LXXIX.—*Iminoethers Corresponding with Ortho-substituted Benzenoid Amides.*

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PINNER's well-known reaction for the formation of iminoethers of the :NH type, by the addition of the elements of an alcohol to the nitriles, fails either completely or partially with such aryl nitriles as contain a substituent in the *ortho*-position with respect to the cyanogen group (*Ber.*, 1890, 23, 2917, 2952). An attempt has already been made by one of us (*Trans.*, 1901, 79, 695) to prepare *o*-toluiminoethyl ether from the corresponding amide by means of dry silver oxide and ethyl iodide; the reaction, which was carried out in boiling alcoholic solution, resulted in the formation of *o*-toluonitrile.

The present paper contains an account of further experiments, bearing on the formation and properties of some imino-ethers of this type, which have led to the preparation of the hitherto unknown ethyl- and methyl-iminoethers from *o*-chlorobenzamide and *o*-toluamide. Since experiments do not appear to have been made on the formation of the *o*-chlorobenziminoethers, we first satisfied ourselves that Pinner's reaction is not available for the production of these ethers from *o*-chlorobenzonitrile.

Experiments with salicylamide were also started, but, as Pinner (*loc. cit.*) has shown that iminoether formation occurs with *o*-ethoxybenzonitrile to an appreciable extent, they were not continued, after we had found that the results agreed with our other observations, the hydroxy-group also undergoing alkylation (*Trans.*, 1900, 77, 745).

The formation and yield of *ortho*-substituted iminoethers depends on the experimental conditions, for whereas they are not entirely absent from the product of synthesis in boiling alcoholic solution, and although nitriles are present when boiling ethereal solutions are used, yet the proportion of iminoether to nitrile is notably greater in the latter than in the former case. It is unlikely that this difference depends on the higher temperature of the synthesis in alcohol than in ether, for benziminoethyl ether is not changed by boiling with alcohol. We find further that the formation of nitrile occurs also in the synthesis in boiling alcohol of iminoethers which do not contain an *ortho*-substituent, such as the benzimino- and *p*-toluimino-compounds, but to a very much smaller extent than with an *ortho*-derivative.

As regards the mechanism of the formation of nitriles, it is most improbable that it can be regarded as a simple process of dehydration of the amide, and is, we think, dependent on the formation of iminoether and its decomposition in the following way $R \cdot C(OEt):NH \longrightarrow R \cdot C:N +$

HOEt, this change being known to occur on heating. *o*-Toluiminoethyl ether may be distilled unchanged in a partial vacuum, and we are unable to explain why the change in question should occur in the synthetical operation more readily than with the pure substances. Our purpose, however, was to ascertain the relative stability of the compounds with respect to the loss of alcohol, and, although we have never been in possession of sufficient material to determine the relative temperatures of decomposition, the considerably larger proportion of nitrile formed in the synthesis of an *ortho*-iminoether, as compared with that obtained in the *para*-series, indicates, in our opinion, that the decomposition occurs more easily in the case of the *ortho*-compounds.

The results possess some interest, from the theoretical standpoint, in the light of our knowledge of the influence of orientation and substitution on the course of chemical reaction. From the relationship between iminoether and nitrile, expressed by the scheme

it might be expected that the reaction of formation would as an additive process be subject to retardation when an *ortho*-substituent is present, but that the reverse change, which, when formally expressed, consists only in the expulsion of a molecule of alcohol, should be facilitated, as our results indicate, by the same constitutive factor. We are not aware of any illustration of this phenomenon among *ortho*-substituted benzenoid derivatives, but the increase in the ease of anhydride formation which accompanies the successive introduction of alkyl groups in the succinic acid series (Bischoff, *Ber.*, 1891, 24, 1074) presents a closely allied case.

The previously recorded attempt to prepare *o*-toluiminoethyl ether was made in the hope that it would display the same relative stability towards hydrolysis by acids as the *N*-*o*-tolylacetiminoethers,

We find, as a matter of fact, that in this respect *o*-toluiminoethyl ether has a stability greater than that of its *para*-isomeride.

EXPERIMENTAL.

o-Chlorobenziminoethers.

o-Chlorobenziminoethyl Ether.—Having shown that this compound cannot be prepared from the nitrile by Pinner's method, the alkylation of *o*-chlorobenzamide by means of dry silver oxide and ethyl iodide was attempted in alcoholic solution. A solution of 8 grams of the amide in 24 grams of ethyl iodide and 75 c.c. of absolute alcohol

was treated at the boiling temperature with 18 grams of dry silver oxide. After boiling for one and a half hours, a sample of the solution was tested with ethereal hydrochloric acid, when the slight turbidity produced showed that very little base was present. On distilling the product of reaction in a partial vacuum, the main portion passed over between 129° and 132° under 34 mm. pressure, and solidified to colourless needles fusing at $42-43^{\circ}$, and having the other properties of *o*-chlorobenzonitrile.

Dry ether was now employed as a menstruum instead of alcohol, and a mixture of 6 grams of *o*-chlorobenzamide, 18 grams of ethyl iodide, 15 grams of oxide and 150 c.c. of ether was boiled for 4 hours. Dry ethereal hydrochloric acid precipitated the hydrochloride of the desired base from the filtered solution; the yield, however, was poor, about 3 grams of hydrochloride being obtained. After purification by solution in cold alcohol and precipitation with ether, the hydrochloride decomposed with evolution of ethyl chloride at 105° , forming *o*-chlorobenzamide melting at 139° , and underwent the characteristic ester hydrolysis on warming in aqueous solution. Chlorine was estimated in the ammonium chloride solution remaining after removing, in a current of steam, the ethyl *o*-chlorobenzoate produced on warming the hydrochloride with water :

0.5646 gave 0.3675 AgCl. Cl = 16.1.

$C_6H_4Cl \cdot C(OC_2H_5) : NH, HCl$ requires (for 1 mol. Cl) Cl = 16.1 per cent.

o-Chlorobenziminomethyl Ether.—*o*-Chlorobenzamide undergoes "anomalous methylation" (compare this vol., 415) when boiled with methyl iodide and dry silver oxide in ethereal solution. Ten grams of amide were employed, the other materials being used in the same proportions as in the foregoing experiment; the boiling was continued for 4 hours. By treatment of the clear solution with ethereal hydrochloric acid, *o*-chlorobenziminomethyl ether hydrochloride was precipitated as an oil which solidified on stirring, and was purified by recrystallisation from alcohol and ether. On observing the melting point in the usual way, the substance, which had previously evolved methyl chloride, melted sharply at 139° , this being the melting point of *o*-chlorobenzamide. By introducing specimens into baths at various temperatures, it was found that fusion with decomposition occurs at 110° and above that temperature. The compound gave the characteristic hydrolysis and was analysed in the same way as the ethyl homologue :

0.5456 gave 0.3756 AgCl. Cl = 17.0 instead of the calculated Cl = 17.2 per cent.

o-Chlorobenzmethylamide, which does not appear to have been previously described, was isolated from the ethereal solution after

separating the iminoether hydrochloride by shaking the liquid with sodium carbonate solution, drying with anhydrous potassium carbonate and evaporating; the residual solid gave a small quantity of *o*-chlorobenzonitrile on extraction with light petroleum, and the remaining solid, after crystallisation from dilute alcohol, formed colourless needles melting constantly at 92—94°. On hydrolysis, these were shown to be *o*-chlorobenzmethylamide by the formation of *o*-chlorobenzoic acid and methylamine:

0.2076 gave 14.7 c.c. moist nitrogen at 12° and 756 mm. $N = 8.4$.

$C_6H_4Cl \cdot CO \cdot NH \cdot CH_3$ requires $N = 8.3$ per cent.

Benzamide also undergoes "anomalous methylation" under conditions similar to those described above for the *o*-chloroamide.

o-Toluiminoethers.

Some experiments were made with the object of effecting the iminoether synthesis by the action of the respective alkyl iodides on the silver derivative of *o*-toluamide, and *o*-toluiminomethyl ether was prepared in this way.

The silver derivative of *o*-toluamide, precipitated as a light brown, amorphous powder by adding the calculated quantity of pure sodium hydroxide solution to a dilute alcoholic solution of the amide and silver nitrate in molecular proportion, was not obtained in a pure state, since it contained 49.7 per cent. of silver instead of the calculated 44.6, and was probably contaminated with silver oxide, the presence of which did not, however, seem prejudicial to the purpose of synthesis.

The formation of the methyliminoether took place on allowing the dried silver derivative to remain during three days at the ordinary temperature in contact with a solution of methyl iodide in benzene, the mixture being shaken at intervals. The hydrochloride of the iminoether was precipitated from the clear benzene solution and purified by crystallisation from methyl alcohol and ether. On heating, this hydrochloride behaved like *o*-chlorobenziminomethyl ether hydrochloride; it melted at 139° (*o*-toluamide melts at 140—142°), but did not melt when suddenly heated to 105°; at 110°, decomposition was just perceptible, and it fused and decomposed at 115°:

0.1289 gave 0.1017 AgCl. $Cl = 19.4$.

$C_6H_4(CH_3) \cdot C(OCH_3) : NH, HCl$ requires $Cl = 19.1$ per cent.

The amount of iminoether formed in the above manner was very small, less than 1 gram resulting from 19 grams of impure silver derivative. We were not therefore able to observe the formation of either the nitrile or the isomeric substituted amide.

o-Toluiminoethyl Ether.—As the main object of this work was to obtain comparative data relating to the formation and behaviour of the *ortho*-substituted iminoethers, parallel experiments were carried out with *p*-toluamide under conditions as nearly as possible comparable with those under which the *ortho*-amide was studied. The alkylation of the two isomeric amides was examined in ethereal and in alcoholic solutions.

Ethylation of o- and p-Toluamides in Ethereal Solution.—Ten grams of each amide were boiled with 38 grams of ethyl iodide, 28 grams of dry silver oxide, and 100 c.c. of dry ether for 16 hours, the clear solutions extracted with water and sodium hydroxide solution, and dehydrated with dry potassium carbonate.

The hydrochloride, precipitated from about one-third of the solution of the product from *o*-toluamide, after crystallisation from alcohol and ether, decomposed at 105—106°, solidified and then melted at 139°, and had the other properties of an iminoether hydrochloride:

0.4908 gave 0.3508 AgCl. $\text{Cl} = 17.7$.

$\text{C}_6\text{H}_4(\text{CH}_3) \cdot \text{C}(\text{OC}_2\text{H}_5) : \text{NH}, \text{HCl}$ requires $\text{Cl} = 17.8$ per cent.

In like manner, a portion of the product from *p*-toluamide yielded the hydrochloride of *p*-toluiminoethyl ether, decomposing at 130—131°, solidifying, and then melting at 152°.

The remaining portions of the ethereal solutions were distilled in a partial vacuum, when the product from the *ortho*-isomeride passed over, without sign of decomposition, between 106° and 118° under 20—25 mm. pressure (the boiling point of *p*-toluiminoethyl ether is 116—118° under 21 mm. pressure).

Both distillates possessed the properties of iminoethers, but whereas that from the *para*-amide was practically free from nitrile, giving a clear solution in cold aqueous hydrochloric acid, the product from the *ortho*-amide was only partially soluble in this reagent, the undissolved portion being identified as *o*-toluonitrile. A comparative estimation of the relative proportions of iminoether and nitrile was made by precipitating and weighing the hydrochlorides from solutions of the same strength in ether and light petroleum; the product from the *ortho*-amide gave a quantity of hydrochloride corresponding with 67 per cent., whilst the hydrochloride obtained from the *para*-isomeride corresponded with 95 per cent. of iminoether.

The stability with regard to hydrolysis by means of aqueous hydrochloric acid was compared by dissolving, at the same moment, 0.3 gram each of *o*- and *p*-toluiminoethyl ether hydrochlorides in 20 c.c. of water at the laboratory temperature. A turbidity, due to the formation of ester, appeared in the solution of *para*-salt after 40 minutes, and in that of *ortho*-salt after $1\frac{1}{2}$ hours, the latter compound dis-

playing, as was anticipated, greater stability in respect to this decomposition.

Ethylation of o- and p-Toluamides in Alcoholic Solution.—The reaction was carried out in each instance with 10 grams of amide and the corresponding proportions of oxide and iodide, 75 c.c. of alcohol being added, and the boiling continued for 3 hours. The products were extracted with ether, the extracts being treated similarly to those described above, and distilled in a partial vacuum. Both distillates contained iminoether mixed with a proportion of nitrile which was larger than that found in the 'ether' synthesis.

The amounts of iminoether were determined in each sample by gently warming for a few moments with an excess of *N*/10 hydrochloric acid, and determining the amount of acid neutralised.

0.2633 *ortho*-product required 2.2 c.c. *N*/10 HCl, corresponding with 13.6 per cent. of iminoether.

0.2093 *para*-product required 9.0 c.c. *N*/10 HCl, corresponding with 70.0 per cent. of iminoether.

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