

ALKYL AMIDES OF ISOTHIOCYANACETIC ACID

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Theoretically, anilides of chloracetic acid, of which chloracetanilide I is the simplest representative, might be expected to interact with potassium thiocyanate in two ways, namely, to form either a normal thiocyanate or its structural isomer, an isothiocyanate, as is represented by formulas II and III, respectively. A careful study of this reaction, however, has revealed the fact that it is productive only of the thiocyanate



I



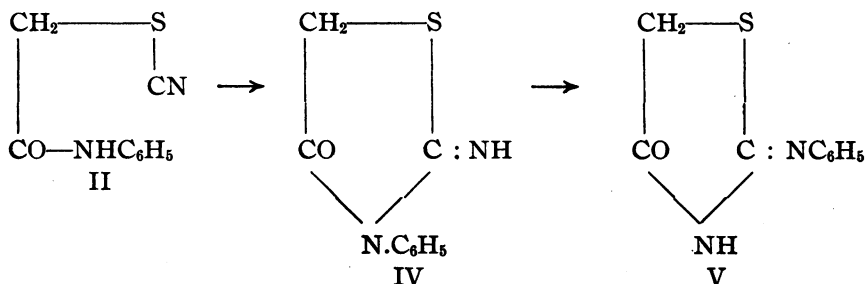
II



III

form of these two isomers, or that combination in which sulphur is joined to carbon as represented in formula II. In every case, where the reaction has been represented as proceeding in the other manner, a careful examination of the properties of the reaction-product has revealed an incorrect interpretation of the change, and shown that the primary reaction-product possesses a different constitution than that of an isothiocyanate. In other words, we may conclude from the evidence thus far presented, that no anilide of isothiocyanacetic acid has yet been prepared.¹

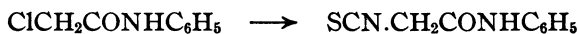
Wheeler and Johnson² submitted this reaction between potassium thiocyanate and chloracetanilides to a very careful investigation and showed that the primary product of reaction is always a normal thiocyanate. They found, however, that these combinations are not always stable and in some cases it was extremely difficult to isolate them in a state of purity. This instability is explained by the fact that they easily undergo an unique rearrangement and are transformed into pseudothiohydantoin. In no case were normal thiohydantoin obtained by rearrangement. The isomerization of thiocyanacetanilide may be represented as follows:



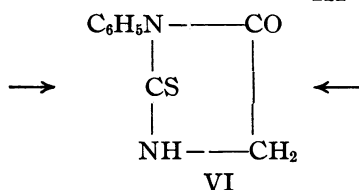
The conclusions recorded in a recent publication by Beckurts and Frerichs³ have now forced us to turn our attention again to this field of

research. These investigators have included in their recent work several new anilides of chloracetic acid, and in the case of three of them they interpret the reaction with potassium thiocyanate as leading to the formation of isothiocyanates. The anilides which interact with potassium thiocyanate in this unique manner are the *m*-toluide, *p*-chloranilide and *p*-aniside of chloracetic acid.

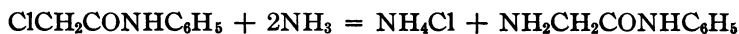
In the light of these interesting results, it has become necessary for us to take up again this question of constitution from an entirely new viewpoint, and apply the synthetical method of investigation. The question of tautomeric behavior of potassium thiocyanate must be excluded from further consideration, and a fundamental method of synthesis be developed whereby only true isothiocyanate combinations corresponding to formula III can be formed. At present such a method of synthesis is not known. These isothiocyanates if formed would not revert by rearrangement to normal thiocyanates, and should exhibit a chemical behavior quite as characteristic as that of the isomeric thiocyanates. Theoretically combinations corresponding to formula III should easily undergo isomerization with formation of normal thiohydantoins. In other words, if the isothiocyanate III is a product of reaction when potassium thiocyanate interacts with chloracetanilide as Frerich and Beckurts assume, it should act in an entirely different manner than the thiocyanate II and isomerize to the same hydantoin VI, as is obtained by interaction of phenylisothiocyanate with glycine⁴ or its ethyl ester. These changes are represented as follows:



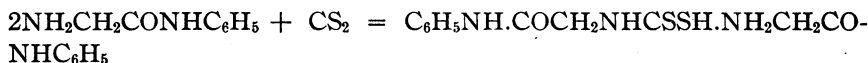
III



We are now in position to report a practical method of synthesis which enables us to obtain anilides of isothiocyanacetic acid. Starting with chloracetanilide for illustration the complete operation may be outlined as follows: Chloracetanilide is first converted into the anilide of glycoll (glycine) VII, and this then combined with carbonbisulphide when the corresponding dithiocarbamate VIII is obtained in excellent yield. This salt VIII is a crystalline substance melting at 145° and its formation from chloracetanilide is expressed as follows:



VII



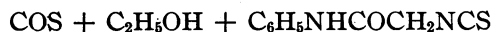
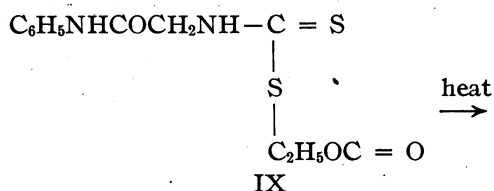
VIII

The dithiocarbamate VIII interacts smoothly with ethyl chlorformate to give the corresponding ester represented by formula IX. This ester IX is the first representative of its type to be described in the chemical

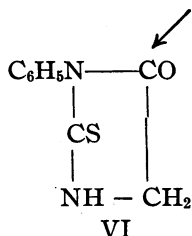


IX

literature, and is a crystalline substance melting at 100° . This ester can be crystallized without decomposition, but undergoes the normal decomposition, characteristic of its constitution, when heated above its melting point temperature. It then breaks down into carbonoxysulphide, ethyl alcohol and the unknown isothiocyanate III. This characteristic decomposition reaction is expressed as follows:



III



Thus far we have not succeeded in stopping our reaction at the stage where the isothiocyanate III is formed. To our surprise this substance is so unstable that the heat applied to decompose the dithiocarbamic ester IX is sufficient to produce immediate rearrangement of the resulting isothiocyanate III into the normal phenylthiohydantoin VI. The yield of this cyclic compound is excellent, and as we anticipated it proved to be identical with the thiohydantoin previously described in the literature.⁵ We obtained no evidence of the formation of either of the two pseudothiohydantoins IV and V which result by rearrangement of thiocyanacetanilide II. In other words, our method of synthesis not only excludes the possibility of formation of a normal thiocyanate, but has also revealed

to us for the first time the striking dissimilarity in chemical behavior between these two types of isomeric compounds.

It seems safe to conclude, therefore, from the results of this new work that any isothiocyanate formed by interaction of potassium thiocyanate with a secondary chloracetanilide will be found to be unstable and easily transformed into its corresponding thiohydantoin. Whether Beckurts and Frerichs were actually dealing in their work with such normal thiohydantoin instead of the pseudo modifications must be decided by further investigation. In the case of tertiary anilides of isothiocyanacetic $\text{SCN.CH}_2\text{CO.NR}_2$, such cyclic rearrangements cannot take place, and in such cases we expect to obtain acyclic combinations containing the grouping NCS functioning as a true isothiocyanate. Investigations dealing with various phases of this interesting problem are now in progress and the results will be published in the *Journal of the American Chemical Society*.

¹ Wheeler and Merriam, *J. Amer. Chem. Soc.*, **23**, 1901 (283).

² *Amer. Chem. J.*, **28**, 1902 (121); Johnson, *J. Amer. Chem. Soc.*, **25**, 1903 (483).

³ *Arch. Pharm.*, **253** (233); *Chem. Zentrbl.*, **2**, 1915 (614); *Chem. Abstracts*, **10**, 1916, (888).

⁴ Aschan, *Ber. chem. Ges.*, **17**, 1884 (420); Marckwald, Neumark and Stelzner, *Ibid.*, **24**, 1891 (3278).

⁵ *Loc. cit.*

STUDIES OF MAGNITUDES IN STAR CLUSTERS. XI. FREQUENCY OF CURVES THE ABSOLUTE MAGNITUDE AND COLOR INDEX FOR 1152 GIANT STARS.

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Kapteyn, Schwarzschild, Parkhurst, Russell, and other investigators of statistical problems in stellar astronomy have paid special attention to the relative frequency of successive values of the absolute brightness of stars (the luminosity law) and the relative frequency of different spectral or color types. The laws of the frequencies of absolute magnitude and spectrum are indeed fundamental in studies of stellar evolution and the arrangement of stars in space; but to determine these laws, at the same time keeping the errors due to unavoidable and vitiating selection of data at a minimum, is by no means a simple process. Insufficient knowledge of stellar distances, and frequently of apparent magnitudes and spectra as well, presents a serious obstacle. In particular, it is difficult to obtain satisfactory luminosity curves for each spectral type, or representative spectral curves for small and clearly defined intervals of absolute magnitude. The luminosity curve that does not differentiate