	Fe–X	X–X in the layers	X–X in adjacent layer
$FeCl_3$	2.48	3.50	3.59
$FeBr_3$	2.63	3.70	3.77

The X–X distance between adjacent layers is consistent with the accepted values for the crystal radii of the bromide and chloride ions[5] ($Cl^- = 1.81$; $Br^- = 1.95$). Using the normal crystal radii of the halogens, the ferric ion has available a calculated volume of radius 0.67 in $FeCl_3$ and 0.68 in $FeBr_3$. In view of the fact that the halogens are pulled somewhat closer together within the layers by the metal ions and that the radius ratio indicates anion–anion contact, these values appear consistent with the reported ionic radius of 0.60 for ferric ion.[5]

The author would like to acknowledge the generous permission of Professor E. C. Lingafelter for the use of X-ray equipment.

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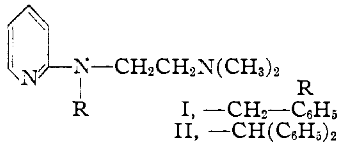
[5] L. C. Pauling, "Nature of the Chemical Bond," Cornell University Press, Ithaca, N. Y., 1942.

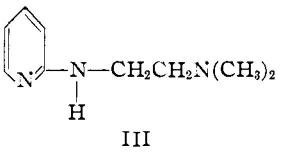
DEPARTMENT OF CHEMISTRY AND CHEMICAL ENGINEERING
UNIVERSITY OF WASHINGTON
SEATTLE 5, WASHINGTON
RECEIVED JULY 31, 1950

Displacement of the Benzohydryl Group by an Alkyl Group

BY LUTHER A. R. HALL[1] AND J. H. BURCKHALTER

α-(Benzylamino)-pyridine condenses readily with 2-dimethylaminoethyl chloride in the presence of lithium amide to give the expected tertiary amine (I).[2] However, we have not yet succeeded in isolating II from an analogous reaction of α-(benzohydrylamino)-pyridine with the same chloride. Instead we find that the reaction mixture,



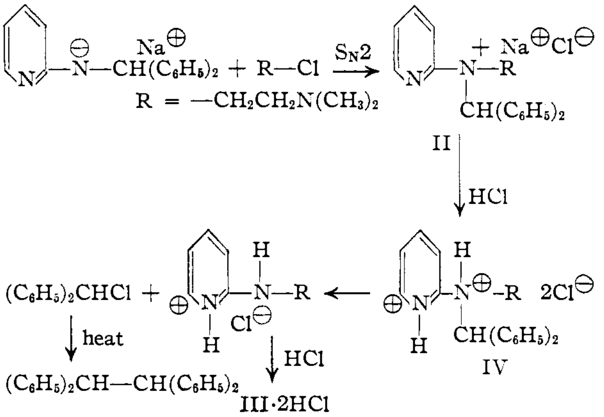


III

after treatment with hydrogen chloride, unexpectedly gives the dihydrochloride of III in 40% yield along with small amounts of benzohydryl chloride[3] and *sym*-tetraphenylethane.[4] These results represent the over-all displacement of a benzohydryl group by an alkyl group.

Experiments have been conducted in an attempt to establish a mechanism for the reaction. The sodamide catalyzed condensation between III and benzohydryl bromide resulted in only unreacted III (54 to 74% recovery as the dihydrochloride), some benzohydryl bromide and *sym*-tetraphenylethane. Under the same experimental conditions and with the omission of III, benzohydryl bromide decomposed to form a small amount of *sym*-tetraphenylethane.[5] In another experiment it was established that treatment of α-(benzohydrylamino)-pyridine with sodamide will not displace the benzohydryl group. Simply the sodium salt of the starting amine results, and 80% of the amine can be recovered.

With these experimental facts in mind, the following possible mechanism is proposed as an explanation of the unexpected formation of III during the attempted synthesis of II. In regard to the decomposition of IV, it is not known whether there is a direct displacement on the benzohydryl group by the chloride ion, or whether there is a spontaneous ionization of IV followed by the combination of the benzohydryl carbonium ion with the chloride ion. Further, failure to isolate II or IV may be attributed to steric requirements. There may be insufficient space in II for the presence of the benzohydryl group, which would cause it to be expelled as a carbonium ion, whereas there is sufficient space in I for the smaller benzyl group.



Experimental[6]

α-(Benzohydrylamino)-pyridine (V) Hydrobromide.—A mixture of 98.8 g. (0.4 mole) of benzohydryl bromide and 37.6 g. (0.4 mole) of α-aminopyridine reacted very exothermically within a few minutes, and on cooling a reddish-brown resin formed. The resin was recrystallized once from absolute alcohol to give 77 g. (57% yield) of a light tan hydrobromide; m.p. 190–191°.[7]

The hydrochloride of V, prepared in the customary manner and recrystallized several times from alcohol, melted at 192–193°.[8]

Anal. Calcd. for $C_{18}H_{16}N_2.HCl$; C, 72.84; H, 5.78. Found: C, 72.62; H, 5.84.

Reaction between α-(Benzohydrylamino)-pyridine (V) and 2-Dimethylaminoethyl Chloride.—A mixture of V [prepared from 51.1 g. (0.15 mole) of the hydrobromide salt and 20% sodium hydroxide solution and extracted with benzene] and 6.6 g. (0.17 mole) of sodamide[9] in 250 ml. of dry benzene was refluxed for forty-five minutes with the evolution of ammonia and the formation of a brown sodium salt of V. A volume of 100 ml. of benzene solution of 2-di-

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[1] Postdoctorate fellow, 1950–1951.

[2] Huttrer, Djerassi, Beears, Mayer and Scholz, THIS JOURNAL, **68**, 1999 (1946).

[3] Huntress, "Organic Chlorine Compounds," John Wiley and Sons, Inc., New York, N. Y., 1948, pp. 30–32.

[4] Anschütz, *Ann.*, **235**, 220 (1886).

[5] It is known from references 3 and 4 that gentle heating alone will convert benzohydryl chloride to sym-tetraphenylethane.

[6] C and H analyses by Mr. Charles Beazley, Skokie, Illinois.

[7] Ssokow, *J. Gen. Chem.* (*U.S.S.R.*), **10**, 1457 (1940); *Chem. Zentr.*, **112**, I, 2246 (1941), using a similar procedure, reported 195–196° but gave no yield.

[8] Ssokow reported 190–191°.

[9] Vaughn, Vogt and Nieuwland, THIS JOURNAL, **56**, 2121 (1934).

methylaminoethyl chloride(10) [prepared from 21.6 g. (0.15 mole) of the hydrochloride and 20% sodium hydroxide solution] was added to the sodium salt suspension. The mixture was heated at reflux temperature for six hours, and the turbid light brown solution cooled and filtered to remove sodium chloride. Benzene was evaporated from the filtrate, and 75 ml. of absolute alcohol was added. Dry hydrogen chloride gas was passed in, and upon evaporation of solvent to one-third of the original volume, 14.5 g. (40% yield) of the dihydrochloride of α-(2-dimethylaminoethylamino)-pyridine (III) was unexpectedly obtained; m.p. 223–225°.

The identity of the product was confirmed by a mixed melting point with an authentic sample(2) and by analysis.

Anal. Calcd. for $C_9H_{15}N_3 \cdot 2HCl$: C, 45.39; H, 7.20; Cl, 29.77. Found: C, 45.02; H, 7.18; Cl, 29.85.

The filtrate from which III dihydrochloride was isolated was evaporated to a viscous black liquid, which was extracted twice with hot benzene. The insoluble layer was distilled at 4 mm. to give 5.5 g. of *sym*-tetraphenylethane; m.p. 209–210.5°.(11) The benzene layer was evaporated and the residue distilled at 135–145° (2–4 mm.) to give 5 g. of benzohydryl chloride.(12) Heated gently, in accord with the literature,(5) the chloride was converted to *sym*-tetraphenylethane, m.p. 204–209°.

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(10) Burckhalter, Stephens and Hall, *J. Am. Pharm. Assoc.*, **39**, 271 (1950).

(11) Anschütz found 207°.

(12) Huntress lists 135–145° (4 mm.).

DEPARTMENT OF PHARMACEUTICAL CHEMISTRY
UNIVERSITY OF KANSAS SCHOOL OF PHARMACY
LAWRENCE, KANSAS
RECEIVED JULY 24, 1950

Preparation of Nitroaminoguanidine

BY RONALD A. HENRY, ROBERT C. MAKOSKY AND G. B. L. SMITH

The synthesis of nitroaminoguanidine reported by Phillips and Williams(1) involves the reaction of nitroguanidine with an equivalent amount of hydrazine sulfate and two equivalents of one normal ammonium hydroxide solution at 55–60°. Reduced to its simplest terms, this hydrazinolysis is represented by the equation

$$NH_2C(NH)NHNO_2 + N_2H_4 \longrightarrow NH_2NHC(NH)NHNO_2 + NH_3$$

Although these authors claimed yields of 50%, repeated duplication of their procedure, coupled with more precise methods for the analysis of nitroaminoguanidine, indicated that their yields were actually 30–35% and the purity of their product 70–80%.

In an attempt to improve the yield of nitroaminoguanidine, certain variables in the reaction of hydrazine with nitroguanidine in aqueous systems were investigated in this Laboratory.

As a result, a modified procedure has been developed which consistently yields nitroaminoguanidine of improved purity in 40–50% yield. The by-products formed in this reaction were described previously.(2)

Experimental

Typical Procedure for the Preparation of Nitroaminoguanidine.—In a two-liter, three-necked flask, equipped with a stirrer, a dropping funnel and a thermometer was placed 52 g. (0.5 mole) of nitroguanidine and one liter of distilled water at 60–65°. To the well-agitated slurry was added, dropwise, 31.9 g. (0.55 mole) of 87% hydrazine hydrate in 500 ml. of water. The temperature was maintained at 55–60°. The addition of the hydrazine required 55–60 minutes after which the solution was stirred for an additional 15 minutes. Ammonia was copiously evolved throughout the entire reaction period. When the reaction was completed, the orange-colored solution was rapidly cooled to below 45° and neutralized with concentrated hydrochloric acid to stop further reaction. The solution obtained from the reaction was chilled at 0° for several hours, after which the impure crystalline product was removed by filtration, washed with several small volumes of ice-cold water, and air-dried. The yield of impure product, containing about 96% nitroaminoguanidine, was 25–30 g. (41–49%); m. p. 186–187° (dec.). Two recrystallizations from water (30 ml. per gram) gave a white powder, decomposing at 190°. The melting point is an unsatisfactory criterion for ascertaining the purity of this compound.

Anal. Calcd. for $CH_5O_2N_5$: hydrazino nitrogen, 23.53. Found: hydrazino nitrogen, 23.51, 23.56, 23.53, 23.49.

Rapid evaporation of the original mother liquor over an open flame to one-third the original volume and cooling for 24 hours at 0° gave a second crop of crude material (12–20 g.), containing about 30% nitroaminoguanidine. Recovery of the pure nitroaminoguanidine, as such, from this crop was very difficult.

Analysis of Nitroaminoguanidine.—The purity of nitroaminoguanidine samples was determined by the following modification of the Jamieson method(3) for estimating hydrazine nitrogen: A 90- to 110-mg. sample of material is accurately weighed into a 125-ml. iodine flask; 20 ml. of water is added and the sample dissolved by heating and swirling. The solution is then cooled to 20–25°, 25 ml. of concentrated hydrochloric acid is added and the solution recooled to 25°, after which 15 ml. of chloroform is added and the solution titrated with standardized 0.1 *N* potassium iodate solution (theoretically 5.3505 g./liter) until the iodine color is completely discharged from the chloroform layer. Initially the iodate is added in increments of 5 to 6 ml., followed by shaking. As the end-point is approached (gradual fading of the iodine color), the size of the increment is progressively decreased so that ultimately the iodate solution is being added dropwise. The shaking between each addition must be maintained and must be very vigorous. If the approximate titer of the sample is known, 90 to 95% of the iodate solution can be added all at once, followed by the more careful addition. The usual precautions must be taken to prevent spurting when the stopper from the iodine flask is being removed.

$$\%\ \text{nitroaminoguanidine} = \frac{(\text{ml. of } KIO_3)(\text{normality of } KIO_3)(119.09/4)}{(\text{sample weight})(10)}$$

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(1) Phillips and Williams, THIS JOURNAL, **50**, 2469 (1928).

(2) Henry, Lewis and Smith, *ibid.*, **72**, 2015 (1950).

(3) Jamieson, "Volumetric Iodate Methods," Chemical Catalog Co., Inc., New York, N. Y., 1926, p. 36.

INORGANIC CHEMISTRY BRANCH
CHEMISTRY DIVISION
U. S. NAVAL ORDNANCE TEST STATION
CHINA LAKE, CALIFORNIA
RECEIVED JULY 17, 1950

The Rates of Absorption of and the Formation of Liver Glycogen by L-Proline and L-Hydroxyproline(1)

BY W. C. HESS AND I. P. SHAFFRAN

L-Proline fed to chickens, as the half sodium salt, was found by Kratzer(2) to be adsorbed at the rate of 49.8 mg. per 100 g. body weight per hour. No previous reports upon the rate of absorption of L-hydroxyproline were found in the literature. Dakin(3) fed L-proline to phlorhizinized dogs and noted the production of extra urinary glucose. Stöhr(4) reported that feeding L-proline and L-

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(1) Presented in part before the Division of Biological Chemistry of the American Chemical Society, Phila., April, 1950.

(2) Kratzer, *J. Biol. Chem.*, **153**, 237 (1944).

(3) Dakin, *ibid.*, **14**, 321 (1913).

(4) Stöhr, *Biochem. Z.*, **299**, 242 (1938).