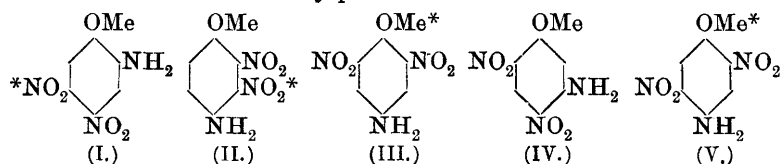


CXXXIX.—*The Diazotisation of Dinitroanisidines and Related Compounds.*

By RAPHAEL MELDOLA, F.R.S., and JAMES GORDON HAY.

IN the last paper dealing with this series of researches (Trans., 1906, 89, 923) the conclusion was reached that when a nitro-group is in the ortho- or para-position with respect to an amino-group no displacement of the nitro-group takes place on diazotisation unless there is a second nitro-group adjacent to the first (mobile) group. The only two known dinitroanisidines in which this condition is fulfilled are those derived respectively from ortho- and para-anisidine (I and II), which have been dealt with in previous communications. The dinitro-*p*-anisidine (III: Meldola and Stephens, Trans., 1905, 87, 1204), the dinitro-*m*-anisidine (IV: Meldola and Stephens, Trans., 1906, 89, 927), and the new dinitro-*p*-anisidine recently obtained by Reverdin and Bucky (*Arch. Sci. phys. nat.*, 1906, 22, 140) do not contain the substituents in the necessary positions:



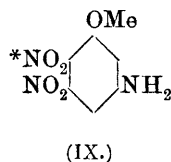
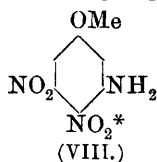
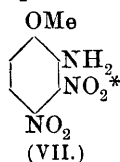
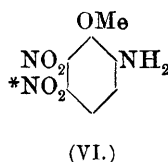
IN accordance with this conclusion, the nitro-group marked * in I and II has been found to be displaceable when the compounds are diazotised, whereas no displacement in III, IV, or V takes place under these conditions. On the other hand, it has been found that when a methoxy-group is in the para-position with respect to the amino-group and at the same time has a nitro-group in an adjacent position, demethylation takes place on diazotisation (Meldola and Stephens, Trans., 1905, 87, 1205). As the final product of demethylation is a diazo-oxide, it appears certain that the elimination of the alkyl radicle must also follow the ortho-para rule. This conclusion is confirmed by the following observations:

(a) Compound No. IV complies with only one of the conditions. There is a nitro-group adjacent to the methoxy-group, but the amino-group is in the meta-position. This compound on diazotisation loses neither methyl nor NO_2 (Meldola and Stephens, *Trans.*, 1906, 89, 928).

(b) Compound No. V complies with both conditions. There is a nitro-group adjacent to the methoxy-group and an amino-group in the para-position. On diazotisation, the diazonium salt yields 2:5-dinitrophenol when boiled with alcohol, so that in this case demethylation takes place (Reverdin and Bucky, *Ber.*, 1906, 39, 2691).

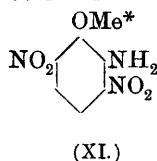
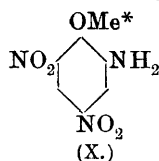
The displaceable methyl groups in III and IV are indicated by the *. In these compounds, the nitro-group in the ortho-position with respect to the methoxy-group is no doubt the determining cause of the mobility of the methyl or methoxy-group.†

Among the possible dinitroanisidines indicated by theory, there are four other isomerides (VI to IX) in which the configuration is favourable for the displacement of the nitro-group :



None of these compounds is, however, at present known, and as the nitro-groups marked * might be expected to be displaceable, an attempt will be made to prepare some of them in order to test the generality of the conclusions reached at this stage of the investigations. Compound No. VI is of special interest owing to the circumstance that both the nitro- and methoxy-groups are in positions favourable for displacement.

Compounds No. X (the methyl ether of picramic acid) and No. XI (unknown) contain the substituents in positions favourable for the displacement of the methyl (methoxy) group :



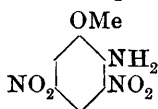
The conclusions arrived at concerning the conditions which determine the displacement of nitro- and methoxy-groups on diazotisation

† Whether the process is simply one of demethylation or whether the methoxy-group is eliminated as a whole must for the present remain an open question. On the hypothesis of "isomeric change" it might be expected that it is the methoxy-group which is mobile.

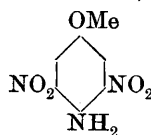
are in harmony with the results obtained by other investigators who have been studying the displacement of halogens under similar conditions. This kind of displacement, which has long been known to those who have worked in the field of diazo-chemistry, has been utilised for technical purposes (Badische Co., Fr. Pat. No. 315932 of 1902) and has recently been made the subject of systematic researches by K. J. P. Orton, who has approached the question from the point of view of isomeric change. A consideration of the constitution of the compounds in which this displacement of halogen occurs brings out clearly the same principle—that the displaceable halogen atom must be in the ortho- or para-position with respect to the diazonium group and that the mobility of the halogen, although in this case not absolutely dependent upon, 'is largely augmented by the proximity of another substituent (halogen atom or nitro-group) in the ortho-position with respect to the displaceable atom. This is most clearly seen on reference to the list of compounds given by Orton (Trans., 1903, 83, 800) in which the mobility of the halogen atom has been determined by the percentage of free halogen liberated in a given time.

In continuation of our previous work, several attempts have been made to prepare the dinitroanisidine, No. X, corresponding to picramic acid, but hitherto without success. Experiments having for their object the methylation of the silver and potassium salts of acetyl picramic acid invariably resulted in the production of the original compound. Although this dinitroanisidine figures in chemical literature (Beilstein, Vol. II., p. 733), it is doubtful whether it has ever been obtained, as the reduction of trinitroanisole by ammonium sulphide apparently gives rise to other products. The experiments in this direction are, however, not yet completed, and the conclusions will be withheld for a future communication.

In the present paper, the results of diazotising two other dinitroanisidines are made known. Of these, No. XII was first prepared by Blanksma (*Proc. K. Akad. Wetensch. Amsterdam*, 1903, 5, 650) and No. XIII was described in a former communication by one of the authors and F. G. C. Stephens (*Trans.*, 1905, 87, 1206):



(XII.)



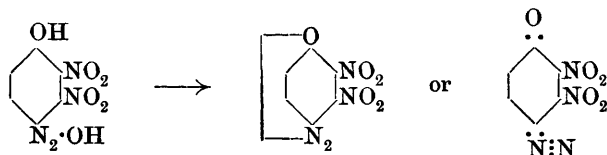
(XIII.)

As will be seen on reference to the formulæ, there is no group in either of these compounds in a position favourable for displacement, and, as might have been anticipated, they behave quite normally on diazotisation.

Incidentally in the course of the present investigation we have discovered the hitherto unknown 2:3-dinitro-4-aminophenol and we have also succeeded in isolating the 2:3:5-trinitro-4-aminophenol of which the acetyl derivative was described recently by one of us (Trans., 1906, 89, 1935). The constitution of these compounds is shown below:



The discovery of these compounds has enabled us to study their products of diazotisation, a point of considerable importance in view of the fact that one of them corresponds to the dinitro-*p*-anisidine investigated from this point of view five years ago (Meldola and Eyre, Trans., 1902, 81, 988). There has thus been made possible a comparative study of a dinitroaminophenol with its methyl ether, and the special influence of the methoxy-group has by this means been determined. As will be seen from the experimental part, the methoxy-group has a decided "loosening" influence upon the nitro-group, since, under the same conditions of diazotisation as those which cause the displacement of the 3-nitro-group in dinitro-*p*-anisidine (Trans., 1902, 81, 998), a dinitro-derivative is obtained from the new dinitroaminophenol. This result is no doubt due to the facility with which the diazo-derivative can pass into the comparatively stable para-diazo-oxide (quinonediazide) in the dinitroaminophenol:



In the case of the corresponding dinitroanisidine the quinonediazide must belong to the ortho-series and can only be formed by the elimination of the nitro-group. The trinitroanisidine corresponding to the new trinitroaminophenol has not yet been obtained, and all attempts to prepare it have hitherto failed.

EXPERIMENTAL.

Diazotisation of 3:5-Dinitro-o-anisidine (3:5-Dinitro-2-aminoanisole).

This dinitroanisidine was prepared from 1:3:5-trinitrobenzene by the method described by Blanksma (*loc. cit.*). After repeated crystallisation from glacial acetic acid, the compound consisted of ruby-

1478 MELDOLA AND HAY: THE DIAZOTISATION OF

coloured needles with a green, metallic lustre melting at 181° (174° : Blanksma):

0.1323 gave 23.05 c.c. moist nitrogen at 18° and 758.5 mm. $N = 20.07$.
 $C_7H_7O_5N_3$ requires $N = 19.76$ per cent.

This dinitroanisidine dissolves readily in boiling glacial acetic acid with an orange colour, but, on cooling, practically the whole of the substance separates out in a crystalline form. It was not found possible to diazotise the base in acetic acid, but it diazotises readily in sulphuric acid, and the diazonium salt thus formed retains both nitro-groups. This was proved by combining the diazotised base with β -naphthol in alkaline solution and also by replacing the diazonium group by iodine.

On mixing the solution of the diazonium sulphate with an alkaline solution of β -naphthol in the usual way, the azo-compound separates out as a red precipitate. It can be purified by crystallisation from boiling aniline or acetic anhydride and is then obtained in dark scales with a metallic lustre, melting with decomposition at 291° . It dissolves in strong sulphuric acid with a deep violet colour, becoming red on dilution:

0.1039 gave 13.7 c.c. moist nitrogen at 14.5° and 747 mm. $N = 15.07$.
 $C_{17}H_{12}O_6N_4$ requires $N = 15.25$ per cent.

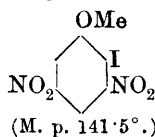
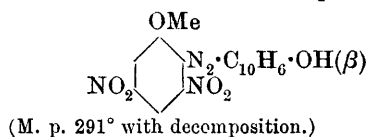
The replacement of the amino-group in this dinitroanisidine by iodine was effected by boiling the diazonium sulphate with hydriodic acid as long as nitrogen was evolved. The product after crystallisation from alcohol was obtained in large, flat, ochreous needles with serrated edges melting at 141.5° . Analysis proved it to be iododinitroanisole:

0.1619 gave 11.85 c.c. moist nitrogen at 14° and 749 mm. $N = 8.49$.
 0.1139 „ 0.0828 AgI. $I = 39.3$.

0.3022 by Berry's method * required 9.35 c.c. $N/10 AgNO_3 = 0.1186$ of iodine; $I = 39.25$.

$C_7H_6O_5N_2I$ requires $N = 8.66$; $I = 39.18$ per cent.

The constitution of these compounds is shown by the formulæ:



Diazotisation of 3:5-Dinitro-p-anisidine (3:5-Dinitro-4-aminoanisole).

This dinitroanisidine has already been described in a former paper (Trans., 1905, 87, 1206). As the preparation of this compound in

* See Chem. News, 1906, 94, 188.

quantity has presented considerable difficulties, we give further details respecting the method which, after much experimenting, we have found most advantageous. Following the instructions given by Reverdin, who discovered the dinitroaminophenol corresponding to this dinitroanisidine, we prepared in the first place dibenzoyl-*p*-aminophenol and then, by nitration, obtained from this the dinitrobenzoyl derivative of the dinitroaminophenol. The nitration of the dibenzoyl-*p*-aminophenol was carried out by dissolving the substance in a mixture of equal volumes of concentrated sulphuric and fuming nitric acids cooled in ice, 10 grams of the dibenzoyl compound requiring about 130 c.c. of the mixture of acids. After the addition of the whole of the substance, the solution was removed from the ice-bath and the temperature allowed to rise to that of the atmosphere, at which temperature it was allowed to stand for about two hours and then finally heated on to the water-bath for about an hour. The solution was then poured on to ice and the product collected, washed free from acid, and crystallised from alcohol or acetic acid. At this stage, the dinitrodibenzoyl-3 : 5-dinitro-*p*-aminophenol of Reverdin was obtained, and from this certain new derivatives have been prepared which are most conveniently described here.

The tetranitro-compound is easily hydrolysed by the action of a cold alcoholic solution of sodium hydroxide, the *O*-nitrobenzoyl group being removed. The product after crystallisation from alcohol consists of white, silky needles, soluble in aqueous alkali with an orange colour and having a melting point of 215.5° :

0.0596 gave 8.1 c.c. moist nitrogen at 9.5° and 757.3 mm. $N = 16.25$.

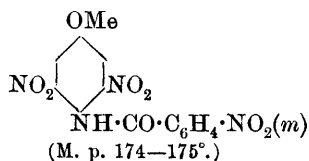
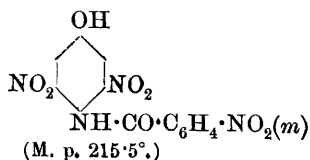
$C_{13}H_8O_8N_4$ requires $N = 16.13$ per cent.

On hydrolysis by sulphuric acid and purification of the product by crystallisation from water, Reverdin's dinitro-*p*-aminophenol was obtained in red needles melting at 240.5° (corrected by reference to short-stemmed standard thermometer). The compound was methylated by dimethyl sulphate in presence of alkali and, after crystallisation from acetic acid, consisted of white, prismatic needles melting at $174-175^{\circ}$:

0.1212 gave 15.2 c.c. moist nitrogen at 11.5° and 771.2 mm. $N = 15.14$.

$C_{14}H_{10}O_8N_4$ requires $N = 15.46$ per cent.

The constitution of these compounds is shown by the formulæ:



All attempts to hydrolyse the above methyl derivative were unsuccessful. The compound is decomposed completely by alkaline hydrolysing agents, and sulphuric acid fails to remove the nitrobenzoyl group at moderate temperatures, or at higher temperatures removes both this and the methyl group. The compound had therefore to be abandoned as a source of the required dinitro-*p*-anisidine. The latter was ultimately obtained in quantity by starting from Reverdin's 3:5-dinitro-*p*-aminophenol, which we have found to be most conveniently prepared by hydrolysing the dinitrodibenzoyl derivative prepared as above by means of sulphuric acid, and purifying the product, as recommended by its discoverer, by crystallisation from hot water in order to free it from *m*-nitrobenzoic acid. The dinitroaminophenol is then acetylated by heating for a short time with acetic anhydride so as to convert it into the *N*-monoacetyl derivative (m. p. 182°: Reverdin, *Arch. Sci. phys. nat.*, 1904, 18, 439), and the latter methylated by methyl iodide and silver oxide and hydrolysed by sulphuric acid as described in the former paper (*loc. cit.* p. 1206).

3:5-Dinitro-*p*-anisidine could not be diazotised in acetic acid solution. It diazotises readily in sulphuric acid, and the diazonium sulphate solution on being mixed with an alkaline solution of β -naphthol gives a non-phenolic azo-compound which, after crystallisation from glacial acetic acid, consisted of large needles of a ruby-red colour by transmitted light and having a green, metallic lustre. The melting point is 226°, and the compound dissolves in alcoholic soda with a dull red colour, in boiling acetic acid with an orange colour, and in strong sulphuric acid with a deep violet colour becoming red on dilution. Analysis showed that two nitro-groups are contained in the molecule:

0.1286 gave 16.25 c.c. moist nitrogen at 16° and 766.6 mm. N = 14.86.

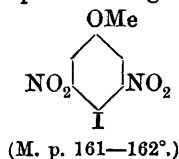
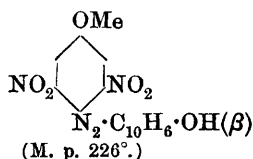
$C_{17}H_{12}O_6N_4$ requires N = 15.25 per cent.

A further quantity of the diazonium sulphate was decomposed by boiling with hydriodic acid as long as nitrogen was evolved. The product was purified by repeated crystallisation from acetic acid and alcohol alternately, and finally obtained in dense, ochreous prisms melting at 161–162°. Analysis proved the compound to be iodo-dinitroanisole:

0.0970 gave 7.15 c.c. moist nitrogen at 15.5° and 765.1 mm. N = 8.67.

$C_7H_5O_2N_2I$ requires N = 8.66 per cent.

The constitutional formulæ of these compounds are given below:



2:3-Dinitro-4-aminophenol and its Products of Diazotisation under Various Conditions.

This compound was discovered incidentally in the course of experiments having for their object the study of the influence of the *O*-acetyl group in determining the position of entry of nitro-groups in acetylated *p*-aminophenol. It had long been known that diacetyl-*p*-aminophenol on nitration gives the diacetyl derivative of 3-nitro-*p*-aminophenol (Hähle, *J. pr. Chem.* 1901, [ii], 63, 63), and this by partial hydrolysis yields 3-nitro-4-acetylaminophenol (Reverdin and Dresel, *Arch. Sci. phys. nat.*, 1904, 18, 442). In this last compound the hydroxyl group is therefore unprotected by acetyl, and it became of interest to ascertain whether by further nitration a dinitrophenol could be obtained corresponding to one of the known dinitroanisidines. Under all conditions with fuming nitric acid, either alone or in acetic acid solution, the nitroacetylaminophenol* is converted into 2:3:5-trinitro-4-acetylaminophenol. [By using a weaker acid, however (1.42 sp. gr.), and dissolving the mononitro-compound in this acid cooled in ice, the nitration can be regulated so as to give a dinitro-acetylaminophenol. The best result is obtained by dissolving 5 grams of the mononitro-compound in about 35 c.c. of the cooled acid and, after standing for an hour, pouring the solution on to ice. The product, after being collected and washed, can be purified by crystallisation from hot water or dilute acetic acid. It consists of large, yellow needles melting at 199.5° with decomposition and beginning to darken about 8° below this temperature.

0.1389 gave 20.85 c.c. moist nitrogen at 19° and 770.5 mm. $N = 17.49$.

0.1141 „ 16.4 „ „ „ „ 10° „ 765.3 mm. $N = 17.33$.

$C_8H_7O_6N_3$ requires $N = 17.47$ per cent.

The dinitroacetylaminophenol thus obtained was shown to have the nitro-groups in positions 2:3 by methylating the compound in methyl alcohol by silver oxide and methyl iodide. There was obtained by this method the 2:3-dinitro-*p*-acetanisidide of m. p. 230—231°, giving the 2:3-dinitro-*p*-anisidine of m. p. 188° (Meldola and Eyre, *Trans.*, 1902, 81, 990). The constitution of the compound having been established by this result, it appeared probable that the 3-nitro-group would be found to be displaceable, as the configuration is favourable for a “mobility” of this group. Some of the compound was accordingly

* The hydrolysis is most conveniently carried out by suspending the diacetyl compound in cold water and adding sodium hydroxide solution, with constant agitation, until the substance passes into solution. In the course of a few minutes, the hydrolysis is complete and the monoacetyl derivative is precipitated by acidifying the solution with hydrochloric acid.

dissolved in aniline and the solution kept warm on the water-bath for three to four hours. The excess of aniline having been removed by dilute hydrochloric acid, the product was dissolved in dilute sodium hydroxide, the solution filtered to remove aminoazobenzene, and the phenolic portion precipitated by acid. To ensure complete conversion into an iminazole, the product, after being collected, washed, and dried, was heated for a short time on the water-bath with concentrated sulphuric acid and then recovered by diluting the solution with water and neutralising the acid by sodium hydroxide. The product after crystallisation from dilute alcohol was obtained as an ochreous, micro-crystalline powder melting at 200—203·5° :

0·1375 gave 18·7 c.c. moist nitrogen at 18° and 760 mm. $N = 15·7$.

$C_{14}H_{11}O_3N_3$ requires $N = 15·65$ per cent.

The compound is phenolic and has all the properties of an iminazole. The 3-nitro-group of the new dinitroacetylaminophenol is thus shown to be mobile, and from its mode of formation the iminazole must be :



(7-Nitro-6-hydroxy-1-phenyl-2-methylbenziminazole.)

The dinitroacetylaminophenol cannot be hydrolysed by alkalis, as it is readily decomposed under these conditions. It can be readily hydrolysed by heating on a water-bath for a few minutes with concentrated sulphuric acid, but the dinitroaminophenol is also very unstable, and the course of the hydrolysis must be followed by frequent tests or the whole of the product may be lost by decomposition. The best method is to heat the sulphuric acid solution of the monoacetyl compound in a flask on the water-bath until a drop withdrawn and diluted with water on a watch-glass gives a bright red, crystalline deposit which does not increase in intensity of colour after successive tests. The whole operation is complete in a few minutes, and must be at once arrested when the requisite stage has been reached by rapidly cooling the flask in water or melting ice. On pouring the acid solution on to ice, the dinitro-compound is precipitated as a red, crystalline deposit which can be collected on a filter and washed free from acid, as it is so feebly basic that its salts are completely dissociated by water. It has not been found possible to isolate the dinitroaminophenol in a state suitable for analysis, since it begins to decompose with the evolution of gas as soon as it is freed from acid by washing on the filter. The mobile nitro-group in proximity to the amino-group is no doubt the determining cause of the instability.

Diazotisation in Presence of Sulphuric Acid.—Some of the dinitro-

aminophenol, prepared as above, was dissolved in glacial acetic acid, some concentrated sulphuric acid added to the solution, and then diazotisation effected in the usual way. A diazo-oxide (quinonediazide) is apparently formed at this stage, as the solution on dilution with water gives a yellow precipitate. As our main object was to ascertain whether the 3-nitro-group was eliminated, the diazotised product was at once decomposed by boiling with hydriodic acid in the usual way, and the compound thus obtained, after purification and repeated crystallisation from dilute alcohol, consisted of ochreous scales melting at 140° and proving on analysis to be iododinitrophenol:

0.1185 gave 8.8 c.c. moist nitrogen at 13° and 770.1 mm. $N = 8.89$.

$C_6H_3O_5N_2I$ requires $N = 9.05$ per cent.

The above result having shown that no elimination of the nitro-group takes place, the experiment was repeated with the substitution of cuprous chloride for hydriodic acid. In this case, no attempt was made to isolate the dinitroaminophenol, but the sulphuric acid solution, after the hydrolysis of the acetyl compound, was diluted with water and diazotised with sodium nitrite. The solution was then mixed with a solution of cuprous chloride and heated until the decomposition was complete. The product was volatile to a small extent in steam, but the main portion separated from the cold solution in a crystalline form. After being freed from copper compounds by alkaline extraction, filtration, and precipitation by acid, the compound was purified by crystallisation from alcohol and obtained in transparent, colourless prisms melting at 127° and proving on analysis to be chlorodinitrophenol:

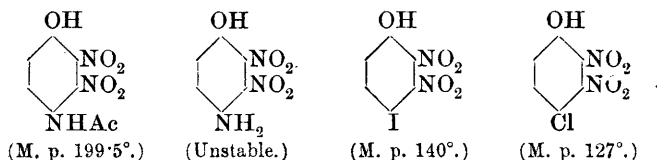
0.0993 gave 11.3 c.c. moist nitrogen at 18° and 755.6 mm. $N = 13.06$.

0.1473 „ 0.0954 AgCl. $Cl = 16.01$.

$C_6H_3O_5N_2Cl$ requires $N = 12.85$; $Cl = 16.22$ per cent.

The compound is phenolic in character, soluble in all the ordinary solvents and in boiling water; it is slightly volatile in a current of steam, and by this means is obtained in slender, white needles.

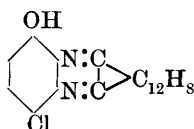
The constitution of the foregoing compounds is shown by the formulæ:



Confirmation of the ortho-position of the nitro-groups was obtained by reducing some of the chlorodinitrophenol by zinc dust in acetic acid solution and heating with phenanthrenequinone in the same

1484 THE DIAZOTISATION OF DINITROANISIDINES, ETC.

solvent, so as to bring about azine condensation. A phenolic azine containing chlorine was thus obtained which, after crystallisation from dilute alcohol, consisted of small, orange needles melting at 131° and having the composition of the azine :



0.0109 gave 0.75 c.c. moist nitrogen at 16.5° and 772.4 mm. $N = 8.14$.

$C_{20}H_{11}ON_2Cl$ requires $N = 8.49$ per cent.

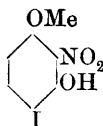
It is thus shown that when diazotised in presence of a strong acid the dinitroaminophenol behaves like the corresponding dinitroanisidine.

Diazotisation in Presence of Acetic Acid.—Some of the dinitroaminophenol was prepared as above, freed as rapidly as possible from sulphuric acid by washing with water, and dissolved in glacial acetic acid with the addition of sodium acetate to ensure the absence of free mineral acid, the base being then diazotised in the acetic acid solution. On decomposing the product by heating with hydriodic acid, there was obtained the same iododinitrophenol (m. p. 140°) as that resulting from the diazotisation in presence of sulphuric acid :

0.0694 gave 5.4 c.c. moist nitrogen at 20° and 768.3 mm. $N = 8.99$.

$C_6H_5O_5N_2I$ requires $N = 9.05$ per cent.

The "loosening" influence of the methyl group is thus brought out very clearly, since the corresponding dinitroanisidine under similar conditions loses the 3-nitro-group. In order to make the comparison more rigid, some 2 : 3-dinitro-*p*-anisidine was diazotised in acetic acid by the method previously described (Trans., 1902, 81, 998) and the product decomposed by boiling with hydriodic acid. A compound was thus obtained which was crystallised from water and, finally, from dilute acetic acid, and then consisted of minute, ochreous needles melting at 87° and having the composition of the expected iodonitroresorcinol methyl ether :



0.1004 gave 4.1 c.c. moist nitrogen at 19° and 760 mm. $N = 4.69$.

$C_7H_6O_4NI$ requires $N = 4.76$ per cent.

(There is simultaneously formed in this reaction a small quantity of a red, crystalline, phenolic substance, which volatilises with the steam

and condenses on the watch-glass covering the neck of the flask. The melting point is 143.5° . Very little of this compound was obtained, but an attempt will be made to prepare it in larger quantity.)

The action of cuprous chloride on the product obtained by diazotisation in the absence of mineral acid is remarkable, and will be made the subject of further investigation in connexion with the general question of the action of cuprous chloride on these products of diazotisation (see *Trans.*, 1902, **81**, 997). We may state, as a preliminary result, that the chief product is the 4-chloro-2-nitrophenol of m. p. 87° (Faust and Saame, *Ann. Suppl.*, 1871, **7**, 190), so that the cuprous chloride acts simultaneously as a chlorinating and reducing agent, the 3-nitro-group being removed without replacement by hydroxyl or chlorine. There is also formed in this process a substance crystallising in red needles with serrated edges melting at 120° and giving a benzoyl derivative melting at 94° and crystallising in white needles. The products of diazotisation of 2:3:5-trinitro-4-aminophenol have also been studied in a preliminary way, and the results will be made known when more fully worked out.

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