Similarly, *o*-iodomercuri-anisole gives the mercuri-bis compound melting at 108°.

Reaction of the *p*-Iodomercuri-phenol Ethers with Potassium Iodide and with Potassium Thiocyanate.—The reactions between these substances apparently lead to the formation of mercuri-bis compounds, as the filtrates contain inorganic mercury and are not alkaline. However, the products are very difficult to purify.

Reaction of Mercuric Chloride with the Mercuri-bis-phenol Ethers.—One g. of *o*-mercury-dianisyl is heated with 0.7 g. of mercuric chloride in 25 cc. of alcohol for 15 minutes. The chloride deposits on cooling, and is recrystallized from alcohol; m. p., 177–178°. Dimroth obtained the same compound in small amount by direct mercuration of anisole. He gives the melting point as 173–174°.

Similarly, *o*-mercury-diphenetyl reacts with mercuric chloride to give pure *o*-chloromercuri-phenetole.

Summary

1. Protection of the hydroxyl groups in mercurated phenols by alkylation has the same effect as protection by acylation, that is, the stability of the carbon-mercury linkage to iodides, thiocyanates, and to thiosulfates is increased.

2. Mercurated phenol ethers react with iodides, with thiocyanates, and with thiosulfates to form the corresponding mercuri-bis compounds giving solutions which contain inorganic mercury but no alkali, showing that the protection of the phenolic hydroxyl has prevented the splitting of the carbon-mercury linkage with the accompanying formation of alkali which occurs with the mercurated phenols.

3. The formation of the mercuri-bis compounds takes place much more readily in the case of the *ortho* compounds than with the *para* compounds.

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THE PREPARATION OF ALKYLGUANIDINES

BY ROSS PHILLIPS AND H. T. CLARKE

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In a recent paper, Arndt[1] describes a new and convenient reagent, methyl iso-thio-urea sulfate, from which methyl mercaptan may be obtained in a pure condition by warming it with dil. alkalies; dicyanodiamide is formed as a by-product. This reagent, produced by the addition of dimethyl sulfate to thio-urea, bears a close relation to the alkyl iodide addition products of thio-urea,[2] which react with primary and secondary aliphatic amines to form alkyl guanidines and alkyl mercaptans.

We have found that methyl iso-thio-urea sulfate undergoes an exactly analogous reaction with methylamine and dimethylamine, methyl mercap-

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[1] Arndt, *Ber.*, **54B**, 2236 (1921).

[2] Wheeler and Jamieson, *J. Biol. Chem.*, **4**, 111 (1907). Schenck, *Z. Physiol. Chem.*, **77**, 328 (1912).

tan and methylguanidine sulfate (and α,α-dimethylguanidine sulfate) being produced in excellent yield, without the use of an appreciable excess of the base. As far as we can ascertain, these sulfates have hitherto never been described; they crystallize well from water and are practically insoluble in methyl alcohol. The reaction does not take place with aniline, either alone or in the presence of alkali.

Incidentally to the isolation of the methyl mercaptan, which is formed as a by-product, we have found that when the gas is passed into a 25% solution of sodium hydroxide the sodium salt of methyl mercaptan crystallizes in long, flat needles of the composition, $2CH_3SNa.9H_2O$.

Experimental Part

Methylguanidine Sulfate.—To a suspension of 700 g. of methyl iso-thio-urea sulfate in 700 cc. of cold water is added, all at once, 525 g. of a 33% aqueous solution of methylamine. The vessel is immediately fitted with a reflux condenser, from the upper end of which tubes lead the evolved gas through a wash bottle containing 250 cc. of 10% hydrochloric acid (to remove any entrained methylamine) into 700 cc. of a 25% solution of sodium hydroxide cooled by running water. When the mixture in the flask is shaken and gently warmed, a vigorous reaction sets in at about 30°; methyl mercaptan is evolved at a steady rate without application of heat. When the reaction slackens, the mixture is heated until finally it boils; it is then concentrated under reduced pressure until the weight is about 1000 g. The resulting sirup is chilled to —5°, whereupon it sets to a mass of crystals; 300 cc. of methyl alcohol is then added and the crystals are collected by suction and washed with cold methyl alcohol in which the product is practically insoluble. The yield of pure dry methylguanidine sulfate is about 500 g., or 82%; m. p., 239–240°.

Analysis. Subs., dried at 120°, 0.4826: $BaSO_4$, 0.4675. Calc. for $C_4H_{16}O_4N_6S$: S, 13.12. Found: 13.30.

The combined filtrates and washings are concentrated to 300 g., cooled to 50°, and treated with 60 cc. of nitric acid (d., 1.42). The mixture is chilled to 0° and the resulting crystals of the nitrate are collected: when dry, this material weighs about 90 g., a 13% yield. After recrystallization from rather less than its own weight of water, it melts at 149–150°.

The picrate[3] (prepared both from the sulfate and from the nitrate) melts at 199–200°.[4]

α,α-Dimethylguanidine Sulfate.—A suspension of 250 g. of methyl iso-thio-urea sulfate in 300 cc. of cold water is treated exactly as above with 285 g. of a 33% aqueous solution of dimethylamine. After the reaction is complete, the solution is concentrated under reduced pressure until crystals begin to form, chilled to 0°, and the crystals are collected on a filter and washed with methyl alcohol. The mother liquors are again concentrated, and the recrystallization process is repeated twice. In this way 200 g. of α,α-dimethylguanidine sulfate, melting with decomposition at 285–288°, is obtained, an 82% yield.

Analysis. Subs., dried at 120°, 0.4581: $BaSO_4$, 0.4052. Calc. for $C_6H_{18}O_4N_6S$: S, 12.40. Found: 12.13.

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[3] Fischer, *Ber.*, **30**, 2414 (1897), gives the melting point as 200°.

[4] Werner and Bell, *J. Chem. Soc.*, **121**, 1790 (1922), describe a picrate, prepared from the reaction product of dicyandiamide and methylamine hydrochloride, which decomposes at 285° without melting.

The picrate is precipitated by the addition of a solution of sodium picrate to aqueous dimethylguanidine sulfate; after recrystallization from water, it melts sharply at 229–230°.[5]

Methyl Mercaptan Sodium Salt.—When methyl mercaptan is passed into a 25% solution of sodium hydroxide, absorption takes place with evolution of heat; after saturation, the solution on standing deposits flat needles which may attain a length of several centimeters. These crystals rapidly effloresce on exposure to air, apparently giving up water of crystallization. The salt is readily soluble in cold water and even more so in cold methyl alcohol. Although a boiling alkaline solution of methyl mercaptan (unlike ethyl mercaptan and its homologs) does not yield the free mercaptan in appreciable quantities to the distillate, the salt possesses a powerful odor; attempts to determine directly the percentage of water of crystallization were unsuccessful, owing to loss of substance other than moisture. When the crystals are heated above 200° decomposition sets in, sodium disulfide being formed in considerable amount.

Analyses. Subs., 0.5468: Na_2SO_4, 0.2540. Subs., 0.6584: NaCl, 0.2489. Calc. for $2CH_3SNa.9H_2O$: Na, 15.23. Calc. for $CH_3SNa.5H_2O$: Na, 14.75. Found: Na, 15.04, 14.90.

Summary

A convenient method is described for the preparation of mono- and dialkylguanidines.

A description is given of 3 crystalline salts hitherto not mentioned in the literature: methylguanidine sulfate, α,α-dimethylguanidine sulfate, and the sodium salt of methyl mercaptan.

ROCHESTER, NEW YORK

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SOME DIALKYLBARBITURIC ACIDS WITH TERTIARY AMINO GROUPING

BY ARTHUR W. DOX AND LESTER YODER

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In continuation of the investigations in the barbituric acid series which have been in progress in this Laboratory during the past 2 years, it seemed worth while to prepare certain more complex derivatives for the purpose of studying their physiological activity. Previous work has shown that the dialkylbarbituric acids of the veronal type exhibit hypnotic properties over quite a range of molecular weight. Our aim was now to add to the dialkylbarbituric acid another grouping with known physiological activity, but united through a stable linkage so that the substance would not readily undergo hydrolysis and enable the two components to exert their separate activities independently. The phenomenon of "synergy," familiar to pharmacologists, has been studied rather extensively in the case of simple mixtures of physiologically active substances, but comparatively little

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[5] Schenck, Ref. 2, gives the melting point as 230°. Werner and Bell, Ref. 4, give 227°.