusters of needles which were readily soluble in hot water; the *silver* salt separated as a granular, white precipitate:

0.2272 gave 0.0772 Ag. $Ag=34.0$.

$C_9H_8O_5NAg$ requires $Ag=34.0$ per cent.

The *methyl* ester, $C_{10}H_{11}O_5N$, crystallised from dilute methyl alcohol in silky needles melting at 47° .

Nitration of 6-Methoxy-m-toluic Acid (X).

The finely powdered acid (1.4 grams) was gradually added to nitric acid (D 1.52:5 grams), the temperature being kept between 30° and 35° . The acid dissolved with considerable evolution of gas, and, after remaining for ten minutes, the mixture was poured into water and the solid which separated was collected and triturated with dilute sodium carbonate solution, a considerable quantity of a neutral substance, A (0.62 gram), remaining undissolved. This was separated, the filtrate acidified, and the acid which was deposited (0.97 gram) crystallised from dilute alcohol, when it was obtained in fine needles melting at $180-181^\circ$, this melting point being unaltered on admixture with a specimen of the acid obtained by the oxidation of the nitro-aldehyde. The neutral substance A was purified by crystallisation from methyl alcohol, from which it separated in glistening needles melting at 69° . For analysis, it was dried in a vacuum:

0.1404 gave 11 c.c. N_2 at 30° and 759 mm. $N=8.5$.

$C_9H_9O_5N$ requires $N=8.4$ per cent.

This substance would appear to be 6-nitro-o-tolyl methyl ether (XIII). It was attacked by a hot alkaline solution of potassium permanganate only with great difficulty, but it was found to be readily oxidised by chromic acid under the following conditions: the nitro-compound (0.25 gram) was dissolved in concentrated sulphuric acid (1 c.c.) and gradually treated with chromic acid (0.3 gram) dissolved in concentrated sulphuric acid (2 c.c.), the temperature being kept at about 40° . When the reaction was

complete, water was added, the nitro-acid which separated was collected, dissolved in a little dilute sodium carbonate solution, and filtered from a little unattacked material. On acidifying the alkaline filtrate, the *nitro-acid* separated in fine, prismatic needles which melted at 159—160°. After crystallisation from hot water, in which it was readily soluble, it melted at 161°. This acid was probably 6-nitro-2-methoxybenzoic acid (XIV), an acid which does not appear to have been described previously. It was not identical with 5-nitro-2-methoxybenzoic acid, which also melts at this temperature (Simonsen and Rau, T., 1917, 111, 228), since a mixture of the two acids melted at about 140°. Unfortunately, this new acid was not obtained in sufficient quantity for a detailed examination.

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