not previously been found to result directly from the reduction of a nitro compound.

The work of Paul[5] has demonstrated that aliphatic aldoximes in contact with Raney nickel will spontaneously rearrange upon gentle heating to the corresponding amides. It is therefore likely that some of the intermediate oxime (un-isolated) rearranged in the course of the present reduction

$$Me_2C(CH_2NO_2)_2 \xrightarrow[Ni]{H_2} Me_2C(CH{=}NOH)_2 \longrightarrow \begin{cases} Me_2C(CONH_2)_2 \\ Me_2C(CH_2NH_2)_2 \end{cases}$$

It is possible that the reduction of a nitro compound or an oxime to an amine proceeds by way of the intermediate amide. However, the difficulty of reducing amides to amines[6] would indicate that this is probably not the most important reaction.

Experimental

Reduction of Dinitroneopentane.—A solution of 97.2 g. (0.6 mole) of dinitroneopentane in 750 ml. of absolute alcohol was placed in a hydrogenation bomb with 6 g. of Raney nickel catalyst. The hydrogenation proceeded at 1000 p. s. i. and 60°, requiring about two hours for completion. The contents of the bomb were placed in a beaker and allowed to stand at room temperature for twenty-four hours. The crystalline material and the catalyst were then filtered, and the crystalline material was removed from the mixture of extraction with hot water. Cooling the hot water solution gave white crystals, m. p. 268–269°, after one recrystallization from water. A second crop of the above compound was obtained by partly evaporating the alcohol from the original reaction mixture.

Anal. Calcd. for $C_5H_{10}O_2N_2$: C, 46.15; H, 7.69; N, 21.54. Found: C, 46.54; H, 7.84; N, 21.63.

The compound was shown to be the diamide of dimethylmalonic acid by comparison with a sample of that substance prepared from dimethylmalonic acid through the acid chloride, and subsequent treatment with liquid ammonia.

Diaminoneopentane.—The diaminoneopentane from the above reduction was obtained by treating the alcoholic solution above with anhydrous hydrogen chloride, which caused the separation of the di-hydrochloride. The hydrochloride was recrystallized from alcohol, m. p. 256–257°.

Anal. Calcd. for $C_5H_{16}N_2Cl_2$: Cl, 40.50. Found: Cl, 40.54.

This compound prepared in another way has been reported as having the m. p. 280–281°.[7] However, the picrate of the compound agreed with that prepared by these authors (m. p. 240°).

The recrystallized hydrochloride was dissolved in 300 ml. of methanol and methanolic potassium hydroxide was added. After filtering the potassium chloride formed, the diaminoneopentane was separated by distillation in an efficient column. It was a mobile water white liquid, fuming in moist air, b. p. 151–153° (737 mm.); $n^{20}D$ 1.4566.

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(5) R. Paul, *Bull. soc. chim.*, [5] **4**, 1115–1121 (1937).

(6) Adkins, "Reactions of Hydrogen," University of Wisconsin Press, Madison, Wisconsin, 1937.

(7) Kommpa and Sevon, *C. A.*, **27**, 3914 (1933).

Evidence for a Solid Dihydrate of Hexafluoroacetylacetone[1]

BY BOYD G. SCHULTZ AND EDWIN M. LARSEN

In the final step in the production of hexafluoroacetylacetone according to the process of Staniforth[2] in which the solvent and product are separated by fractional distillation, we continually obtained a white crystalline residue with corresponding poor yields of the low boiling product.

The white crystalline product was very soluble in ether, slightly soluble in benzene and petroleum ether, and slowly soluble in water. The water solution of this compound was acid to litmus and slowly liberated carbon dioxide from a solution of sodium hydrogen carbonate. It had a pungent odor and was very volatile as evidenced by substantial sublimation occurring even at room temperature. No melting point was observed as the compound sublimed completely before reaching 115°. On the basis of the following experimental results we have concluded that the material obtained is the dihydrate of hexafluoroacetylacetone.

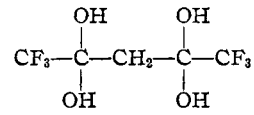
Experimental

For analysis the compound was recrystallized from ether, washed with benzene to remove any diketone present, and dried at room temperature under 0.1 mm. pressure. A qualitative elementary analysis confirmed the presence of carbon and fluorine, and the absence of any metallic elements. From the results of the quantitative analysis for carbon,[3] hydrogen[3] and fluorine, the empirical formula of the compound was calculated to be $C_5H_6O_4F_6$.

Anal. Calcd. for $C_5H_6O_4F_6$: C, 24.58; H, 2.47; F, 46.71. Found: C, 24.48; H, 2.54; F, 46.3.

The neutral equivalent of this compound as determined by titration of an aqueous solution with 0.1 *N* NaOH solution gave a value which corresponded to the molecular weight of the compound, $C_5H_6O_4F_6$: calcd. mol. wt., 244.10; exptl. neutral eq., 245.

Since the fluorine was all present in the starting material as trifluoromethyl groups, it was considered unlikely that the fluorine could be arranged in any other manner, and therefore on the basis of these data it was concluded that this compound was hexafluoroacetylacetone dihydrate



As one would expect, if the proposed formulation were correct, the dihydrate in ether solution was incapable of forming the copper chelate derivate directly. However, a small amount of the enol form must be present in both the ether and water solution of the dihydrate, because on standing in contact with a copper acetate solution for twenty-four hours, a greenish tint, characteristic of the copper chelate, was observed in the ether layer, and after several days the intensity of the coloration increased.

Additional experiments were conducted to test the possibility of dehydration as expressed in the reaction

$$CF_3C(OH)_2CH_2C(OH)_2CF_3 \rightleftharpoons CF_3C(OH){=}CH{-}CO(CF_3) + 2H_2O$$

(1) Based on research carried out under Task Order 4 of Contract N7onr-28504 between the Office of Naval Research and the University of Wisconsin.

(2) Henne, Newman, Quill and Staniforth, THIS JOURNAL, **69**, 1819 (1947).

(3) Analyses by Clark Microanalytical Laboratory, Urbana, Ill.

An ether solution of the dihydrate was treated with phosphorus pentoxide, and samples taken at intervals during a twenty-four-hour period were tested for the presence of hexafluoroacetylacetone.[4] Upon standing for a short time, no test for the hexafluoroacetylacetone was obtained, although after twenty-four hours an immediate test was obtained. The dehydration process progressed rapidly when an ether solution of the dihydrate was refluxed over phosphorus pentoxide for one hour, and then fractionally distilled. The fraction coming over above 35° gave an immediate test for the diketone.

Similarly, an increase in the *p*H of an aqueous solution resulted in a shift of the equilibrium to the right. Thus, an aqueous solution which had been brought up to a *p*H of 7 with 0.1 *N* sodium hydroxide, when treated with a copper acetate solution, gave immediately the ether extractable derivative.

The equilibrium could also be reversed as evidenced by the fact that when an ethereal solution of the hexafluoroacetylacetone was shaken with water, an immediate test for the diketone could not be obtained.

(4) The presence of hexafluoroacetylacetone was determined by shaking the test solution with aqueous copper acetate. The appearance of a green ethereal layer was taken as evidence of the formation of bis-(1,1,1,5,5,5 hexafluoro-2,4-pentanediono)-copper. This was confirmed by analyses of such copper derivatives recovered by evaporation of the ether solution. *Anal.* Found Cu, 13.4; F, 46.7; m. p. 114–116°. Calcd. Cu, 13.3; F, 47.8; m. p. 113–115°.

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Resolution of DL-Tryptophan

BY A. C. SHABICA[1] AND MAX TISHLER

Although a number of excellent methods for the preparation of DL-tryptophan have been reported,[2] no equally satisfactory procedure for the resolution of the DL-mixture is known. We wish to report[3] a method of resolution developed by us several years ago which is simpler than the chemical procedures already reported.[4]

In this method N-acetyl-DL-tryptophan, an intermediate in a few of the recent syntheses, is resolved by brucine. The brucine salt of N-acetyl-D-tryptophan separates cleanly from ethanol and the L- form is obtained from the mother liquor. The N-acetyl enantiomorphs are hydrolyzed to the optically active amino acids by heating with 2*N* hydrochloric acid for about two hours. Both D- and L-tryptophan can be obtained in pure form and in good yields.

Brucine Salt of D- and L-N-Acetyltryptophan.—A mixture of 123 g. of N-acetyl-DL-tryptophan, 208 g. of brucine and 1750 cc. of absolute ethanol was boiled under reflux until solution was effected. After cooling, seeding and storing for twelve hours, the crystalline product was separated and slurried twice with small quantities of ethanol: Weight of dried product, 161 g.; $[\alpha]^{25}D$ − 16.5 ± 1°. Recrystallization from 320 cc. of hot ethanol gave 146 g. of pure brucine salt of N-acetyl-D-tryptophan ($[\alpha]^{25}D$ − 18.4°) as was indicated by its constant rotation when subjected to further recrystallization.

The brucine salt of N-acetyl-L-tryptophan was obtained from the resolution mother liquor by concentration of the solution to dryness under reduced pressure, dissolution of the residue in 320 cc. of hot methanol, charcoal treatment of the solution, dilution of the latter with 325 cc. of dry ether, seeding and storage of the mixture for several hours. The crystalline brucine salt was subjected again to the same recrystallization procedure whereby 139 g. of product was obtained; $[\alpha]^{25}D$ + 1.3 ± 1° (*c*, 1% in water). *Anal.* Calcd. for $C_{36}H_{40}O_7N_4$: C, 67.48; H, 6.29; N, 8.74. Found: C, 67.54; H, 6.13; N, 8.69.

L- and D-Tryptophan.—To a mixture of 49 g. of the recrystallized brucine salt of N-acetyl-L-tryptophan in 170 cc. of water was added 70 cc. of cold 1*N* sodium hydroxide solution. The salt dissolved readily and very soon brucine separated. After cooling in ice for a few hours, the mixture was filtered and the brucine washed with cold water. The combined filtrate and washings were neutralized with hydrochloric acid to *p*H 7.0, concentrated under reduced pressure to 140-cc. volume, treated with charcoal and finally acidified with hydrochloric acid *p*H 3.0. The N-acetyl-L-tryptophan was collected and slurried twice with cold water; weight 16.1 g. (85% yield); $[\alpha]^{25}D$ + 29° (*c*, 1% in H_2O + 1 equivalent NaOH).

A mixture of the product with 160 cc. of 2*N* hydrochloric acid was boiled under reflux for two and one-half hours and the resulting solution was concentrated under reduced pressure to dryness. The residue was dissolved in 40 cc. of hot water and the solution was treated with charcoal. A solution of 7 g. of sodium acetate in 20 cc. of water was added to the product solution and the mixture was stored at 5° for fourteen hours. The product was recrystallized by dissolution in 84 cc. of water containing 2.8 g. of sodium hydroxide, acidifying the warmed solution (at 70°) with 4.5 cc. of acetic acid and storing the mixture at 5° for fourteen hours. The pure L-tryptophan was collected and washed with small amounts of 50% ethanol followed by ethanol and then dry ether; weight, 10.9 g.; 82% yield; $[\alpha]^{25}D$ −31.90 (*c*, 1% in water + 1 equivalent of NaOH).

D-Tryptophan was obtained from the brucine salt of its N-acetyl derivative following the same procedure. The over-all yields were slightly better, however.

(1) Present address: Ciba Pharmaceutical Products, Inc., Summit, New Jersey.

(2) Snyder and Smith, THIS JOURNAL, **66**, 350 (1944); Albertson, Archer and Suter, *ibid.*, **66**, 500; **67**, 36 (1945); Howe, Zambito, Snyder and Tishler, *ibid.*, **67**, 38 (1945); Lyttle and Weisblat, *ibid.*, **69**, 2118 (1947); Warner and Moe, *ibid.*, **70**, 2765 (1948).

(3) The procedure is reported at this time because of a number of recent requests for our method of effecting resolution of DL-tryptophan.

(4) du Vigneaud and Sealock, *J. Biol. Chem.*, **96**, 511 (1932); Berg, *ibid.*, **100**, 79 (1933).

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