

Still greater delicacy may be obtained by slanting the whole apparatus, giving the manometer a decided inclination.



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## METHYLATION OF HALOGEN AMIDES WITH DIAZOMETHANE.\*

BY JAS. H. RANSOM.

Since the classical work of Hofmann on the rearrangement of the halogen amides to derivatives of the isocyanates the mechanism of this reaction has been the subject of numerous investigations. Hoogewerff and van Dorp extended the work of Hofmann and pointed out the probability of a similarity in this reaction and that known as the "Beckmann rearrangement" of the oximes. After some more recent work on the brom-amides by Lengfeld and Stieglitz, the latter, with his pupils, studied the influence of the amide hydrogen atom on the rearrangement. He found that when this hydrogen was replaced by an alkyl radical no rearrangement took place in the sense of the Hofmann reaction, and suggested as the simplest and most reasonable explanation, that at some early stage of the reaction, under the influence of the alkali, the molecule

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\*This work was undertaken during the past summer, at the University of Chicago, in company with Dr. Julius Stieglitz.

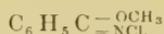
lost hydrobromic acid, leaving monovalent nitrogen, which, by its reactivity, drew to itself the radical originally attached to carbon. As Stieglitz has pointed out, this explanation would account for the Beckmann rearrangement, and for that of the acid azides.

It seemed not without interest, therefore, to determine experimentally the position of the amide hydrogen in the halogen amide molecule. The two possible positions of this atom,  $R\ CO-N\ H/Cl$  and  $RC-(OH)=N\ Cl$ , correspond to the two classes of alkyl derivatives, chlor alkyl acid amides,  $R\ CO\ N\ R/Cl$ , and chlorimido acid esters, whose properties are now known. But the fact that the salts of such a molecule may have a different constitution from that of the free acid would make quite uncertain any conclusions drawn from the results obtained from the usual methods of introducing an alkyl radical.

Von Peckmann has shown that substances of an acid character react readily with diazomethane, forming a methyl derivative of the substance, the methyl entering where the hydrogen was attached. As the reaction is carried out with the free acid in absolute ethereal solution the probability of a rearrangement of the molecule during the process of methylation is reduced to a minimum. Ransom has shown, also, in two cases, that this method of methylation can be used to advantage in deciding delicate questions of constitution.

With these ideas in view, the following work was undertaken: Benzchloramide is best made by adding a solution of chloride of lime to a cold saturated solution of benzamide, which had previously been acidified with acetic acid, and extracting the oil which is formed with ether. On drying the ethereal solution with calcium chloride and evaporating the ether in vacuo without heating, a crystalline residue results which after recrystallizing from benzol was found to be 98.1 per cent. pure. The purity was determined by finding the percentage of active chlorine in the substance, by adding potassium iodide to a dilute alcoholic solution and titrating the free iodine with sodium thiosulphate. An ethereal solution of diazomethane was then prepared and some of the benzchloramide, suspended in a little ether, added to it until the yellow color of the diazomethane had nearly disappeared. Nitrogen was evolved in large quantities. When the action had ceased the ether was evaporated and there was left an oil with a peculiar but not unpleasant ethereal odor. The oil did not solidify even in a freezing mixture. Some of it was dissolved in ligroin and dry hydrogen chloride passed into the solution.

Chlorine was evolved and a white solid separated which was very soluble in water. The aqueous solution after standing some time gave off a distinct odor of benzoic ether ( $C_6H_5COOCH_3$ ). Caustic soda separated from the solid an oil which had the characteristic odor of benzimido ether ( $C_6H_5C \begin{smallmatrix} OCH_3 \\ =NH \end{smallmatrix}$ ). A quantity of the salt was heated in a bath to  $118^\circ$ . A gas ( $CH_3Cl$ ) was evolved which burned with a green flame, and in the tube there remained a crystalline substance which proved to be benzamide. Some of the methylated chloramide was suspended in water and reduced with hydrogen sulphide. When the oil had become dissolved the solution was poured from the free sulphur and distilled with a concentrated solution of caustic soda, the distillate being collected in hydrochloric acid. This distillate was evaporated to dryness, and the residue extracted with absolute alcohol. Very little dissolved in the alcohol and no trace of methyl amine could be detected, nor of aniline by using either the delicate Jacquemine test or the isocyanide reaction. The properties of this substance therefore and its reactions correspond in every detail with what would be expected from the constitution,



Besides, benzchloramide is a fairly strong acid, as its alcoholic solution can be titrated against standard caustic alkalis, using either phenolphthalein or litmus as indicator. This acidity is not due to hydrolysis, thus forming free hydrochloric acid, since it gives with silver nitrate, even on standing, only a trace of silver chloride. A solution of the substance therefore contains hydrogen ions, a thing not to be expected on the supposition of an amide hydrogen. We may conclude therefore that benzchloramide contains an hydroxyl group.

Attempts were made to extend the investigation to other amides, viz., *m*-nitrobenzamide and anisic acid amide. The chloramide of the former however was found to be so unstable even at  $0^\circ$  that work on it was discontinued for the time. Anisic acid chloramide is also unstable, but at  $-5^\circ$  enough of it was obtained to try the action of diazomethane upon it. The bleaching powder method was the one used to make the chloramide, but it always contained some of the dichloride, which was then converted into the monochloride by dissolving in caustic soda and reprecipitating it with acetic acid. As the least excess of acid decomposes it completely, the yields are very poor. A small amount of the substance, about 90 per cent. pure, was methylated as described above.

An oil was obtained which, when dry hydrogen chloride was passed into its solution, evolved chlorine, and deposited an oily solid salt. At 115°-120° it lost methyl chloride and there remained a crystalline substance which, however, was not the amide and contained chlorine. This was saponified with caustic soda, but the acid formed melted at 205°-210° and still contained chlorine. It is evident that at some stage the benzene ring became chlorinated. But the fact that methyl chloride was evolved on heating indicates that the methyl was united to oxygen.

A little preliminary work was done with the brom-amides, they being more easily prepared pure than the corresponding chlor derivatives. While the results were not conclusive, they indicated that either methylation occurred on the nitrogen atom or that a rearrangement of the amide to the amine had taken place. For a distinct isonitril odor was observed when the saponified product was boiled with chloroform and caustic potash. Besides when m-nitro benzbromamide was methylated a substance was obtained with quite different properties from those in the former cases. It contained a large amount of bromine, though almost inactive. A small amount of the substance gave a distinct test for formaldehyde (resorcin and sulphuric acid). This might indicate that a molecule of the brom amide had added itself to the methine (CH<sub>2</sub>) group, thus:



This on saponification would give a derivative of formaldehyde and would contain inactive bromine.

The work will be extended in this and other directions as soon as opportunity offers.

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## NOTE ON THE APPARENT DETERIORATION OF FORMALIN.

BY THOMAS LARGE.

Attention of chemists and naturalists is called to the following facts: A stock of formalin, purchased from a prominent firm, for 40 per cent. formaldehyde, was kept at the Biological Station of Illinois for three years, where it was subjected to winter temperatures. When temperature was low a precipitate of white paraform (?) appeared, and was