

crystallized as a hydrochloride. The white, powdery base was dissolved in two volumes of chloroform and could be precipitated with ether; m. p. 150°, yield 50%.

Anal. Calcd. for $C_{23}H_{21}NO_3S$: S, 7.71. Found: S, 7.55.

2-(3,4-Methylenedioxystryryl)-4-acetylamino-6-methoxyquinoline, CC974.—Piperonaldehyde was condensed with 2-methyl-4-amino-6-methoxyquinoline in the presence of acetic anhydride. The deeply-colored condensation product was purified by converting the base to an orange-colored hydrochloride in alcohol; this salt was collected on a filter and again converted to a base. 2-(3,4-Methylenedioxystryryl)-4-acetylaminoquinoline is a tan solid, melting at 234°; it is difficultly soluble in ether, readily in chloroform, and moderately soluble in alcohol.

Anal. Calcd. for $C_{21}H_{18}N_2O_4$: N, 7.73. Found: N, 7.61.

Acknowledgment.—The author wishes to express appreciation to Dr. L. H. Cretcher and to Dr. O. F. Hedenburg for helpful discussion.

DEPARTMENT OF RESEARCH IN PURE CHEMISTRY
MELLON INSTITUTE RECEIVED NOVEMBER 12, 1946
PITTSBURGH 13, PENNSYLVANIA

2-Aminofluorene

By JOHN R. SAMPEY AND E. EMMET REID

In the Diels¹–Kuhn² method for the preparation of 2-aminofluorene ten times the calculated amount of zinc is used. Conditions have now been found whereby the amount of zinc can be reduced to one-third, or, if the time of reduction is doubled, to one-sixth of this amount.

Procedure.—To a suspension of 30 g. of 2-nitrofluorene in 820 ml. of 95% alcohol and 180 ml. of water are added 10 g. of crystalline calcium chloride in 15 ml. of water, 10 ml. of glacial acetic acid and 50 g. of zinc dust. The mixture is refluxed vigorously for four hours in an oil-bath and, while hot, filtered with suction. The residue is washed with 50 ml. of hot 80% alcohol and the filtrate and washings poured into 2 liters of cold water. The precipitate recrystallized from boiling 50% alcohol (yield 80–90%), melted at 127° (uncor.).

With mossy or 10-mesh granular zinc appreciable amounts of orange-yellow azo and azoxy compounds are formed which are not reduced even after the addition of the required amount of zinc dust.

(1) Diels, *Ber.*, **34**, 1758–1768 (1901).

(2) Kuhn, *Org. Syn.*, **13**, 74–76 (1933).

FURMAN UNIVERSITY
GREENVILLE, SOUTH CAROLINA
BALTIMORE, MARYLAND RECEIVED NOVEMBER 8, 1946

The Interaction of Thiols and Quinones¹

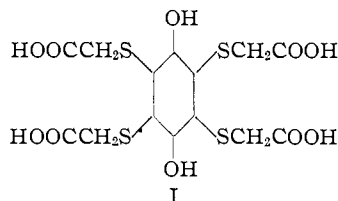
By MAXWELL SCHUBERT

In connection with some chemotherapeutic work being carried out at this Laboratory the chemistry of the interaction of quinones and thiols came under consideration. Preliminary experiments led to the isolation of two easily prepared and previously undescribed kinds of compounds. As it is unlikely that this work will be further pursued here, these compounds are now

(1) The work described in this note was done under a contract, recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and New York University.

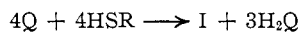
presented and their relation to known compounds pointed out.

If a mole of thioglycolic acid is added to a mole of quinone suspended in water, there results the white crystalline hydroquinone tetrathioglycolic acid, I.



This compound on oxidation with nitric acid yields the corresponding red quinone. The quinone on reduction with thioglycolic acid regenerates the hydroquinone. That I represents the structure of the product described is shown by the fact that the same compound results from the action of excess thioglycolic acid on chloranil.

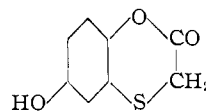
The formation of I from thioglycolic acid and quinone probably results from a sequence of reactions in which quinone adds thioglycolic acid to form a thio substituted hydroquinone which is then oxidized by excess benzoquinone to a thio substituted quinone. This pattern of reaction is repeated until the quinone is completely substituted. The over-all effect is



where R represents $-\text{CH}_2\text{COOH}$ and Q represents quinone.

Thus, only a quarter of the original quinone could appear in the final product, the other three quarters being used to oxidize the intermediate hydroquinones. On the basis of this scheme, the yield of I recovered after recrystallization was 30%, and the hydroquinone recovered, also after recrystallization, was 63% of that calculated.

Snell and Weissberger² in a study of the reaction of thiols and quinones reviewed the older literature. They isolated mono and bis-thio derivatives of quinone and hydroquinone and explained the formation of the bis compounds on the basis of the first steps of the above scheme. Specifically, with thioglycolic acid, they isolated hydroquinone monothioglycolic acid as the lactone.



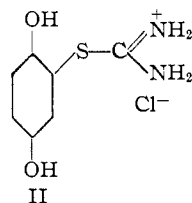
This compound has also been isolated from our reaction mixture after separation of the hydroquinone derivative, I. Whether the mono or the tetrathioglycolic acid derivative of hydroquinone is formed predominantly seems to depend on the conditions of mixing the components. For example, if a suspension of the quinone in water is added to an aqueous solution of thioglycolic acid,

(2) Snell and Weissberger, *THIS JOURNAL*, **61**, 450 (1939).

only small amounts of the derivative, I, are produced.

Dimroth, Kraft and Aichinger³ described bis and trisphenylthioquinones and accounted for their formation by the first steps of the scheme above. I seems to be the first tetrathio derivative to be reported.

Thiourea also reacts with quinone in aqueous medium and at room temperature producing dark colored products which could not be crystallized. However, by working in acid medium and keeping to temperatures not above 30° even during recrystallization procedures, white crystalline products have been obtained. These are salts of the base 2,5-dihydroxyphenyl isothiourea. The hydrochloride is



The sulfate is less soluble and the nitrate is quite insoluble in cold water. In hot water these salts rapidly decompose forming reddish tars. The free base crystallizes out on neutralization of an aqueous solution of the chloride. Nitric acid oxidizes them to a red compound but this has not been isolated. A similar thiuronium salt has been isolated from 2-methylnaphthoquinone, differing, however, in that a mole of water has been split out. This compound is even less stable than II.

Experimental

Hydroquinone Tetrathioglycolic Acid.—Powdered *p*-benzoquinone (50 g.) was suspended in water (400 ml.). The suspension was stirred and a solution of thioglycolic acid (36 ml. or 48 g.) in water (150 ml.) was added dropwise over two and one-half hours. The mixture at first turned to a dark brown suspension and finally to a light brown solution from which a white crystalline product separated. The mixture was stirred until no more dark particles were left, a total of three hours. It was then chilled and the white crystalline product filtered off. It was recrystallized from 1500 ml. of boiling water by chilling; yield 14 to 17 g.; m. p. 288 to 289° with decomposition. For analysis it was recrystallized twice more.

Anal. Calcd. for C₁₄H₁₄O₁₀S₄: C, 35.75; H, 3.00; S, 27.23. Found: C, 35.96; H, 3.12; S, 27.44.

This compound dissolved in water on addition of sodium bicarbonate and such a solution was slowly oxidized by air to a deep red quinone.

Hydroquinone was recovered from the filtrate of the reaction mixture by evaporating *in vacuo* to 250 ml., adding 25 g. of sodium bicarbonate and extracting five times with 200-ml. portions of ether. Drying and evaporating the ether left a crystalline residue (37 g.) which on recrystallization from water gave a product (24 g.) with a melting point and mixed melting point with hydroquinone of 171°.

Chloranil (10 g.) stirred in water (100 ml.) was heated in a bath at 100° while thioglycolic acid (45 cc.) was added dropwise over a half hour. A thick suspension of white crystals remained which was chilled and filtered. The product was recrystallized as above and 16.8 g. or 83%

was obtained with m. p. 288 to 289° with decomposition. Mixed melting point of the two preparations was also 288 to 289°.

Anal. Found: C, 35.56; H, 3.11; S, 27.21.

Hydroquinone tetrathioglycolic acid (15 g.) was added to a mixture of water (1000 ml.) and concentrated nitric acid (200 ml.) in a bath at 50 to 60° and stirred for fifteen minutes. A red crystalline product was formed. After chilling it was filtered off, washed with water and extracted with boiling water (1800 ml.). The clear red solution was filtered and cooled. The red crystalline product was filtered off within an hour and dried; yield 9 g. After one more recrystallization from water, the m. p. was 270 to 273° with decomposition.

Anal. Calcd. for C₁₄H₁₂O₁₀S₄: C, 35.90; H, 2.58; S, 27.35. Found: C, 35.71; H, 3.11; S, 27.59.

This quinone on reduction in hot water with aqueous thioglycolic acid gave the corresponding hydroquinone I, in a yield of 90% after recrystallization.

2,5-Dihydroxyphenylthiuronium Chloride.—Quinone (32 g.) was powdered and added in portions over fifteen minutes with good stirring to thiourea (30 g.) in 2 *M* hydrochloric acid (150 ml.). A white crystalline product separated. Concentrated hydrochloric acid (25 ml.) was added and the mixture chilled. The product was dissolved in water (325 ml.) at room temperature, stirred with Darco (2 g.), filtered and the product precipitated by addition of concentrated hydrochloric acid (70 ml.) and chilling; yield 40 g. or 60% of the theoretical. The compound decomposed on heating between 150 and 160°.

Anal. Calcd. for C₇H₉O₂SN₂Cl: C, 38.18; H, 4.12; S, 14.54; N, 12.76; Cl, 16.14. Found: C, 38.71; H, 4.27; S, 14.63; N, 12.15; Cl, 16.07.

Thiourea reacted similarly with 2-methylnaphthoquinone to give a product with salt-like character that was very unstable in hot water. A mixture of 2-methylnaphthoquinone (0.5 g.), thiourea (1.5 g.), 2 *M* hydrochloric acid (20 ml.) and alcohol (5 ml.) was stirred for two hours. The mixture at first turned brown then pale yellow and became perfectly clear. After a few days on ice, more rapidly on seeding, a white crystalline product separated. It was recrystallized by dissolving in water (35 ml.) and precipitating by addition of concentrated hydrochloric acid (10 ml.). A yield of 0.4 to 0.5 g. resulted.

Anal. Calcd. for C₁₂H₁₁ON₂SCl: C, 54.15; H, 4.16; N, 10.53; S, 12.03; Cl, 13.35. Found: C, 53.77; H, 4.81; N, 10.58; S, 12.06; Cl, 13.53.

The compound had no melting point but turned gray on heating over 260°.

DEPARTMENT OF THERAPEUTICS

NEW YORK UNIVERSITY COLLEGE OF MEDICINE

NEW YORK, N. Y.

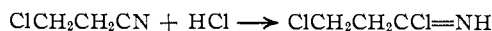
RECEIVED NOVEMBER 6, 1946

A Convenient Synthesis of β -Chloropropionitrile

BY ROSS STEWART AND R. H. CLARK

Having occasion to use considerable quantities of β -chloropropionitrile the present authors have investigated a new method for its synthesis, the usual method being treatment of ethylene cyanohydrin with phosphorus pentachloride.¹ This compound, however, can be synthesized very conveniently and in good yield by the addition of 0.95 equivalent of dry hydrogen chloride gas to the cheap and readily obtainable acrylonitrile.

An excess of hydrogen chloride lowers the yield because of the production of β -chloropropionimide chloride.



(3) Dimroth, Kraft and Aichinger, *Ann.*, **545**, 124 (1940).