CL.—*The Action of Sodamide and of Acyl-substituted Sodamides on Organic Esters.*

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THE marked reactivity of sodamide with most classes of compounds and the peculiar nature of the results in many cases has rendered the study of its behaviour with organic substances of considerable importance. The author has already shown (Trans., 1897, 71, 462) that with substances containing the NH_2 or NH group, the hydrogen atom becomes replaced by sodium on treatment with sodamide if the neighbouring group possesses even only a very weak negative character, ammonia being at the same time produced. Thus all amides readily give rise to sodium derivatives of the type $\text{R}\cdot\text{CO}\cdot\text{NHNa}$ or $(\text{R}\cdot\text{CO})_2\text{NNa}$, which are conveniently looked upon as substituted (acyl) sodamides. The behaviour of the latter, and of sodamide itself, with alkyl and acyl haloids, as well as with potassium alkyl sulphates, has already been described (*loc. cit.*).

The behaviour of sodamide with ester, when first examined, presented some anomalous features which made it clear that esters of the aliphatic or phenyl aliphatic acids behaved differently from those of true aromatic acids like ethyl benzoate. It was found that the former, owing to the enolic tendency present in the grouping $-\text{CH}_2\cdot\text{CO}-$, reacted with sodamide, giving rise, with formation of ammonia, to condensation products similar to those obtained by means of sodium ethoxide.

When the interaction of sodamide and an ester was carried out carefully in the cold in presence of pure, dry benzene, there was at first practically no evolution of ammonia; a white, insoluble, flocculent powder, however, slowly separated which was very unstable and readily evolved the gas. This solid, which appears to be formed as an intermediate product in all the ester reactions, is probably an

additive compound containing the group $-\text{C} \begin{array}{l} \text{OR} \\ \text{NH}_2 \\ \text{ONa} \end{array}$; but owing to

its instability, no reliable means of ascertaining its nature could be obtained by analysis or otherwise. Such intermediate products were formed in the case, for example, of the action of sodamide on esters of acetic, oxalic, and benzoic acids, but by allowing the action to proceed further, results of a very different kind were obtained in these three typical instances.

Before attempting to elucidate the general nature of the reaction between sodamide and the group $-\text{CO}\cdot\text{OR}$, the behaviour of this substance with simple ketonic compounds was studied. Acetone was

selected for the purpose, but, like the aliphatic ketones generally, it was found to behave quite differently from purely aromatic ketones; thus whilst it reacts with sodamide with great energy in benzene solution, benzophenone under similar circumstances is quite unaffected. Here, as with aliphatic esters, the enolic tendency in acetone, and not the simple CO group, is responsible for the action. The change is almost entirely one of condensation, and the ultimate result of whatever reactions occur is the withdrawal of the elements of water, which at once decomposes more sodamide, liberating ammonia. Mesityl oxide, phorone, and isophorone are the chief products formed.

The interaction of sodamide and ethyl acetate, which was chosen for study as a typical ester, was examined under a variety of conditions, but in all cases it was evident that the chemical change could not be confined to a simple action between the carbethoxyl group and sodamide. When the ester is allowed to act in well-diluted benzene solution on finely powdered sodamide, the whole being kept cool, a white, flocculent precipitate is formed, which is very unstable, readily giving off ammonia, and is presumably an additive product as already conjectured. If the mixture is allowed to stand, or is warmed, a vigorous action sets in and a white or yellowish-white solid separates. This solid is essentially ethyl sodacetoacetate, from which it appears that the ultimate action of sodamide is similar to that of sodium ethoxide. The action may be expressed thus:

A small quantity of sodium acetamide and a considerable quantity of sodium acetate are also formed owing to secondary reactions.

The production of sodium acetate is not easy to explain. With all esters the action of which with sodamide has been examined, it has been found that the group CO·OR becomes CO·ONa to a greater or less extent (as a bye-product), even when moisture is rigidly excluded. There can be no doubt that the sodium ethoxide formed as one of the products of all these reactions exerts a saponifying influence, even in presence of benzene. Geuther (*Jahresber.*, 1868, 513) has shown that sodium ethoxide is readily capable of saponifying ethyl benzoate, forming sodium benzoate and ethyl ether, among other products, on heating.

By the action of sodamide on esters of formic acid, large quantities of sodium formate are produced. This was observed with ethyl, butyl, and amyl formates, all of which react vigorously, giving off ammonia even when well cooled or diluted with benzene. Sodium formamide and formate are formed in large quantities as thick, white, solid products. One of the changes which occurs is therefore simply

No evidence whatever could be obtained of the replacement of the hydrogen atom in these formic esters by sodium giving derivatives of the type $\text{Na}\cdot\text{CO}\cdot\text{OR}$ (compare Freer and Sherman, *Amer. Chem. J.*, 1896, 18, 7).

As the behaviour of ethyl acetate and other fatty esters threw no light on the nature of the action between the carbethoxyl group itself and sodamide, ethyl benzoate was selected as a convenient ester for this purpose. Its action with sodamide is much less vigorous, and in benzene solution in the cold the formation of the white, flocculent additive compound is very slow indeed. When the mixture is gently warmed, ammonia is gradually disengaged and a white, gelatinous solid separates, which slowly turns yellow and consists essentially of sodium benzamide and sodium ethoxide, but also contains sodium benzoate, the relative proportions of these products varying with the proportions of ethyl benzoate and sodamide taken.

Similar observations, made with other ethyl esters in which there was no enolic tendency, serve to show that, under suitable conditions, the carbethoxyl group reacts with sodamide, yielding acyl-substituted sodamides according to the general equation:

Phenyl esters, on the other hand, appear to behave quite differently. As yet, only the action of phenyl acetate and of phenyl benzoate on sodamide has been studied. The former behaves like the ethyl ester, but the latter has an entirely different action, for instead of sodium benzamide, which is not formed, sodium dibenzamide is obtained in large quantity along with sodium phenoxide and ammonia. The action, moreover, is completed more quickly and is attended with practically none of the secondary decompositions which occur during experiments with the ethyl ester. The change may be expressed thus:

It is far more probable, however, that the reaction occurs in two stages; in the first of these, an intermediate additive compound is formed, which in the second is almost immediately acted on by a mol. of the ester. The phenol formed at once liberates ammonia from the sodamide present:

In this equation, the sodium compound, derived from the tautomeric form of dibenzamide, is represented as the product, as its stability in aqueous solution suggests the hydroxy-structure, free dibenzamide being a non-dissociated, perfectly neutral substance, like the pseudo-acids of Hantzsch.

On similar lines, the production of sodium benzamide in the ethyl ester experiments probably occurs through the removal of a mol. of alcohol from the additive compound

in which the sodium derivative of the imino-hydroxy compound results. It has, however, not been found possible to prove this (see *Trans.*, 1901, **79**, 407).

When the action of potassium alkylsulphates on sodium dibenzamide, prepared from sodium ethoxide and dibenzamide in presence of alcohol, was examined, the results were found to be anomalous, as the expected alkyl derivative, $(\text{C}_6\text{H}_5 \cdot \text{CO})_2\text{NR}$, was not obtained. Primary acyl sodamides readily allow replacement of sodium by an alkyl group under these conditions, as has been already pointed out (*Trans.*, 1901, **79**, 400). From among the products of the reaction between sodium dibenzamide and potassium ethylsulphate, three substances were isolated, namely, benzamide, benzethylamide, and ethyl benzoate, but no ethyl dibenzamide. A small quantity of benzonitrile was also formed, and when the sodium dibenzamide was prepared from sodamide (that is, in absence of alcohol), the nitrile and ester were the chief products. The reaction in the latter case can be expressed by the equation

As this behaviour is very curious, the experiments were repeated under varying conditions. In one set, potassium ethylsulphate and sodium dibenzamide, in molecular proportion were dissolved in the minimum quantity of alcohol, and after removal of the bulk of the latter the mixture was carefully heated and distilled, whereby a yellowish oil was obtained. From this oil, some needles of dibenzamide separated, and after removing these and fractionating, a liquid boiling between 190° and 215° came over, from which ethyl benzoate and some benzonitrile were isolated. At higher temperatures, an oil came over, boiling between 290° and 300° , which, on standing, mostly solidified in the form of rectangular plates; these, after recrystallisation, melted at

69·5° and consisted of benzethylamide, $C_6H_5 \cdot CO \cdot NH \cdot C_2H_5$. Some benzamide was also isolated.

On repeating this experiment, without distilling but simply heating in a bath at 200°, and afterwards treating the mass with water and extracting with ether, a much larger quantity of benzamide was obtained. Only a little benzethylamide was apparently formed in this case, and in neither experiment could any ethyldibenzamide, $(C_6H_5 \cdot CO)_2N \cdot C_2H_5$, be isolated.

Similar results were obtained in experiments in which potassium methylsulphate was used.

Lastly, the action of potassium ethylsulphate on sodium diacetamide was examined, the latter being prepared from sodium ethoxide and diacetamide in alcoholic solution. After removal of the alcohol, the mixture was gently heated and distilled. The distillate, on fractionation, gave essentially two products, one boiling at about 80°, which was ethyl acetate (with a little acetonitrile), and the other, boiling at 222°, as an oil which quickly set to a crystalline mass of acetamide, melting after recrystallisation at 81°. There was no indication of the formation of ethyldiacetamide.

The cause of these abnormal relations was traced to the influence of the alcohol present, although, as previously shown (*loc. cit.*), it does not interfere in the action between potassium alkylsulphates and the sodium derivatives of primary amides. In the case of secondary amides, on the other hand, such as dibenzamide, it appeared on investigation that their sodium derivatives, although perfectly stable in alcoholic, and usually even in aqueous, solution, suffer a change on heating with alcohol at about 160°, which may be represented by the reversible system :

The change is probably much more complex in reality and is occasioned by the presence of sodium ethoxide which, to some small extent, must be present in equilibrium with sodium dibenzamide in an alcoholic solution of this substance.

If sodium ethoxide dissolved in alcohol is treated with dibenzamide in about equivalent proportion, the latter dissolves on warming, forming a clear solution of the sodium derivative. This solution remains clear for some time, but on keeping hot it suddenly gelatinises to a white, semi-solid mass. If a portion of the latter be now treated with water, benzamide (in very small quantity) remains insoluble, although previously the sodium dibenzamide was completely soluble in that liquid. At the same time, there is a distinct odour of ethyl benzoate noticeable. As yet, however, the action is very incomplete, and at

higher temperatures it proceeds sufficiently far to give a large quantity of benzamide. At the same time, much undecomposed sodium dibenzamide remains, and if there has been an excess of sodium ethoxide the ester formed is mostly saponified, giving sodium benzoate. The change may be represented thus:

These changes at once account for the peculiar observations made in the potassium alkylsulphate experiments. The benzethylamide, obtained in the experiments with sodium dibenzamide, is a product of a secondary reaction between the alkylsulphate and the sodium benzamide which is formed.

The peculiar reversible nature of the reaction between alcohol and sodium dibenzamide led to a study of the conditions under which the opposite reaction takes place, and in general of the nature of the interaction between organic esters and sodium derivatives of primary amides. It was found that the reaction

is general, except with derivatives containing the radicle $-\text{CH}_2\cdot\text{CO}-$ in the groups $\text{R}'\cdot\text{CO}-$ and $\text{R}''\cdot\text{CO}-$ (for example, aliphatic or phenyl aliphatic esters). Thus, in the aromatic series, by heating an acyl-substituted sodamide with an ester, a general change may be brought about between the groups $-\text{CO}\cdot\text{NHNa}$ and $-\text{CO}\cdot\text{OR}$, in which $\text{R}\cdot\text{OH}$ is eliminated and a magma obtained consisting largely of the sodium derivative $-\text{CO}\cdot\text{NNa}\cdot\text{CO}-$, from which the secondary amide may be prepared. Dibenzamide, for instance, may easily be obtained in this way from ethyl benzoate and sodium benzamide, and in a limited sense the reaction may be employed as a general method of synthesis of secondary amides. Two new mixed derivatives, $\text{R}\cdot\text{CO}\cdot\text{NH}\cdot\text{COR}'$, were thus obtained in putting the method to a trial.

The mechanism of the reaction is apparently very simple and (assuming the sodium compounds to have the tautomeric structure) may be represented thus:

To illustrate the difference exercised by the $\text{CH}_2\cdot\text{CO}$ group, reference may be made to the action of sodium acetamide on ethyl benzoate, in which benzamide and dibenzamide are obtained in molecular proportion.

This reaction may be expressed :

but it is difficult to explain why it should take this course. The first step is possibly to be represented thus :

the formation of sodium dibenzamide being due to a secondary action between the ethyl benzoate and sodium benzamide.

EXPERIMENTAL.

*Sodamide and Acetone.**

Pure acetone, prepared from the bisulphite compound and dried with anhydrous calcium chloride, was used. In one experiment, 10 grams of finely powdered sodamide were covered with benzene, and treated with 20 grams of acetone mixed with 50 grams of benzene, this mixture being added in small portions. An immediate reaction set in, with steady evolution of ammonia and formation of a gelatinous, yellowish solid. This, which rapidly turned red when exposed to air, was found to consist mostly of the sodium derivatives of the enolic forms of several condensation products. At the close of the reaction, which was completed by warming, the mass was treated with water and a reddish oil liberated, which was extracted by the benzene present and by fractionation resolved into at least three different ketonic condensation products. The oil boiled between 100° and 220° , and by repeated fractionation a colourless oil was obtained boiling at 130° , which was *mesityl oxide*; another was separated boiling at 190 – 200° , which, although it did not solidify, showed the properties of *phorone*; but the chief portion boiled at 217 – 220° and came over as a pale yellow oil, volatile with steam, and having a strong, camphor-like odour. This substance, on analysis, was found to have the composition $\text{C}_9\text{H}_{14}\text{O}$, and therefore is isomeric with *phorone* :

0.1357 gave 0.3890 CO_2 and 0.1247 H_2O . $\text{C} = 78.18$; $\text{H} = 10.16$.

$\text{C}_9\text{H}_{14}\text{O}$ requires $\text{C} = 78.18$; $\text{H} = 10.14$ per cent.

Further investigation of the oil showed its properties to be identical

* Since this paper was written, Freund and Speyer (*Ber.*, 1902, **35**, 2321) have published an account of the action of sodamide on acetone and on ethyl acetate. Their observations agree with mine.—A. W. T.

with those of *isophorone*. It was not further examined, since it has already been investigated by Knøevenagel (*Chem. Centr.*, 1897, ii, 698), Kerp and Müller (*Annalen*, 1896, 290, 123), Bredt, and Rübel, and others, and its constitution placed beyond doubt.

Sodamide and Ethyl Acetate.

Thirty-two grams of ethyl acetate freed from alcohol and acid and mixed with 200 grams of benzene were added gradually to 14 grams of sodamide in a flask fitted with a reflux condenser. The mixture, which soon grew hot, was cooled and well shaken, and when the action had moderated, gently heated on the water-bath for about 5 hours, during which ammonia was steadily evolved. On subsequent treatment with acetic acid, an oil was obtained from the benzene extract which boiled at 100–105° under 84 mm., and at 181° under 760 mm. pressure, and was identical in every respect with *ethyl acetoacetate*. The yield of the latter is not so great as that obtained in the preparation from sodium and ethyl acetate, and this is due to several secondary changes occurring, notably those in which sodium acetamide and sodium acetate are formed. The gas evolved contained no ethylamine or ethylene, and was found to consist entirely of ammonia.

Sodamide and Ethyl Benzoate.

As already mentioned, the results obtained in carrying out this reaction varied with the proportion of ester and sodamide used. In one set of experiments, 2 mols. of sodamide and 1 mol. of ethyl benzoate were taken, the ester being dissolved in twice its weight of benzene. The action was allowed to proceed quickly by warming gently for about 6 hours. At the end of that time practically all the sodamide had disappeared (provided it had been very finely ground) and no more ammonia was evolved. The thick, semi-solid mass was drained on the pump, washed with benzene to remove small quantities of undecomposed ester, and dried in a vacuum. It contained a large quantity of sodium benzamide and sodium ethoxide, and when treated carefully with ice-cold water, a thick, brownish solid was precipitated, consisting of impure benzamide, which after one or two recrystallisations was obtained pure and melted at 128°. The yield varied between 30 and 40 per cent. of that required by theory, the ultimate reaction being expressed by the equation:

Sodium benzoate was always obtained as a bye-product in these reactions, the relative amount being increased by using large quantities

of sodamide. No sodium dibenzamide was formed in those experiments where benzene was present as a menstruum (compare the action of phenyl benzoate on sodamide in presence of benzene, *infra*); but when benzene was absent and higher temperatures were employed, it was found that sodium dibenzamide was formed by a secondary change taking place between the ester and sodium benzamide (p. 1530).

Sodamide and Phenyl Benzoate.

In the absence of benzene, the action between sodamide and phenyl benzoate is much more energetic than that between sodamide and the ethyl ester under similar circumstances; much more dilute benzene solutions of the phenyl ester were therefore employed in studying its behaviour with sodamide. Under these conditions, in the cold, a white, flocculent powder is formed slowly, at first without evolution of ammonia, but on allowing the mixture to stand the latter commences to be formed, and on warming is rapidly liberated. In one experiment, 5 grams of pure phenyl benzoate (m. p. 69°), dissolved in 20 grams of benzene, and 2 grams of finely powdered sodamide were taken. After heating the whole for two hours, the action was complete, and the contents of the flask formed a thick, white magma. This was found to be a mixture of *sodium dibenzamide* and *phenoxide*, and to contain no sodium benzamide. No trace of aniline was formed.

The benzene, which was removed by draining hot on the pump, left no appreciable residue on evaporation, and the white solid remaining after removal of the benzene was *completely* soluble in water, and in alcohol, giving a strongly alkaline solution of a slightly yellow colour. The aqueous solution, on exposure to atmospheric carbon dioxide, slowly deposited dibenzamide in clusters of long needles. The latter was obtained from the aqueous solution by treating it with a current of carbon dioxide after diluting it sufficiently to prevent precipitation of phenol from the sodium phenoxide present. A thick, semi-solid mass of fine, white needles was thrown out, which after recrystallisation from alcohol separated in thick prisms melting at 148° . The yield of dibenzamide was 64 per cent. of that required by theory.

The filtrate from the dibenzamide contained only a little sodium benzoate and a large quantity of phenol, which was recovered in almost theoretical amount.

An easier method of isolating dibenzamide from the aqueous alkaline solution is to acidify with acetic acid, after diluting, and digest the crystalline precipitate after washing, with aqueous sodium carbonate to remove the benzoic acid present.

Sodamide and Ethyl Oxalate.

The necessary precautions were taken to ensure freedom of the ester from traces of acid and alcohol. When mixed with sodamide in the absence of a diluent, the action is very vigorous. If the sodamide is moistened with a little benzene and the two are mixed in a mortar and triturated together, there is an energetic evolution of ammonia, the whole grows very hot, and a yellowish-grey, friable solid is formed. If, on the other hand, the ester is well diluted with benzene, there is no reaction until the flask is gently warmed, and then a thick, white, flocculent powder begins to separate, without any appreciable evolution of ammonia, until towards the end of the reaction if the temperature is well regulated. The change which occurs is very similar to that observed in the case of ethyl benzoate so far as one carbethoxyl group is concerned, inasmuch as it ultimately becomes the amide grouping. The second group becomes $\text{CO}\cdot\text{ONa}$, thus resembling the formation of sodium benzoate. The final product obtainable, after treatment with water, is sodium oxamate, but a small quantity of oxamide is also formed as might be expected.

In one experiment, equivalent quantities of sodamide (2 mols.) and ester (1 mol.) were taken, the latter being dissolved in ten times its weight of benzene, and after heating on the water-bath until ammonia ceased to be evolved, the greyish-white, gelatinous solid was filtered off hot. The benzene filtrate, on cooling, deposited a jelly identical with the undissolved solid, which (as the author has frequently observed among many sodamide derivatives) is quite appreciably soluble in benzene. The gelatinous solid was only sparingly soluble in alcohol, although readily so in water, except for a small quantity of undissolved oxamide. A portion which had been dissolved in alcohol gave, with alcoholic silver nitrate, a deep orange precipitate darkening on standing, characteristic of amides in which a hydrogen atom is replaced by sodium (compare Trans., 1901, 79, 409). Treatment with water immediately converted the gelatinous solid into sodium oxamate, and on adding to the filtered strong aqueous solution one and a half volumes of alcohol the pure sodium salt was precipitated as a thick, white, gelatinous mass. The yield of oxamate was very satisfactory. No oxamethane could be isolated.

The action of *sodamide on benzimino-ethyl ether* was examined concurrently with that on esters. In presence of benzene, no action occurs at first, but after a short time the mixture grows warm and the sodamide rapidly disappears, while ammonia is steadily evolved and sodium ethoxide separates as a white, gelatinous solid. If this is

filtered off on the pump and the benzene distilled off from the filtrate, benzonitrile remains as a pale yellow oil. Apparently an additive compound is not formed, the elements of ethyl alcohol being simply removed from the ether thus: $\text{Ph}\cdot\text{C}(\text{NH})\cdot\text{OEt} = \text{Ph}\cdot\text{CN} + \text{EtOH}$.

Sodium Benzamide and Ethyl Benzoate.

Several attempts were made to bring about condensation between *free* benzamide and ethyl benzoate: that is, to eliminate alcohol and form dibenzamide, but the results were negative. On the other hand, in presence of sodium or sodium ethoxide in sufficient quantity, condensation at once takes place at about 180° ; or if sodium benzamide (separately prepared from benzamide and sodamide) is heated with the ester, condensation takes place similarly and sodium dibenzamide results.

The conditions necessary are best indicated by the following description of an experiment. Powdered sodamide (1 mol.) was suspended in benzene and treated with benzamide (1 mol.) and ethyl benzoate (about $1\frac{1}{2}$ mols.), and the mixture heated until a thick, white mass of sodium benzamide was formed and most of the ammonia expelled. The benzene was then driven off and the mixture heated at $200\text{--}215^\circ$ in a flask provided with an air condenser. The contents, which liquefied and boiled, were kept at this temperature for 15 minutes, whereby a viscid liquid was obtained, which, on cooling, set to a translucent solid. This consisted of sodium dibenzamide with unchanged ester and sodium benzamide. It was treated with warm water, and when completely disintegrated was made ice cold, and filtered from the soft mixture of ester and benzamide. The filtrate, which was turbid and strongly alkaline and contained sodium dibenzamide, was now carefully treated with acetic acid until nearly neutral and a white turbidity began to form. The acid was then added cautiously drop by drop, with shaking between each addition, until all the dibenzamide was precipitated. In this way, it came down as fine needles, in the form of a very bulky precipitate making a white, semi-solid froth. (If the neutralisation is not carefully performed, the dibenzamide comes down impure as an oily precipitate, solidifying and clogging into lumps.) In order to remove benzoic acid, which was usually present, the whole was rendered just alkaline with sodium carbonate, allowed to stand for half-an-hour, filtered, and washed on the pump. The product was white, melted at $145\text{--}147^\circ$, and after once recrystallising from alcohol was pure, melting at 149° . The yield (on the benzamide taken and using an excess of ester) was only a little short of the theoretical, but in experiments where less ethyl

benzoate was taken, or other conditions were not carefully regulated, it was much smaller :

0.1235 gave 6.9 c.c. moist nitrogen at 19° and 768.5 mm. $N = 6.45$.
 $C_{14}H_{11}O_2N$ requires $N = 6.22$ per cent.

Sodium Acetamide and Ethyl Benzoate.

The result of the change which takes place between these substances was quite unexpected, and there was no formation of sodium acetylbenzamide. The action was tried under several conditions, both in presence and in absence of alcohol. In the former case, acetamide was treated with sodium ethoxide in alcoholic solution and then with ethyl benzoate. A jelly formed which was heated first to remove alcohol, and then, as in the sodium benzamide experiments, at 200°, at which temperature a reaction set in with production of ethyl acetate in large quantity. On cooling and treating the product with water, a considerable bulk remained insoluble, consisting of benzamide (m. p. 127°) and unchanged ethyl benzoate. The portion soluble in water contained sodium dibenzamide, and gave with acid a large quantity of a white, oily precipitate, quickly becoming solid and crystalline. From this, a small quantity of benzoic acid was removed with sodium carbonate, and the dibenzamide was recrystallised from alcohol. The yield was good, and the proportion to benzamide approximately molecular.

Precisely similar results were obtained when the pure crystalline sodium acetamide obtained from sodamide was used, alcohol being excluded.

Sodium Benzamide and Ethyl Acetate.

Here also there is no formation of sodium acetylbenzamide. The experiments were carried out in sealed tubes at fairly high temperatures. The sodium benzamide was first prepared in the tube from sodamide and benzamide intimately mixed while dry and then moistened with a little benzene and heated in a water-bath until ammonia ceased to be evolved. After cooling, pure ethyl acetate in excess (2 mols.) was added, and the tube, after sealing, heated at 170° for 3 hours. At the end of this time, the contents, which were brownish, were treated with water. A light layer of oil floated on top, which contained ethyl acetate, benzamide, and ethyl benzoate. The aqueous portion was washed with ether to remove traces of these substances, freed from ether, and then acidified with hydrogen chloride. A dirty, oily precipitate was obtained which contained ethyl acetoacetate and apparently some dibenzamide, but no acetylbenzamide.

Sodium benzamide and phenyl acetate at 190° gave similar results.

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The action between fatty esters in general and acyl sodamides is complicated, owing to the latter exerting a condensing influence, like sodium ethoxide, and to secondary changes.

Similar results were obtained in the reaction between *sodium benzamide* and *ethyl phenylacetate*, $\text{C}_6\text{H}_5\cdot\text{CH}_2\cdot\text{CO}_2\text{Et}$, which was carried out at 200—230°. Dibenzamide, and not benzylbenzamide (which was looked for), was the chief product obtained, owing to secondary changes. The reaction was not further investigated.

The mixed secondary amides, hippurylbenzamide, and salicylbenzamide, which have not previously been described, were readily obtained in the following way.

Sodium Benzamide and Ethyl Hippurate. Hippurylbenzamide,
 $\text{C}_6\text{H}_5\cdot\text{CO}\cdot\text{NH}\cdot\text{CH}_2\cdot\text{CO}\cdot\text{NH}\cdot\text{CO}\cdot\text{C}_6\text{H}_5.$

The reaction proceeds normally, but must be carried out with great caution at the lowest possible temperatures. If the mixture of ester and sodium benzamide be taken in small quantity only, it may be heated at about 150° for a very short time and quickly cooled down again, but if larger quantities be used and it is necessary to heat for several minutes, the mass slowly becomes yellow and finally dark red. On cooling, a hard, brittle, transparent product is obtained, from which only a very small quantity, or none, of the mixed amide can be isolated, owing to its sodium derivative, which is unstable, having suffered decomposition. In several experiments, the results were negative even at so low a temperature as 125°. The best results were obtained as follows.

Benzamide and sodamide were converted into sodium benzamide, to one molecular equivalent of which $1\frac{1}{2}$ mols. of ethyl hippurate were added, the two being well mixed in an open glass beaker and just moistened with a little benzene. The mixture was heated very cautiously at a temperature not exceeding 100—110° (at which a reaction quickly sets in) for as short a time as possible, and only until the semi-liquid mass became homogeneous, this being assisted by stirring with a thermometer. No discoloration occurred. The product was cooled, forming a soft magma, which was then treated with ice-cold water and extracted once or twice with benzene to remove unchanged amide and ester. The aqueous portion was filtered and cautiously acidified with hydrogen chloride, whereby an oily turbidity quickly solidifying to a mass of nearly white needles was thrown out. These were washed with sodium carbonate to remove any hippuric acid present, and recrystallised from alcohol. In this way, hippurylbenzamide was obtained as white clusters of long, silky needles melting at 179° :

0.0984 gave 8.6 c.c. moist nitrogen at 22° and 762 mm. $N = 9.92$.

$C_{16}H_{14}O_3N_2$ requires $N = 9.93$ per cent.

Hippurylbenzamide is sparingly soluble in cold, but readily so in hot, alcohol. It is insoluble in sodium carbonate solution, but readily soluble in sodium hydroxide. This aqueous solution of its sodium derivative, on acidifying, at once gives a milkiness, immediately changing to a voluminous precipitate of white needles.

Sodium Benzamide and Methyl Salicylate. Salicylbenzamide,

The sodium benzamide (1 mol.), prepared from sodamide as usual, was mixed with the ester ($1\frac{1}{2}$ mols.) and heated at about 170° until the fused mass became homogeneous. After cooling, the product was treated with water, the unchanged amide and ester removed by filtration, and the aqueous portion acidified with hydrochloric acid, when a thick, white, milky oil was precipitated which quickly solidified to crystalline lumps. These were removed, drained on a porous plate, and crystallised from alcohol. Fine prisms separated of pure salicylbenzamide melting at 122°:

0.1012 gave 5.1 c.c. moist nitrogen at 23° and 759 mm. $N = 5.67$.

$C_{14}H_{11}O_3N$ requires $N = 5.80$ per cent.

Salicylbenzamide is soluble in hot water, from which, on cooling and long standing, it separates as long, thick prisms. It is slowly soluble in aqueous sodium carbonate (compare dibenzamide), but much more readily so in sodium hydroxide, forming the disodium derivative, from which it is precipitated as needles on the addition of an acid.

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