marked difference between acylation and alkylation in regard to mechanism, yields, conditions and velocity of reaction.[2]

Summary

1. The alkyl and acyl fluorides undergo the typical reactions with benzene in the presence of aluminum chloride.

2. Aluminum fluoride is inert in acylation and alkylation.

3. Zinc fluoride may be used to acylate and alkylate under selected conditions.

4. The order of reactivity for acyl halides in the Friedel–Crafts ketone synthesis is I > Br > Cl > F.

5. The order of reactivity of alkyl halides in the Friedel–Crafts alkylations is F > Cl > Br > I.

6. Alkylation may be primarily dependent on the formation of hydrogen halide.

NASHVILLE, TENN. RECEIVED APRIL 8, 1937

[CONTRIBUTION FROM THE ORGANIC LABORATORIES, SCHOOL OF PHARMACY, UNIVERSITY OF MARYLAND]

Diazonium Borofluorides. II. Their Use in the Preparation of Nitro Compounds[1]

BY EDGAR B. STARKEY

During the course of an investigation under way in our Pharmaceutical Chemical Laboratories, certain aromatic nitro compounds which could not be obtained by nitration were desired as intermediates. Sandmeyer[2] and Hantzsch and Blagden[3] have reported the substitution of the nitro group for the amino group through the diazonium reaction. However, no reference could be found to the replacement of an amino group by the nitro group, when the amino group was para or ortho to a nitro, carbonyl or similar group, except the preparation of para dinitrobenzene in 23.7% yield from *p*-nitroaniline by Meisenheimer and Patzig.[4] Since the diazonium borofluorides of Balz and Schiemann[5] have been used in our Laboratories for the preparation of mercury compounds,[1] and since they are stable, easily purified and obtained in good yield, they were chosen for the preparation of the desired nitro intermediates. These will be reported elsewhere.

The method described below and represented by the equation $RN_2BF_4 + NaNO_2 \longrightarrow RNO_2 + N_2 + NaBF_4$, proved satisfactory. Other available amines were used in similar experiments to determine the effect of substituents in the ring on the ease of replacement, and on the yield. The results are summarized in Table I.

While the method is recommended in no case where the compound can be prepared readily either directly or indirectly by nitration, it has been found valuable in all cases tried where the compound could not be obtained conveniently by nitration, *e. g.*, *p*- and *o*-dinitrobenzenes.

(1) Additional papers in this series are in prospect. The paper by Dunker, Starkey and Jenkins, THIS JOURNAL, **58**, 2308 (1936), will be considered number I.

(2) Sandmeyer, *Ber.*, **20**, 1494 (1887).

(3) Hantzsch and Blagden, *ibid.*, **33**, 2544 (1900).

(4) Meisenheimer and Patzig, *ibid.*, **39**, 2526 (1906).

(5) Balz and Schiemann, *ibid.*, **60**, 1186 (1927).

Experimental

Amines of technical quality were used and from these the diazonium borofluorides were prepared by the procedure already described.[1]

Replacement of the Diazonium Group by the Nitro Group.—One-eighth of a mole of the diazonium salt as a thin aqueous paste, was added in small portions to a well-stirred suspension of 20 g. of copper metal, precipitated powder, in a solution of 80 g. of sodium nitrite in 160 cc. of water, contained in a one-liter beaker. The reaction was carried out at room temperature. In those cases where a fair yield of the nitro compound was obtained, the reaction was rapid and accompanied by copious frothing. The froth was broken by adding a few cc. of ether to the reaction mixture from time to time. In a few cases it was necessary to warm the reaction mixture slightly, or to add more copper powder in order to complete the reaction (alkaline β-naphthol test), but in all such cases the yield was

TABLE I

Amino compound	Yield of diazonium compd., %	Yield of pure nitro compd., %	M. p. of nitro compd., °C.
Aniline	92	20	210.0 (B. p.)
o-Nitroaniline	80	33	116.5
m-Nitroaniline	99	43	90.0
p-Nitroaniline	98	64	173.0
o-Chloroaniline	96	32	244.0 (B. p.)
m-Chloroaniline	97	15	44.5
p-Toluidine	74	10	51.5
Ethyl *p*-aminobenzoate	94	50	57.0
p-Aminophenetole	46	..	59.0
p-Aminoazobenzene	92	..	125.5
p-Aminodiphenyl	90	..	112.0
α-Naphthylamine	83	..	58.5

unsatisfactory. The reaction mixture was filtered by suction, the solid washed free of copper salts with water, then with 5% sodium hydroxide to remove phenols, and finally with water.

Extraction and Purification of the Nitro Compounds.—The nitrobenzene, *o*- and *m*-dinitrobenzenes, *o*- and *m*-chloronitrobenzenes, *p*-nitrotoluene, *p*-nitrophenetole and α-nitronaphthalene were separated from the tarry residue by steam distillation and crystallized from alcohol. The *o*-chloronitrobenzene was distilled. The *p*-dinitrobenzene was extracted with benzene, the benzene evaporated, and the residue crystallized first from glacial acetic acid and then from alcohol. The ethyl *p*-nitrobenzoate, *p*-nitroazobenzene and *p*-nitrodiphenyl were extracted with alcohol, and water added to the hot alcoholic extractives nearly to the point of precipitation. The solutions were decolorized with charcoal, filtered hot and allowed to crystallize. The compounds were recrystallized from alcohol.

The experimental data are given in Table I. The nitro compounds obtained are well known and are described in various handbooks and lexicons; hence earlier reference to these are omitted. No figure is given for a yield of less than 10%.

Summary

A method applicable for the preparation of certain nitro compounds is described.

The rate of decomposition of the diazonium borofluoride, and the yield of the nitro compound obtained are influenced markedly by the group present.

BALTIMORE, MARYLAND RECEIVED MARCH 27, 1937

[FROM THE DEPARTMENT OF PATHOLOGY, HARLEM HOSPITAL, NEW YORK CITY]

The Iodination of *p*-Aminobenzenesulfonamide and Some Symmetrical Azobenzenesulfonamides

BY JOHN V. SCUDI

The preparation of the ortho mono- and diiodo derivatives of *p*-aminobenzenesulfonamide was studied in the hope that introduction of this radiopaque element might make it possible to visualize, roentgenologically, the course of this clinically important drug through various parts of the anatomy. Yields ranging from 90 to 100% of the desired compounds were obtained by the usual iodine monochloride methods.[1]

Upon evaporation of hydrochloric acid solutions of 1-amino-2-iodobenzene-4-sulfonamide (I) dismutation of the iodine occurred. *p*-Aminobenzenesulfonamide hydrochloride[2] was isolated and an equivalent weight of I was converted to 1-amino-2,6-diiodobenzene-4-sulfonamide (II). This reaction is suggestive of halogen dismutation of the Chloramine type.[3] However, the iodine is linked to carbon in I and II since they diazotize readily and do not liberate iodine when treated with silver nitrate. Further, II forms a sodio derivative in which both atoms of iodine are retained. Boiling the diiodo derivative (II) into solution in hydrochloric acid caused a cleavage of iodine, and *p*-aminobenzenesulfonamide hydrochloride, I, and some unchanged II were isolated. Dismutation of aryl iodine has been observed in the attempted sulfonation of iodobenzene,[4] iodophenols,[5] and iodoanilines.[6] Treatment of II with 75% sulfuric acid caused cleavage of iodine. Boiling glacial acetic acid is without any appreciable effect. These reactions of I and II may be interpreted as a cleavage of iodine with the formation of iodide and iodate in hydrochloric acid solution at equilibrium with iodine monochloride.[7]

The *p*-acetylamino derivatives were desired since these are expected to be less toxic than their prototypes.[8,9] Using acetic anhydride and limiting the time of heating, the acetyl derivatives of *p*-aminobenzenesulfonamide[2] and I were obtained although a similar derivative of II was not, as might be anticipated from space considerations.

Iodination of *p*-aminobenzenesulfonamide in sodium bicarbonate or sodium hydroxide media was unsatisfactory. Oxidation effects play a significant part since at least one-third of the arylamine was converted to azobenzene-4,4′-disulfonamide (III). In further analogy with the reactions of sulfanilic acid, this same product may be obtained using a variety of oxidizing agents: *e. g.*, the phenol reagent of Folin and Ciocalteu,[10] alkaline potassium ferricyanide,[11]

(1) Kalle and Co., German patent 129,808.
(2) P. Gelmo, *J. prakt. Chem.*, [2] **77**, 372 (1908).
(3) F. D. Chattaway, *J. Chem. Soc.*, **87**, 145 (1905).
(4) H. Hammerich, *Ber.*, **23**, 1635 (1890).
(5) G. S. Neumann, *Ann.*, **241**, 47 (1887).
(6) M. Boyle, *J. Chem. Soc.*, **95**, 1710 (1909).
(7) Gleu and Jagemann, *J. prakt. Chem.*, **145**, 257 (1936).
(8) M. Swick, *Surg. Gyn. Obstetr.*, **56**, 62 (1933).
(9) (a) A. T. Fuller, *Lancet*, **I**, 194 (1937); (b) Marshal, Emerson and Cutting, *J. Am. Med. Assoc.*, **108**, 953 (1937).
(10) O. Folin and V. Ciocalteu, *J. Biol. Chem.*, **73**, 627 (1927).
(11) F. Reitzenstein, *J. prakt. Chem.*, [2] **82**, 265 (1910).