equivalent of sodium ethoxide, which served to convert XV to XIV.

Summary

Ethyl and phenyl α-chloro-N-alkyliminoisobutyrates have been prepared and subjected to alcoholysis. The free iminoesters remain unchanged in this reaction. Hydrogen chloride converts the ethyl esters to the corresponding amides, but the phenyl ester is relatively unaffected by this reagent. Neither of these esters form hydrochlorides. The β-hydroxyethyl N-ethyliminoester appears to cyclize to a more basic structure, $(CH_3)_2CClC(NHC_2H_5)OCH_2CH_2O$, which dehydrochlorinates a portion of the original iminoester. The resulting hydrochloride of this iminoester then decomposes into α-chloro-N-ethylisobutyramide and ethylene chlorohydrin.

Both chloretone and its acetate are converted to ethyl α-ethoxyisobutyrate by sodium ethoxide.

The preparation of 1,1,1-trichloro-2-methylpropene-2 and 1,1,1,2-tetrachloro-2-methylpropane from chloretone are described. The latter compound is converted to the former by alcoholic sodium ethoxide, after which the trichloropropene reacts with this reagent to give 1,1-dichloro-2-methyl-3-ethoxypropene-1 or ethyl β-ethoxyorthoisobutyrate, depending on the amount of the ethoxide employed.

MADISON, WISCONSIN RECEIVED MAY 31, 1947

[CONTRIBUTION FROM THE CHEMICAL LABORATORIES OF NORTHWESTERN UNIVERSITY]

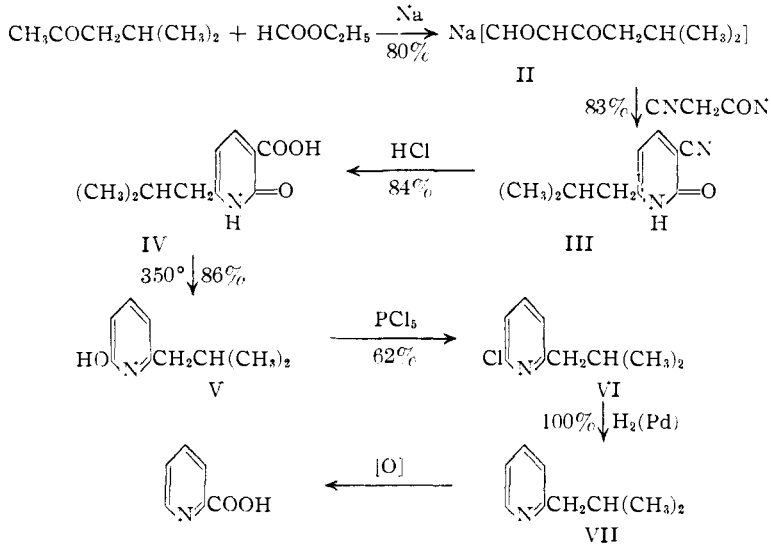
Condensations of Unsymmetrical Ketones. I. Condensations with Ethyl Formate

BY RAYMOND P. MARIELLA

It has been shown independently by Tracy and Elderfield,[1] and Joshi, Kaushal and Deshapande[2] that ethyl formate condenses with an unsymmetrical ketone, methyl ethyl ketone, to give I.

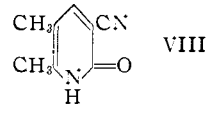
$$CH_3COC(CH_3)=CHOH \quad I$$

The present work was undertaken to determine whether methyl alkyl ketones, in general, are attacked by ethyl formate at the methylene group. Methyl isobutyl ketone was chosen as another example and the series of compounds shown on the accompanying flow sheet was developed.



The cyanopyridone (III), formed in the condensation of the sodium salt of the hydroxymethylene ketone (II) with cyanoacetamide, was converted into the acid (IV) by refluxing with concentrated hydrochloric acid, and then decarboxylated to the pyridol (V) by heating to 350°. This pyridol was converted into the corresponding chloropyridine (VI) with phosphorus pentachloride, and then reduced to 2-isobutylpyridine (VII) with palladium as the catalyst. Oxidation of VII with alkaline permanganate gave picolinic acid, thus proving the initial condensation occurred at the methyl group. The yields on all steps were good, and in no case was a bad mixture encountered.

Also in the present work, the sodium salt of I was prepared and condensed with cyanoacetamide to give the pyridone (VIII).[3] The modification of using the sodium salt instead of the free hydroxymethylene ketone greatly increased the over-all yield of the pyridone.[3]



VIII

Although ethyl formate condenses with methyl ethyl ketone at the methylene group, in the case of a β-substituted aryl or alkyl methyl ethyl ketone, such as methyl β-phenylethyl ketone and methyl isobutyl ketone, the methyl group is the point of attack. Moreover, in the condensation of ethyl oxa-

(1) Tracy and Elderfield, *J. Org. Chem.*, **6**, 63 (1941). See this reference for a review of the literature on this subject.

(2) Joshi, Kaushal and Deshapande, *J. Indian Chem. Soc.*, **18**, 479 (1941).

(3) In the only other attempt to use the sodium salt in this preparation, Barat, *J. Indian Chem. Soc.*, **8**, 801 (1931), reported the salt too hygroscopic to be used.

late[4] and ethyl methoxyacetate[5] with methyl ethyl ketone, itself, the methyl group is the point of attack.

In view of the evidence at the present time, no simple rule for predicting the point of condensation of ethyl formate with an unsymmetrical ketone seems apparent.

The author wishes to express his thanks to the Shell Development Company for a generous sample of methyl isobutyl ketone.

Experimental[6]

Sodium Salt of Hydroxymethylene Methyl Isobutyl Ketone (II).—To a two-liter three-necked flask, immersed in an ice-water cooling bath, and fitted with a mercury seal stirrer, a condenser, protected by a drying tube, and an addition funnel, and containing one liter of dry ether and 33 g. of sodium ribbon was added (dropwise over a period of two hours) a mixture of 106 g. of ethyl formate and 143 g. of methyl isobutyl ketone (b. p. 114.5–115.5° (740 mm.)). When the addition was complete, the cooling bath was removed and the stirring continued for one hour, as the reaction mixture came to room temperature. The brown mud-like slurry was filtered as quickly as possible, washed with a little absolute ether and dried in a vacuum desiccator. The dried product weighed 170 g. (80% yield).

3-Cyano-6-isobutylpyridone-2 (III).—Two solutions were prepared separately. Solution (A) contained 75 g. of II and 37 g. of cyanoacetamide in 200 cc. of water. Solution (B) contained 6 cc. of glacial acetic acid in 15 cc. water and enough piperidine to make the solution basic. Solutions (A) and (B) were mixed and the resulting clear solution refluxed for two hours, cooled, and acidified with glacial acetic acid. The thick brown slurry was filtered, washed with water, and dried, 70 g. (83% yield). After a carbon treatment and several recrystallizations from alcohol, white prisms were obtained; m. p. 149–150°.

Anal. Calcd. for $C_{10}H_{12}N_2O$: N, 15.89. Found: N, 15.64.

3-Carboxy-6-isobutylpyridone-2 (IV).—A solution of 32.7 g. of III in 300 cc. of concentrated hydrochloric acid was refluxed for five hours and then poured on 300 g. of ice. The voluminous white precipitate was filtered, washed well with cold water, and air dried, 30.5 g. (84% yield). A sample recrystallized several times from water had an m. p. 170–171°.

Anal. Calcd. for $C_{10}H_{13}NO_3$: N, 7.18. Found: N, 6.90.

2-Isobutyl-6-hydroxypyridine (V).—A 500-cc. round-bottom flask containing 16.85 g. of IV and protected by a cold finger, was heated to 350° in a mixed salt-bath and kept at that temperature for fifteen minutes, by which time the evolution of carbon dioxide had ceased. The black crystalline residue, 13.0 g., was vacuum distilled at a pressure of 0.2 mm. and a temperature of 120°, and the white crystalline product so obtained weighed 11.2 g. (86% yield), m. p. 98–100°. When sublimed, the material melted at 102–103°.

Anal. Calcd. for $C_9H_{13}NO$: N, 9.26. Found: N, 9.05.

A solution in alcohol turned deep red on addition of a few drops of ferric chloride solution.

2-Isobutyl-6-chloropyridine (VI).—To a solution of 21.5 g. of crude V in 25 cc. of phosphorus oxychloride heated to reflux, were added, in small portions, 33 g. of phosphorus pentachloride, over a period of one-half hour. The bath temperature was then increased to 160° and kept there for one hour. After cooling, and removing the oxychloride under reduced pressure, the residue was poured on ice. The black mixture was then made strongly basic, the material steam distilled, and the product came over as a colorless heavy oil. The material was then taken up in ether, the ether dried and then removed, leaving a yellow oil (17.8 g.). This was distilled *in vacuo* and 15.0 g. (62% yield) of water white liquid, b. p. 91–92° (9 mm.), was obtained, $n^{25}D$ 1.5060.

Anal. Calcd. for $C_9H_{12}ClN$: N, 8.26. Found: N, 8.13.

2-Isobutylpyridine (VII).—To a solution of 8.6 g. of VI in 150 cc. of absolute alcohol were added a solution of 1.0 g. of palladium chloride in 2 cc. concentrated hydrochloric acid, 15 cc. of 15% alcoholic hydrochloric acid, and 3 g. of activated carbon. The reduction proceeded at room temperature and 10 pounds of pressure and was complete in ten minutes, going to theoretical uptake of hydrogen and stopping. The insoluble material was filtered and the clear liquid filtrate concentrated to a viscous colorless oil, which after being pumped to dryness in a vacuum desiccator and kept there for a week, was half solid and half very viscous oil, 8.7 g. (100% yield). This hydrochloride was hygroscopic. The free base was liberated by treating the hydrochloride with an excess of sodium bicarbonate solution. The free base, which possessed the typical pyridine odor, was taken up in ether, dried and the ether removed, leaving a yellow oil. Distillation gave a colorless liquid, b. p. 177–179° (740 mm.),[7] $n^{25}D$ 1.4832.

The picrate was prepared in the form of fine, long yellow needles, m. p. 280–281° (dec.).

Anal. Calcd. for $C_{15}H_{16}N_4O_7$: N, 15.38. Found: N, 15.50.

The chloroaurate was prepared as a yellow powder, m. p. 84–86°.

Anal. Calcd. for $C_9H_{14}Cl_4NAu$: Au, 41.4. Found: Au, 41.4.

The chloroplatinate[7] was obtained as a mass of light yellow prisms, m. p. 191–193°.

Anal. Calcd. for $C_{18}H_{28}Cl_6N_2Pt$: Pt, 28.7. Found: Pt, 29.0.

Oxidation to Picolinic Acid.—The oxidation of 2-isobutylpyridine with alkaline permanganate gave picolinic acid, which did not depress the melting point of an authentic sample, m. p. 136°, obtained in the oxidation of α-picoline.[8] The hydrochloride was also formed, m. p. 210–212°, which did not depress the melting point of an authentic sample of picolinic acid hydrochloride.[8]

Anal. Calcd. for $C_6H_6ClNO_2$: C, 45.16; H, 3.79; N, 8.78. Found: C, 45.20; H, 3.60; N, 8.50.

Sodium Salt of Methyl Hydroxymethylene Ethyl Ketone.—A solution of 111 g. of ethyl formate and 108 g. of methyl ethyl ketone (b. p. 79–80° (750 mm.)) were added to 34.5 g. of sodium metal in one liter of absolute ether (same procedure as for methyl isobutyl ketone). The light brown solid was isolated in a 75% yield (138 g.).

3-Cyano-5,6-dimethylpyridone-2 (VIII).—A solution of 25 g. of the sodium salt of I and 16 g. of cyanoacetamide in 100 cc. of water and piperidine acetate, made from 2 cc. of glacial acetic acid in 5 cc. of water, and enough piperidine to make it basic, was refluxed for two hours. The solution was then cooled, acidified with glacial acetic acid and filtered, 16 g. (56% yield). A sample recrystallized from ethyl alcohol had a m. p. 270–272° (dec.).

Anal. Calcd. for $C_8H_8N_2O$: C, 64.84; H, 5.44. Found: C, 64.79; H, 5.62.

Summary

The condensation of ethyl formate with methyl isobutyl ketone is at the methyl group. The condensation product of cyanoacetamide with the

(4) Tracy and Elderfield, *J. Org. Chem.*, **6**, 70 (1941).

(5) Harris and Wilson, THIS JOURNAL, **63**, 2526 (1941).

(6) Analyses by Miss Patricia Craig and Mrs. Nelda Mold.

(7) Diels and Alder, *Ann.*, **505**, 148 (1933), report a b. p. 180–185°. The chloroplatinate melted at 193°.

(8) Singer and McElvain, "Organic Syntheses," **20**, 79 (1940).

sodium salt of hydroxymethylene methyl isobutyl ketone was degraded to 2-isobutylpyridine. There seems to be no simple rule to predict the point of condensation of ethyl formate with an unsymmetrical ketone.

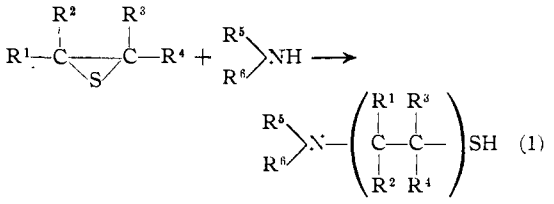
EVANSTON, ILLINOIS RECEIVED MAY 23, 1947

[CONTRIBUTION FROM THE NOYES CHEMICAL LABORATORY OF THE UNIVERSITY OF ILLINOIS]

The Synthesis of Amino Mercaptans from Olefin Sulfides[1]

BY H. R. SNYDER, JOHN M. STEWART[2a] AND J. B. ZIEGLER[2b]

The need for large quantities of mercaptans in the synthetic rubber industry has prompted the investigation of various reactions of possible use in the large-scale production of these substances. The present report concerns a study of the preparation of amino mercaptans by the reaction of olefin sulfides and amines in accordance with equation 1.

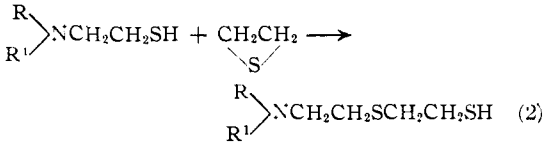


(1)

The reaction has been used previously for the preparation of certain amino mercaptans from ethylene sulfide or propylene sulfide and primary or secondary amines.[3] A number of new amino thiols now have been prepared from these olefin sulfides and others have been obtained from isobutylene sulfide and cyclohexene sulfide.

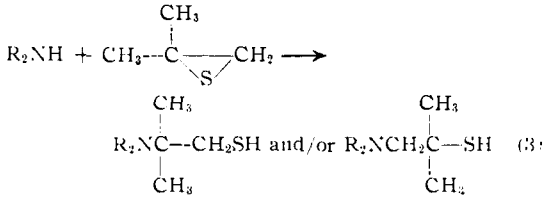
The cyclic sulfides were prepared by the reaction of the oxides with potassium thiocyanate in aqueous or dilute alcoholic solutions.[4] The spontaneous polymerization of ethylene sulfide, noted by previous investigators[5] to occur even at 0° was found to be effectively inhibited by the addition of a small amount of an aliphatic mercaptan.[6] Cyclohexene sulfide could be stored in the refrigerator for periods of several days without polymerization, and samples of isobutylene sulfide have undergone no significant change on storage at room temperature for about three months.

Reactions of the cyclic sulfides with secondary amines were carried out without catalyst or solvent at temperatures near 100°, the period of reaction being ten to twenty hours. The yields were not improved by the addition of phenol,[3] aluminum chloride or the sodium derivative of the amine. The yields of amino mercaptans were adversely affected by the presence of bulky substituents on the nitrogen atom and by increasing degree of substitution in the sulfide ring. The product from ethylene sulfide and di-*n*-butylamine was obtained in 70–80% yields, whereas that from the same sulfide and di-*n*-heptylamine was obtained in only 40 to 55% yields. Only negative results were obtained from ethylene sulfide and diphenylamine or dicyclohexylamine. Isobutylene sulfide reacted with secondary amines such as di-*n*-butylamine only to the extent of 15 to 25%, but the yields from this sulfide and primary amines or cyclic secondary amines such as piperidine and morpholine were in the range of 55 to 75%. Propylene sulfide was treated with only one amine, di-*n*-amylamine, with which it reacted to the extent of 50 to 60%. From the one trial made with it, cyclohexene sulfide appears to be less reactive than isobutylene sulfide; only a 35% yield of the amino mercaptan was obtained from cyclohexene sulfide and piperidine. In most of the reactions small amounts of the products formed by reaction of the amino mercaptan with more of the sulfide were produced (equation 2).[3] The presence of an excess of the amine repressed this side reaction.



(2)

Unsymmetrically substituted olefin sulfides might be expected to yield one or both of two isomeric products in the reaction with secondary amines. For example, the possible products from isobutylene sulfide are a primary and a tertiary mercaptan (equation 3). The Rheinboldt color test[7] indicates the products to be tertiary mercaptans. These amino mercaptans react with iodine to give sulfenyl iodides (equation 4) in good yields, indicating that the substances con-



(3)

(1) This work was carried out under contract Ru RSR 95 between Rubber Reserve Company and the University of Illinois.

(2a) Present address: Montana State University, Missoula, Montana.

(2b) Present address: The J. T. Baker Chemical Co., Phillipsburg, N. J.

(3) German Patent 631,016; *C. A.*, **30**, 6008 (1936).

(4) French Patent 797,621; *ibid.*, **30**, 7122 (1936).

(5) Barr and Speakman, *J. Soc. Dyers Colourists*, **60**, 238 (1944).

(6) U. S. Patent 2,185,660; *C. A.*, **34**, 2865 (1940).

(7) Rheinboldt, *Ber.*, **60**, 184 (1927).