Experimental Section[4]

4-(2-Hydroxyethyl)-3-methyl-2-pyrazolin-5-one (1).—This compound was prepared by a modification of the Bachman and Heisey procedure.[3] To 10.0 g (0.078 mole) of 2-acetylbutyrolactone in 20 ml of acetonitrile was added dropwise 4.0 g (0.078 mole) of hydrazine hydrate (99–100%). The reaction was very exothermic and Dry Ice–acetone cooling was required. After addition, the colorless product was filtered off to yield 10.3 g (93%) of product having a melting point of 181–182°.[3]

4-(2-Chloroethyl)-3-methyl-2-pyrazolin-5-one (2).—To 20.0 g (0.141 mole) of **1** was added all at once 120 ml of thionyl chloride. An exothermic reaction ensued and after 2.5 hr the thionyl chloride was removed *in vacuo*. The viscous residue was dissolved in water and just neutralized to pH 7. The gray precipitate which formed was filtered to yield 16.1 g of crude **3** (76%). Crystallization from ethanol gave material of mp 170–171°.

Anal. Calcd for $C_6H_9ClN_2O$: C, 44.87; H, 5.64; N, 17.44. Found: C, 44.92; H, 5.82; N, 17.07.

The hydrochloride could be obtained by crystallizing the residue obtained after removal of thionyl chloride from acetonitrile–ether (79%), mp 108–113°.

Anal. Calcd: Cl, 18.05. Found: Cl, 18.2 (by titration).

Cyclization of 2 to 4-Methyl-7-oxo-5,6-diazaspiro[2.4]hept-4-ene (3).—Cyclization of **2** could be accomplished by adding an excess of aqueous sodium hydroxide to a suspension of **2** in water, followed by neutralization. Alkaline conditions were not necessary to effect cyclization as shown in the following example. To a suspension of 30.0 g (0.25 mole) of **2** in 200 ml of water was added with stirring a solution of 11 g of sodium hydroxide in 400 ml of water over a 4-hr period. The pH was never allowed to go above 6 and the final pH was 5.9. The solution was filtered from a small amount of insoluble material and evaporated to dryness and the residue was crystallized from acetonitrile to yield 20.0 g of **3**, mp 140–141°. Recrystallization from ethanol raised the melting point to 148–149°.

Anal. Calcd for $C_6H_8N_2O$: C, 58.05; H, 6.50; N, 22.57. Found: C, 58.09; H, 6.57; N, 22.50.

Ring Opening of 3 to 2.—A solution of 1.0 g (0.005 mole) of **3** in 2 ml of concentrated hydrochloric acid was refluxed for 5 min. The solution was cooled and neutalized with aqueous sodium hydroxide. The solid was filtered off to give 1.2 g of product **2** having the identical infrared spectrum and melting point with those of the product prepared above.

Registry No.—**1**, 7721-54-2; **2**, 7721-55-3; hydrochloride of **2**, 7721-56-4; **3**, 7721-57-5.

Acknowledgment.—We wish to thank Dr. Eugene A. Pier of Varian Associates for running and interpreting the nmr spectra.

(4) Melting points were determined on a calibrated Fisher-Johns apparatus and are corrected. Elemental analyses were performed by Midwest Microlab, Inc., Indianapolis, Ind. 46226. Proton nmr spectra were obtained using a Varian HA-100 spectrometer in $CDCl_3$ solution using tetramethylsilane as internal standard.

The Resolution of 3-Amino-3-methylhexane[1]

DON C. IFFLAND AND NGUYEN T. BUU

Department of Chemistry, Western Michigan University, Kalamazoo, Michigan 49001

Received October 17, 1966

A search of the chemical literature has revealed no resolution of simple completely aliphatic tertiary carbinylamines. An interest in the stereochemistry at the tertiary carbon atom has lead us to prepare and resolve 3-amino-3-methylhexane as described in the Experimental Section.

(1) (a) Support of this study by Grant GP 1943 from the National Science Foundation is gratefully acknowledge. (b) Abstracted from a portion of the M.A. thesis of N. T. B., Western Michigan University, 1965.

This amine was repeatedly prepared in 75% yields by the Ritter method.[2] Hydrogen cyanide was alkylated with 3-methyl-3-hexanol and the resulting N-substituted formamide was hydrolyzed in aqueous alkali to form the amine.

Resolution of the racemic amine was realized by the fractional crystallization of the diastereoisomeric monoamine (+)-tartaric acid salts. It was noteworthy that even though successive recrystallizations of this salt provided an amine of successively greater specific rotation, neither the melting points nor the specific rotations of the tartrate salts correlated with the activity of the isolated amine.

The amine isolated after four crystallizations of the salt showed a low specific rotation, $[\alpha]^{25}D$ −0.096°. Although it was possible that this amine was not fully resolved, further recrystallizations were not obtained because of the limited amount of salt at this point. Nevertheless, there is reason to believe that this *t*-alkylamine possesses a low specific rotation when optically pure. Following the conformational analysis and empirical rules described by Brewster,[3] the predicted specific rotation[4] for this amine is 0°. Furthermore, a comparison of the maximum specific rotations reported for the isoelectronic *sec*-alkylamines and *sec*-carbinols shows that the amines commonly have specific rotations 0.4 to 0.8 the values for the related alcohols as indicated in Table I. If this relationship is valid in the *t*-alkyl series, a specific rotation as great as 0.152° would be anticipated for the 3-amino-3-methylhexane based on the $[\alpha]D$ 0.19° reported for 3-methyl-3-hexanol.[5]

TABLE I

SPECIFIC ROTATIONS OF RELATED *sec*-ALKYLAMINES AND *sec*-CARBINOLS

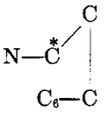
R	$[\alpha]D$, deg RNH_2	$[\alpha]D$, deg ROH	Ratio of RNH_2/ROH
2-Butyl	+7.80[a]	+13.83[b]	0.55
2-Hexyl	+4.3[c]	+10.7[c]	0.40
3-Heptyl	+4.15[c]	+5.12[c]	0.79
4-Octyl	+0.45[c]	+0.74[d]	0.61
3-Nonyl	+4.61[c]	+7.08[d]	0.65

[a] W. Leithe, *Ber.*, **63**, 804 (1930). [b] J. Kenyon, H. Phillips, and V. P. Pittman, *J. Chem. Soc.*, 1077 (1935). [c] P. A. Levine, A. Rothen, and M. Kuna, *J. Biol. Chem.*, **120**, 759 (1937). [d] P. A. Levine and R. E. Marker, *ibid.*, **91**, 418 (1931).

The conversion of the active amine to the N-methylene derivative introduced a group of greater refractivity than present in the amine and accordingly an increase in specific rotation was observed. In a consistent manner, reduction of the N-methylene derivative to 3-methylamino-3-methylhexane resulted in a decrease in the specific rotation.

Resolution of the 3-amino-3-methylhexane was attempted using the following active acids: (+)-

(2) J. J. Ritter and T. Kalisch, *J. Am. Chem. Soc.*, **70**, 4048 (1948).
(3) J. H. Brewster, *ibid.*, **81**, 5475 (1959).
(4) Including, at equal weight, the five-atom strained comformations



leads to a predicted value of 0.5°.
(5) A. G. Davies, J. Kenyon, and L. W. F. Salame, *J. Chem. Soc.*, 3148 (1957).

malic acid, (+)-benzoyltartaric acid, and (+)-camphorsulfonic acid. Although crystalline salts were obtained, the isolated amine was inactive.

Experimental Section[6]

3-Methyl-3-heptanol.—This alcohol was prepared in 60–70% yields by treating 2-pentanone with ethylmagnesium bromide: bp 138–142°, $n^{25}D$ 1.4203 (lit. bp 141°,[7] $n^{20}D$ 1.4231[8]).

3-Amino-3-methylhexane.—The procedure for the conversion of a tertiary alcohol to a *t*-alkylamine as developed by Ritter and Kalish[2] was adapted as follows. A solution of 375 g of sulfuric acid in 200 ml of glacial acetic acid was added slowly to a stirred solution containing 172 g of 3-methyl-3-hexanol (1.5 moles) and 82.5 g (1.5 formula wt) of 90% sodium cyanide in 190 ml of glacial acetic acid. The reaction was maintained 40–60° by the use of an ice–water bath. After remaining for 48 hr at room temperature, a solution containing 600 g of sodium hydroxide dissolved in 800 ml of water was added and the mixture was refluxed for 4 hr. The amine was removed by steam distillation and the distillate was made strongly alkaline with concentrated sodium hydroxide solution. The amine was separated and the aqueous layer was extracted three times with 50-ml portions of pentane. The combined organic portions were dried with anhydrous potassium carbonate and 133 g of colorless amine was isolated by fractional distillation using a 31 × 0.5 cm tantalum wire spiral column: bp 129–130°, $n^{25}D$ 1.4171, d^{25}_4 0.919.

Anal. Calcd for $C_7H_{17}N$: C, 72.96; H, 14.88; N, 12.16. Found: C, 73.16; H, 14.88; N, 12.12.

The nmr spectra indicated no tertiary hydrogen signal (1.6 ppm downfield from TMS).

Resolution of 3-Amino-3-methylhexane.—Over a period of 1 hr, 460 g (4.0 moles) of racemic 3-amino-3-methylhexane was added to a solution of 600 g (5.2 moles) of (+)-tartaric acid dissolved in 2000 ml of water. The mixture was heated over a steam bath for a period of 1 hr and allowed to cool to room temperature. The solution was stored overnight in a refrigerator and yielded 400 g of white, crystalline tartrate salt: mp 115–116°, $[\alpha]^{25}D$ 15.1° (*c* 4, *l* = 2 dm, water).

Anal. Calcd for $C_{11}H_{23}NO_6$: C, 49.80; H, 8.74. Found: C, 49.73; H, 8.65.

The amine was recovered from the amine (+)-tartaric acid salt by the following procedure. The tartrate salt (172 g, 0.65 mole) was dissolved in about 200 ml of water. The solution was made alkaline (with cooling) by adding a solution of 56 g of potassium hydroxide dissolved in 100 ml of water. On standing the mixture separated into two layers. The water layer was extracted with three 20-ml portions of pentane. The extracts were combined with the organic layer, dried over anhydrous potassium carbonate, and distilled through the tantalum wire spiral column. The distillation gave 72.2 g (94% recovery) of the *t*-alkylamine: $[\alpha]^{25}D$ −0.032°, bp 129.5–131.5°.

Anal. Calcd for $C_7H_{17}N$: C, 72.96; H, 14.88; N, 12.16. Found: C, 72.85; H, 14.69; N, 12.10.

After three successive recrystallizations, the above amine (+)-tartrate salt gave the following properties: mp 114–116°, $[\alpha]^{25}D$ 14.8°. However, the specific rotation of the amine liberated from this salt was $[\alpha]^{25}D$ −0.096° (*l* = 4 dm, neat).

(+)-3-Methyleneamino-3-methylhexane.[9]—In 1.5 hr, 150 ml (1.25 moles) of 40% formalin was added with stirring and cooling to 144 g (1.25 moles) of active 3-amino-3-methylhexane ($[\alpha]^{25}D$ −0.032°). After stirring for 1 hr the reaction mixture separated into two layers. The mixture was made alkaline with potassium hydroxide solution and extracted with three 20-ml portions of pentane. The extracts were combined with the organic layer and dried over potassium hydroxide pellets. Distillation through the tantalum wire spiral column gave 137 g (86%) of clear, lachrymatory liquid: bp 141–145°, $n^{25}D$ 1.4318, $[\alpha]^{25}D$ +0.59° (*l* = 2 dm, neat).

Anal. Calcd for $C_8H_{17}N$: C, 75.52; H, 13.47; N, 11.01. Found: C, 75.33; H, 13.34; N, 11.10.

(+)-3-Methylamino-3-methylhexane.[9]—A solution containing 137 g of (+)-3-methyleneamino-3-methylhexane ($[\alpha]^{25}D$ +0.59°) dissolved in 150 ml of methanol was reduced with hydrogen over 0.05 g of platinium oxide catalyst in a Parr low-pressure apparatus. Fractional distillation afforded 127 g (92%) of the secondary amine: bp 152–155°, $n^{25}D$ 1.4218, $[\alpha]^{25}D$ +0.16° (*l* 2 dm, d^{25} 0.924, neat).

Anal. Calcd for $C_8H_{19}N$: C, 74.34; H, 14.82; N, 10.84. Found: C, 74.54; H, 15.00; N, 10.78.

Registry No.—3-Amino-3-methylhexane, 7687-23-2; 3-amino-3-methylhexane tartrate, 7687-24-3; (+)-3-methyleneamino-3-methylhexane, 7687-25-4; (+)-3-methylamino-3-methylhexane, 7687-26-5.

(6) Elemental analyses were performed by Galbraith Microanalytical Laboratories, Knoxville, Tenn. Optical activity was measured with a Rudolph Model 62 polarimeter.

(7) P. M. Ginnings and M. Hauser, *J. Am. Chem. Soc.*, **60**, 2581 (1938).

(8) F. C. Whitmore and D. E. Badertscher, *ibid.*, **55**, 1561 (1933).

(9) Corresponding physical properties and satisfactory elemental analyses were obtained for the racemic compound prepared from inactive amine.

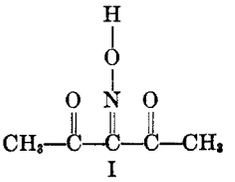
Cyanide-Catalyzed Fragmentation of Triketone Monoximes[1]

ELEANOR V. CRABTREE AND EDWARD J. POZIOMEK

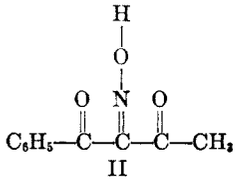
Defensive Research Department, Research Laboratories, Edgewood Arsenal, Maryland 21010

Received August 11, 1966

Reaction of acylating agents with triketone monoximes is reported to be complicated. Green and Saville[2] found that the reaction of acylating agents with 2,3,4-pentanetrione 3-oxime (I) leads to the pro-



I



II

duction of over 6 moles of acid and the consumption of 3 moles of oxime per mole of acylating agent. One would have expected 3 moles of acid and the consumption of 1 mole of oxime as the result of acylation, fragmentation, and hydrolysis. Compound I itself slowly decomposed in neutral, aqueous solution. Pyruvic acid was found among the decomposition products but the mechanism was considered obscure and was not investigated further.

Analogous properties have been observed for 1-phenyl-1,2,3-butanetrione 2-oxime (II).[3] Hydrogen cyanide is one of the products from reaction of II with reagents such as acetic anhydride or benzenesulfonyl chloride which are known to bring about Beckmann fragmentation of α-oximino ketones. The hydrogen cyanide produced by spontaneous decomposition of the oxime increased to a maximum, then decreased after a few hours to a plateau. An explanation offered for the decrease and leveling off of cyanide concentration was that hydrogen cyanide reacts with the remaining excess II to form a cyanohydrin, but no effort was made to isolate products.[3]

This paper concerns itself with elucidating the mechanism of cyanide reaction with the triketone monoxime (II). This is of particular current interest because II

(1) The work was presented in part at the Meeting in Miniature of the Maryland–Washington, D. C., sections of the American Chemical Society, University of Maryland, May 1966.

(2) A. L. Green and B. Saville, *J. Chem. Soc.*, 3887 (1956).

(3) W. J. Barrett and E. B. Dismukes, Southern Research Institute, Birmingham, Ala. 35205.