77. *Nitrosoacylarylamines. Part III. A New Method of Preparation.*

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A new method is described for the preparation of nitrosoacylarylamines, nitrosyl chloride being used in presence of potassium acetate. It enables nitroso-derivatives to be prepared from some acylarylamines (*e.g.*, *p*-nitroacetanilide) which cannot be nitrosated with nitrous fumes. The reaction is rapid and the yield and quality of the products are improved. The reaction provides a very convenient method for the preparation of the three nitrodiphenyls.

A NEW method has been developed for the preparation of nitrosoacylarylamines which is of more general applicability than that described in Part II (preceding paper), since it enables nitroso-derivatives to be obtained from certain acylarylamines which, like *p*-nitroacetanilide, had hitherto resisted all attempts at nitrosation with nitrous fumes. The new reagent is nitrosyl chloride, the reaction being carried out in glacial acetic acid (or a mixture of acetic acid and acetic anhydride) solution in the presence of fused potassium acetate: $Ar{\cdot}NH{\cdot}CO{\cdot}CH_3 + NOCl + CH_3{\cdot}CO_2K \longrightarrow Ar{\cdot}N(NO){\cdot}CO{\cdot}CH_3 + KCl + CH_3{\cdot}CO_2H$. A list of acylarylamines which have been nitrosated in this manner is given in the table, together with reference to such results as have been previously obtained with nitrous fumes. Both the yield and the quality of the nitrosoacylarylamines prepared by the new method are superior to those resulting from the nitrous fumes method and the time taken for the reaction is reduced from hours to minutes. In addition, by the use of a solution of nitrosyl chloride in glacial acetic acid (or acetic anhydride) of known concentration the reaction can be put on a quantitative basis, whereas the older method necessitated the use of a large and often indeterminate excess of nitrous fumes. A further advantage of the use of nitrosyl chloride as the nitrosating agent in the place of nitrous fumes, which may be regarded as a mixture of nitric oxide and nitrogen peroxide, probably lies in the fact that in the former case nitrogen peroxide is virtually absent. When nitrogen peroxide is present, reaction with water will yield both nitrous and nitric acid and the latter, as has been shown in Part II, tends to convert the nitrosoacylarylamine into the corresponding diazonium nitrate.

The reaction of the three nitronitrosoacetanilides, now rendered available, with benzene to give 2-, 3-, and 4-nitrodiphenyl provides a very convenient method for the preparation of these in good yield. In certain cases, *e.g.*, with benzanilide and with diacetyl-1 : 3-phenylenediamine, in which the action of nitrous fumes results in the formation of diazonium nitrates, the nitrosyl chloride method gives normal nitroso-compounds. Further, in the case of 3-acetamidodiphenyl, the new method of nitrosation gives a solid nitroso-compound, whereas the older method yielded only an oily product.

That nitrosation can also be effected by means of nitrosyl chloride in benzene solution is shown by the fact that addition of a benzene solution of nitrosyl chloride to a benzene solution of acetanilide in presence of fused potassium acetate at 5°, followed by warming at 30° for 2 hours, gave a product from which diphenyl was isolated in 40% yield. This method thus dispenses with the isolation of the intermediate nitroso-compound.

	Reaction with nitrosyl chloride.		
Acylarylamine.	Product.	Reaction with benzene.	Reaction with nitrous fumes.
Acetanilide	Nitroso, decomp. 50°	Nitrogen evolved; diphenyl	Nitroso, decomp. 50° (Grieve and Hey, J., 1934, 1797)
o-Nitroacetanilide	Nitroso, oil	Nitrogen evolved; 2-nitrodiphenyl	—
m-Nitroacetanilide	Nitroso, oil	Nitrogen evolved; 3-nitrodiphenyl	Nitroso, oil (France, Heilbron, and Hey, J., 1939, 1288)
p-Nitroacetanilide	Nitroso, decomp. 75°	Nitrogen evolved; 4-nitrodiphenyl	Unchanged
2 : 4-Dinitroacetanilide	Nitroso, oil	Nitrogen evolved; 2 : 4-dinitrodiphenyl	—
2 : 4 : 6-Trinitroacetanilide	Unchanged	—	—
Benzanilide	Nitroso, decomp. 83°	Nitrogen evolved	Benzenediazonium nitrate (Part II, *loc. cit.*)
p-Nitrobenzanilide	Nitroso, decomp. 90°	Nitrogen evolved	Unchanged (Part II, *loc. cit.*)
Oxanilide	Unchanged	—	Unchanged (Part II, *loc. cit.*)
Ethyl *N*-acetylanthranilate	Nitroso, oil	Nitrogen evolved	—
Ethyl 4-acetamidophthalate	Nitroso, oil	Nitrogen evolved; ethyl 4-phenylphthalate	—
3-Acetamidodiphenyl	Nitroso, decomp. 78°	Nitrogen evolved; *m*-terphenyl	Nitroso, oil (France, Heilbron, and Hey, *loc. cit.*)
Diacetyl-1 : 3-phenylenediamine	Dinitroso, oil	Nitrogen evolved; *m*-terphenyl	*m*-Acetamidobenzenediazonium nitrate (Part II, *loc. cit.*)
Diacetyl-1 : 4-phenylenediamine	Dinitroso, decomp. 124°	Nitrogen evolved; *p*-terphenyl	Dinitroso, decomp. 124° (France, Heilbron, and Hey, J., 1938, 1364)
2-Methoxydiacetyl-1 : 4-phenylenediamine	Nitroso, oil	Nitrogen evolved	5-Nitro-2-methoxydiacetyl-1 : 4-phenylenediamine (France, Heilbron, and Hey, J., 1939, 1283)
2 : 5-Diethoxydiacetyl-1 : 4-phenylenediamine	Unchanged	—	Unchanged (France, Heilbron, and Hey, J., 1939, 1283)

EXPERIMENTAL.

Nitrosoacetanilide.—A solution of acetanilide (5 g.) in a mixture of glacial acetic acid (35 c.c.) and acetic anhydride (15 c.c.), containing fused potassium acetate (5 g.) and phosphoric oxide (0·5 g.), was stirred at 8° while a 25% solution of nitrosyl chloride (3 g.) in acetic anhydride was slowly introduced. After 15 minutes, the yellow reaction mixture was poured into ice-water; nitrosoacetanilide (4·7 g.) separated as a yellow crystalline solid, m. p. 50—51° (decomp.), identical with that prepared as described by Grieve and Hey (J., 1934, 1797).

Nitrosation of Nitroacetanilides.—(a) o-*Nitroacetanilide.* To a stirred suspension of *o*-nitroacetanilide (18 g.) in a mixture of glacial acetic acid (80 c.c.) and acetic anhydride (20 c.c.), containing fused potassium acetate (12 g.) and phosphoric oxide (1 g.), at 8°, a 25% solution of nitrosyl chloride (8 g.) in acetic anhydride was added dropwise and, after a further 20 minutes, the reaction mixture was diluted with ice-water. The oily nitroso-compound was immediately extracted with benzene (500 c.c.), and the extract rapidly washed with ice-water and kept at 35—40° over anhydrous sodium sulphate until evolution of nitrogen ceased (3 hours). The dark reaction mixture was filtered and, after removal of the excess of benzene, distillation of the residue at 172—175°/12 mm. gave 2-nitrodiphenyl as a pale yellow oil (12 g., 60% yield) which slowly solidified (m. p. 36°, from alcohol).

(b) m-*Nitroacetanilide.* Under the conditions described for the *o*-compound the nitroso-derivative of *m*-nitroacetanilide was obtained as a yellow oil, which was treated with benzene at 20°. Removal of solvent left an oily residue; this, on distillation at 225—230°/35 mm., yielded 3-nitrodiphenyl (64% yield), which crystallised from methyl alcohol in yellow plates, m. p. 59—60°, undepressed on admixture with an authentic specimen.

(c) p-*Nitroacetanilide.* By the method described above, except that the nitrosation mixture was stirred for 45 minutes in all to ensure complete reaction, the nitroso-compound of *p*-nitroacetanilide was obtained as a pale yellow, microcrystalline solid (85% yield), m. p. 72°, decomp. 75°. Reaction with benzene at 20° for 24 hours, followed by evaporation of solvent, left an orange crystalline solid, which on distillation at 100°/10^{-2} mm. gave 4-nitrodiphenyl (60% yield) in pale yellow needles, m. p. and mixed m. p. with an authentic specimen 112—113°.

(d) 2 : 4-*Dinitroacetanilide.* By the method outlined above, the nitroso-compound of 2 : 4-dinitroacetanilide was obtained as an oil, which was allowed to react with benzene at 20°. After removal of solvent the tarry residue was extracted with benzene, and the extract boiled with charcoal and filtered. Concentration of the filtrate deposited 2 : 4-dinitrodiphenyl (10% yield) in yellow plates, m. p. 108—110° (cf. Gull and Turner, J., 1929, 496).

Nitrosation of Ethyl 4-Acetamidophthalate.—The ester (2·8 g.) was treated with nitrosyl chloride exactly as described above in the case of *o*-nitroacetanilide. The nitroso-compound, which separated as an oil on dilution of the reaction mixture with ice-water, was treated with benzene at 20° and after removal of solvents the oily residue was hydrolysed by boiling with 20% aqueous sodium hydroxide (50 c.c.) for 3 hours. After extraction of unsaponified material with ether, acidification of the alkaline solution precipitated 4-phenylphthalic acid (0·8 g.), which crystallised from aqueous alcohol in colourless needles, m. p. and mixed m. p. with an authentic specimen 194° (cf. Butterworth, Heilbron, Hey, and Wilkinson, J., 1938, 1386).

3-Nitrosoacetamidodiphenyl.—A 30% solution of nitrosyl chloride (10 g.) in acetic anhydride was introduced dropwise into a stirred solution of 3-acetamidodiphenyl (10 g.) in a mixture of glacial acetic acid (75 c.c.) and acetic anhydride (25 c.c.) at 5°, containing fused potassium acetate (15 g.) and phosphoric oxide (0·5 g.). After a further 10 minutes, the reaction mixture was poured into ice-water; 3-*nitrosoacetamidodiphenyl* (9·5 g.) then separated as crystalline aggregates, m. p. 78° (decomp.) (Found : N, 11·6. $C_{14}H_{12}O_2N_2$ requires N, 11·7%). The dry nitroso-compound (9 g.) was allowed to react with benzene (500 c.c.) at 20° for 24 hours and, after removal of the excess of solvent, distillation of the residue at $100°/10^{-2}$ mm. gave *m*-terphenyl (3·5 g.), which separated from methyl alcohol in colourless needles, m. p. 89° both alone and on admixture with an authentic specimen (France, Heilbron, and Hey, J., 1939, 1288).

Nitrosation of Diacetyl-1 : 3-phenylenediamine.—A stirred mixture of diacetyl-1 : 3-phenylenediamine (2 g.), glacial acetic acid (35 c.c.), acetic anhydride (15 c.c.), fused potassium acetate (2·5 g.), and phosphoric oxide (0·5 g.) was treated at 8° with a 30% solution of nitrosyl chloride (3 g.) in acetic anhydride exactly as described above. The oily nitroso-compound which separated on dilution of the reaction mixture with ice-water was treated with benzene at 20° in the usual manner. After removal of solvents distillation of the residue at $90°/10^{-3}$ mm. yielded *m*-terphenyl (0·5 g.), m. p. and mixed m. p. 89° after crystallisation from methyl alcohol.

Nitrosation of Diacetyl-1 : 4-phenylenediamine.—To a stirred suspension of diacetyl-1 : 4-phenylenediamine (10 g.) in a mixture of glacial acetic acid (150 c.c.) and acetic anhydride (75 c.c.), containing fused potassium acetate (12 g.) and phosphoric oxide (1 g.), at 8° was added dropwise a 30% solution of nitrosyl chloride (8 g.) in acetic anhydride. When the reaction mixture was poured into ice-water, dinitrosodiacetyl-1 : 4-phenylenediamine (11·4 g.) separated as a yellow microcrystalline solid, m. p. 124° (decomp.), corresponding with that prepared by France, Heilbron, and Hey (J., 1938, 1364). Reaction with benzene as previously described (*idem, ibid.*) gave *p*-terphenyl, which crystallised from alcohol in plates, m. p. and mixed m. p. 212°.

2 : 4 : 6-Trinitroacetanilide, benzanilide, *p*-nitrobenzanilide, oxanilide, 2-methoxydiacetyl-1 : 4-phenylenediamine, 2 : 5-diethoxydiacetyl-1 : 4-phenylenediamine, and ethyl *N*-acetylanthranilate were treated with nitrosyl chloride in the manner outlined above for *o*-nitroacetanilide. The product obtained on dilution of the reaction mixture with ice-water was examined and deemed to be a nitroso-derivative if (*a*) it decomposed when heated in the naked flame with a characteristic " flash " and (*b*) it evolved nitrogen when dissolved in benzene. In the cases of 2 : 4 : 6-trinitroacetanilide, oxanilide, and 2 : 5-diethoxydiacetyl-1 : 4-phenylenediamine there was no indication of the formation of nitroso-derivatives.

Nitrosation of Acetanilide in Benzene Solution.—A solution of nitrosyl chloride (5 g.) in benzene (25 c.c.) was added dropwise to a stirred solution of acetanilide (5 g.) in benzene (250 c.c.) containing fused potassium acetate (5 g.) and phosphoric oxide (1 g.) at 5°. After 15 minutes the orange-coloured solution was allowed to regain room temperature and was finally warmed at 30° for 2 hours, during which time nitrogen was evolved. Evaporation of the filtered solution left a residue which on distillation at 135—140°/18 mm. gave diphenyl (2·3 g.), m. p. 70°, in 40% yield.

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