a trace of anhydrous copper sulfate and a drop of benzyl cyanide at 150° for six hours. After cooling, dry acetone (100 cc.) was added and the mixture filtered. Removal of the acetone followed by vacuum distillation gave 41.5 g. of benzyl cyanide, b. p. 119–122° (26 mm.).

No appreciable reaction was observed between benzyl chloride and cuprous cyanide at 100° after five hours.

The Action of Cuprous Cyanide on *p*-Methoxybenzyl Chloride.—The addition of *p*-methoxybenzyl chloride (44 g.) to cuprous cyanide (26 g.) at room temperature gave an instantaneous reaction accompanied by heat and gas evolution and the production of a tar. Carrying out the reaction in dry pyridine at −5° and then allowing the mixture to come to room temperature, likewise gave a tar. Treating *p*-methoxybenzyl chloride (26 g.) in acetone (30 cc.) with dry cuprous cyanide (15 g.) at −70° gave no reaction. When the mixture was allowed to reach room temperature, it reacted with an evolution of gas and the formation of a tar.

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The Solubility, Absorption Spectrum and Ionization Constant for Aloe-Emodin

BY K. G. STONE AND N. HOWELL FURMAN

In connection with some other work, it was necessary to know the apparent ionization constant of aloe-emodin. As part of the determination, the solubility and spectrum were required. The results of these measurements are reported here.

Experimental

The aloe-emodin used was prepared by the ferric chloride oxidation of Merck U. S. P. Aloin as described by Cahn and Simonsen.[1] The product after recrystallization from toluene melted at 218° (uncor.). The 0.1 *M* borax-sodium carbonate buffers described by Kolthoff and Vleeschouwer[2] were prepared from C.P. materials which were analyzed where necessary.

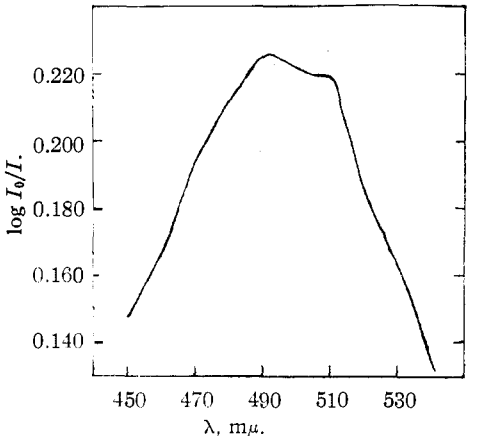

Fig. 1.—Aloe-emodin in *p*H 11 buffer; concentration, 0.20 mg. per ml.

Optical measurements were made with a Cenco-Sheard Spectrophotelometer with an effective slit width of ten millimicrons and 1.0-cm. Corex cells. In all cases solutions containing all reagents except the aloe-emodin were used as blanks. All volumetric glassware was discarded if it did not meet the customary tolerances.

Saturated solutions of aloe-emodin in the buffer solutions were prepared by intermittent shaking of the buffer with solid aloe-emodin in a glass-stoppered flask in a water-bath at 25.0 ± 0.1°. Standard solutions for colorimetric calibration were prepared by dissolving weighed quantities of aloe-emodin in known volumes of buffer solutions.

Results

The spectrum of aloe-emodin in 0.1 *M* borax–sodium carbonate buffer of *p*H 11 is given in Fig. 1. The spectra in the buffers of other *p*H values were almost identical with the spectrum given. Beer's law was followed in all cases in the region from 480 to 510 millimicrons with concentrations up to 0.04 mg. per ml. where the measurements become uncertain.

The solubility measurements given in Table I were obtained by colorimetric analysis of the saturated solutions after dilution with pure buffer if necessary.

TABLE I

SOLUBILITY OF ALOE-EMODIN IN 0.1 *M* BORAX–SODIUM CARBONATE BUFFERS

*p*H	Moles/liter × 10^5
9.8	7.60
10.0	9.63
10.4	14.8
10.8	28.7
11.0	43.3

The apparent ionization constant of aloe-emodin may be calculated graphically using the method of Davidson.[3] By this method it was found that the intrinsic solubility of aloe-emodin is 5.5 × 10^{-5} mole per liter and that the apparent K_A is 6.8 × 10^{-11}.

(3) D. Davidson, *J. Chem. Ed.*, **19**, 221 (1942).

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The Acetylation of *o*-, *m*- and *p*-Nitroacetophenones by the Boron Trifluoride Method[1]

BY HOWARD G. WALKER, JR., AND CHARLES R. HAUSER

Burgess[2] reported that the acylation of acetone with ethyl *p*-nitrobenzoate using sodium amide produced only a poor yield of the corresponding β-diketone. The acetylation of *m*-nitroacetophenone with ethyl acetate by this basic reagent method has also been unsatisfactory.[3] On the other hand it seemed probable that the acetylation of nitroacetophenones with acetic anhydride by the boron trifluoride method[4] would be satis-

(1) R. S. Cahn and J. L. Simonsen, *J. Chem. Soc.*, 2573 (1932).

(2) I. M. Kolthoff and J. J. Vleeschouwer, *Biochem. Z.*, **189**, 191 (1927).

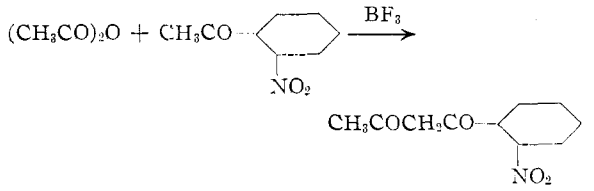
(1) Paper XXXV on "Condensations"; paper XXXIV, THIS JOURNAL, **68**, 700 (1946).

(2) Burgess, *J. Chem. Soc.*, 2017 (1927).

(3) Mr. D. F. Thompson of this Laboratory obtained apparently none of the β-diketone using sodium amide.

(4) (a) Meerwein and Vossen, *J. prakt. Chem.*, **141**, 157 (1934); (b) Hauser and Adams, THIS JOURNAL, **66**, 345 (1944).

factory; this has been verified. Yields of 64–68% of the *o*-, *m*- and *p*-nitrobenzoylacetones have been obtained from the corresponding nitroacetophenones. The acetylation of *o*-nitroacetophenone may be represented as



Since the nitroacetophenones are readily prepared,[5] the present method for preparing the nitro β-diketones is considered quite convenient.[6]

Gabriel and Gerhard[7] have reported that *o*-nitrobenzoylacetone is reduced and cyclized in the presence of phosphorus and hydrogen iodide, or stannous chloride and acetic acid, to form 2-methyl-4-hydroxy-quinoline oxide. McCluskey[8] found that this nitrogen oxide is converted to 2-methyl-4-hydroxy-quinoline on boiling with zinc dust and hydrochloric acid. We have found that the nitrogen oxide is similarly obtained from *o*-nitrobenzoylacetone using low pressure hydrogenation at 60° in the presence of Raney nickel or at room temperature using palladium charcoal (experiment by M. S. Bloom).

Experimental[9]

m-Nitroacetophenone (0.1 mole) was dissolved in 70 ml. (about 0.7 mole) of acetic anhydride, and the stirred mixture was saturated at 0° with boron trifluoride as described previously for similar acylations.[4b] Then 700 ml. of 13% sodium acetate solution was added and the resulting mixture refluxed for twenty minutes. The mixture was chilled in an ice-bath and filtered. The precipitate was washed thoroughly with water, crushed in a mortar and dissolved in 300 ml. of cold 2% sodium hydroxide solution. The alkaline solution was shaken with ether. The ether phase was extracted with additional 2% alkali until it no longer gave a positive enol test. After filtering, the combined alkaline solution was chilled in an ice-bath and acidified with 10% sulfuric acid. The solid *m*-nitrobenzoylacetone was filtered off and recrystallized from 95% ethanol; yield, 64% melting at 113.5–114.5°[2]; m. p. of copper salt, 277–278°.

In a similar manner, we prepared *p*-nitrobenzoylacetone in 66% yield, melting at 111.4–112.6° and after a second recrystallization at 112.0–112.8°[2] (the copper salt darkened but failed to melt at 320°); also, we prepared *o*-nitrobenzoylacetone in 68% yield melting at 54–55°[6] (catalytic reduction gave 2-methyl-4-hydroxyquinoline oxide, melting at 245–246°).[8]

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RECEIVED JULY 29, 1946

(5) See Walker and Hauser, THIS JOURNAL, **68**, 1387 (1946).

(6) *m*-Nitrobenzoylacetone has been prepared in 47% yield by the nitration of benzoylacetone (see reference 2). *o*-Nitrobenzoylacetone has been prepared by the acylation of acetoacetic ester with *o*-nitrobenzoyl chloride followed by abidic cleavage [Gevekoht, *Ann.*, **221**, 323 (1883), and Kermack and Smith, *J. Chem. Soc.*, 814 (1929)].

(7) Gabriel and Gerhard, *Ber.*, **54**, 1067 and 1615 (1921).

(8) McCluskey, THIS JOURNAL, **44**, 1577 (1922).

(9) Melting points are uncorrected.

The Inhalation Toxicity of Ketene and of Ketene Dimer

BY H. A. WOOSTER,[1] C. C. LUSHBAUGH AND C. E. REDEMAN[2]

The literature concerning the use of ketene in organic syntheses stresses its irritant qualities,[3,4] but contains no detailed statement of its toxicity. Preliminary tests indicated that freshly generated ketene was highly toxic.[5]

Extended toxicity testing on mice, rats, guinea pigs and rabbits showed that ten minute exposures to concentrations of freshly generated ketene as low as 0.2 mg./liter (116 p. p. m.) may produce a high percentage of deaths in small animals. Diketene is less than 0.1 as toxic. These findings put ketene in the same order of toxicity as phosgene[4] (0.2–2.0 mg./liter) and hydrogen cyanide[6] (0.2–0.5 mg./liter). Death is from pulmonary edema and is entirely similar to, but much more rapid than is the case with phosgene poisoning. A complete report of this study will be made elsewhere.

(1) Present address: 706 Maloney Bldg., Hospital of the University of Pennsylvania, Philadelphia 4, Pa.

(2) Present address: 770 South Arroyo Parkway, Pasadena, California.

(3) N. T. M. Wilsmore, *J. Chem. Soc.*, **91**, 1938 (1907).

(4) C. D. Hurd and O. Kamm, "Organic Syntheses," Vol. IV, John Wiley and Sons, Inc., 1925, pp. 39–42.

(5) R. W. Gerard and W. Potts, personal communication.

(6) M. B. Jacobs, "Analytical Chemistry of Industrial Poisons, etc.," Interscience Publishers, Inc., 1941, p. 622.

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RECEIVED AUGUST 3, 1946

Direct Replacement of the Mesyloxy[1] Group by Cyanide

BY MORRIS ZIEF, HEWITT G. FLETCHER, JR., AND HOWARD R. KIRSHEN

In the course of the preparation of several organic cyanides, our first approach to the synthesis of tetrahydrofurylacetonitrile by the replacement of the tosyloxy[1] group, followed the method described by Sekera and Marvel[1a] for the preparation of *n*-cetyl cyanide and *n*-butyl cyanide. After this procedure failed, the fusion method suggested by the familiar reaction for the preparation of aryl cyanides by the fusion of the salts of aromatic sulfonic acids with potassium cyanide[2] proved successful. Fusion of tetrahydrofurfuryl tosylate with potassium cyanide produced a nine per cent. yield of the nitrile. When the mesyloxy[1] group, which in most instances has been shown to be more labile than the tosyloxy group,[3] was substituted for the tosyloxy group, a 36% yield was obtained. When 6-tosyldiacetonegalactose, *n*-butyl tosylate or mesylate was fused with potassium cyanide, no reaction was observed. *s*-Butyl mesylate yielded considerable butene-2.

(1) "Tosyl" and "mesyl" are generally accepted abbreviations for *p*-toluenesulfonyl and methanesulfonyl, respectively.

(1a) Sekera and Marvel, THIS JOURNAL, **55**, 348 (1933).

(2) Merz and Mulhauser, *Ber.*, **3**, 710 (1870).

(3) Helferich and Gnuchtel, *ibid.*, **71**, 712 (1938).