

CCVI.—*The Action of Sodium Methoxide on
2 : 3 : 4 : 5-Tetrachloropyridine. Part II.*

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IN Part I. (this vol., p. 1193) an account is given of the gaseous products of this reaction when carried out at 200—205° in sealed tubes. The present communication deals (a) with the examination of any compounds obtained from the sodium derivatives left in

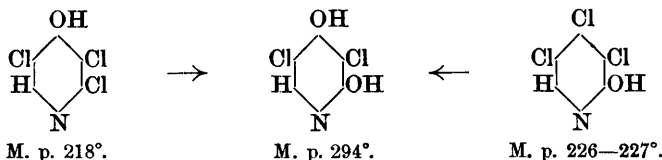
these tubes, and further (b) an account is given of the products when the reaction is carried out by heating the mixture in a water-bath in a flask fitted with a reflux condenser, provision being made for the absorption of any methyl ether which may be produced.

(a) The only substance obtained from the residue left in the tubes after heating to 200—205° is 3:5-dichloro-2:4-dihydroxypyridine, which forms lustrous needles (m. p. 294°), and the same substance is obtained whether the tubes had been exhausted or not before heating.

(b) The reaction in this part of the work was carried out on a fairly large scale, and in two series (b1) and (b2), the sodium methoxide solution employed differing in concentration and consequently in boiling point. In series (b1) the solution of sodium methoxide was only of moderate strength, the products being largely 3:5-dichloro-2:4-dimethoxypyridine (m. p. 57°), with small quantities of 3:5-dichloro-4-hydroxy-2-methoxypyridine (m. p. 174—175°) and 2:3:5-trichloro-4-hydroxypyridine (m. p. 217—218°). No methyl ether was observed in this series. In series (b2) the sodium methoxide solution used was of such strength as practically to solidify when cold; a mere trace of 3:5-dichloro-2:4-dimethoxypyridine is obtained, and practically the whole of the tetrachloropyridine is converted into 3:5-dichloro-4-hydroxy-2-methoxypyridine (m. p. 174—175°). Methyl ether was produced in quantity in this series. The production of methyl ether at this low temperature (79—74°), accompanied as it is by the conversion of a methoxy- into a hydroxy-group, confirms the explanation of this occurrence offered in Part I. (*loc. cit.*). With regard to the compounds produced under (b1), both 3:5-dichloro-2:4-dimethoxypyridine (m. p. 57°) and 3:5-dichloro-4-hydroxy-2-methoxypyridine (m. p. 174—175°) are converted into 3:5-dichloro-2:4-dihydroxypyridine (m. p. 294°) by hydrolysis at 170° with concentrated hydrochloric acid.

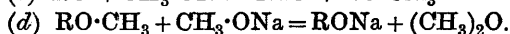
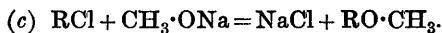
The known readiness with which the halogen in the 2:4-positions is removed by such reagents as sodium methoxide compared with that in the 3:5, renders it extremely probable that the methoxy- and hydroxy-groups concerned in the above-mentioned compounds are in the positions assigned to them. This belief is confirmed by the fact that either of the trichloromonohydroxypyridines having the constitution given below when heated to 180° with sodium methoxide yields the same dichlorodihydroxypyridine (m. p. 294°), identical with the compound obtained by hydrolysis from the above 3:5-dichloro-2:4-dimethoxypyridine and 3:5-dichloro-4-hydroxy-2-methoxypyridine.

In considering the relative positions of the methoxy- and hydroxy-groups in the last-mentioned substance, there is no doubt that the



dimethoxy-compound is the chief product in (b1)—at or below 70°, the temperature reached in this mixture.

In the series (b2) one of the methoxy-groups is shown to have given place to a hydroxy-group at or below the temperature reached by the mixture (79°), the temperature gradually falling as the reaction proceeds, and remaining steady at 74° with the production of 3:5-dichloro-4-hydroxy-2-methoxypyridine and methyl ether, thus:



Noteworthy is the production in small quantity of 2:3:5-trichloro-4-hydroxypyridine in (b1) as pointing to the low temperature at which the 4-methoxy-group is attacked by the sodium methoxide, giving the hydroxy-compound melting at 217–218°.

Further, in some experiments in which 3:5-dichloro-4-hydroxy-2-methoxypyridine was heated in sealed tubes with excess of sodium methoxide, there was no alteration at 125° or at 140°, but at 150° the second methoxy-group was attacked, and 3:5-dichloro-2:4-dihydroxypyridine (m. p. 294°) was produced.

EXPERIMENTAL.

(a) The residue in the tube was dissolved in water, and treated with a current of steam, when nothing passed over. The residual solution was acidified with sulphuric acid, and the crystalline matter collected and recrystallised from boiling water, in which it is moderately soluble. 3:5-Dichloro-2:4-dihydroxypyridine forms glistening groups of needles, which are anhydrous, and melt at 294° without decomposition. It is freely soluble in alcohol, and practically insoluble in the usual organic solvents:

0.355 gave 0.56662 AgCl. Cl = 39.46.

$\text{C}_5\text{H}_3\text{O}_2\text{NCl}_2$ requires Cl = 39.44 per cent.

A solution in dilute ammonia after evaporating all excess of ammonia gives the following reactions: (1) With silver nitrate in dilute solution a silver compound is gradually deposited in clusters of needles; in more concentrated solution a heavy, white, crystalline precipitate is immediately produced, which is sparingly soluble in

boiling water. (2) Mercuric chloride gives no precipitate. (3) Barium chloride produces a white precipitate in spherical groups of needles. (4) The *calcium* compound is soluble.

The apparatus in which both series of experiments (*b1*) and (*b2*) were conducted consisted of a flask with a reflux condenser, to the top of which was fitted a Wöhler tube containing about 20 c.c. of concentrated sulphuric acid to absorb any methyl ether.

(*b1*) To the flask containing about 150 c.c. of dry methyl alcohol in which 9 grams of sodium had been dissolved, were added 20 grams of 2:3:4:5-tetrachloropyridine, and the whole, after cooling in water for a few minutes to restrain the vigour of the reaction, was heated by immersion in a water-bath for six hours. The temperature of the boiling mixture was 70°. The resulting product was distilled in a current of steam, when a considerable quantity of a solid, crystalline substance collected in the receiver. This dissolved freely in hot alcohol, from which it crystallised in colourless, prismatic needles, and on purification melted at 57°. 3:5-Dichloro-2:4-dimethoxypyridine is freely soluble in alcohol or the usual organic solvents, but is practically insoluble in water:

0.35 gave 0.5125 CO₂ and 0.107 H₂O. C=39.93; H=3.40.

C₇H₇O₂NCl₂ requires C=40.38; H=3.36 per cent.

The residue after steam distillation was acidified with sulphuric acid, when a small, crystalline precipitate was obtained. This on purification, by crystallisation from 25 per cent. spirit, was separated into two compounds, one melting at 174—175°, which was recognised as 3:5-dichloro-4-hydroxy-2-methoxypyridine (see below), and the other, melting at 217—218°, as 2:3:5-trichloro-4-hydroxypyridine (Sell and Dootson, Trans., 1903, **83**, 400). (Found, Cl=53.3. Calc., Cl=53.6 per cent.)

In series (*b1*) described above no distinct evidence of methyl ether was obtained. In the experiment (*b2*) 80 c.c. of dry methyl alcohol were used to dissolve 9 grams of sodium, the solution of the latter towards the last being assisted by heating on the water-bath. The rest of the operations were conducted as in (*b1*). There was a trace of the volatile needles of 3:5-dichloro-2:4-dimethoxypyridine in the steam distillate, the only other product beside methyl ether being 3:5-dichloro-4-hydroxy-2-methoxypyridine, which was precipitated from the residual liquid by sulphuric acid, and on purification from much boiling water and also from hot dilute spirit crystallised in colourless needles and plates melting at 174—175°. The substance is freely soluble in alcohol, moderately so in the usual organic solvents or boiling water, and very sparingly so in cold water:

0.163 gave 0.220 CO_2 and 0.038 H_2O . $\text{C}=36.8$; $\text{H}=2.58$.

0.327 „ 0.4742 AgCl . $\text{Cl}=36.44$.

$\text{C}_6\text{H}_5\text{O}_2\text{NCl}_2$ requires $\text{C}=37.01$; $\text{H}=2.57$; $\text{Cl}=36.59$ per cent.

The pure substance distils slowly in a current of steam.

A solution in dilute ammonia after evaporation to remove excess of ammonia gives the following reactions: (1) With silver nitrate a flocculent precipitate sparingly soluble in boiling water, from which it separates on cooling in delicate, microscopic needles. (2) With lead acetate white bunches of needles are slowly deposited. (3) The *barium*, *calcium*, and *magnesium* salts are soluble.

Examination for Methyl Ether.—The sulphuric acid from the Wöhler tube in the experiments from (b2) gave a good yield of methyl ether, which was examined in a similar way to that described in Part I. (*loc. cit.*). It was inflammable, and freely soluble in water. The dry gas was liquefiable, and boiled at -21° . A portion exploded with excess of oxygen gave the following results:

Vol. of ether	1.8 c.c.	After KOH	10.4 c.c.
„ „ + oxygen ...	17.6 „	„ pyrogallol	0.0 „
After explosion ...	14.0 „	$(\text{CH}_3)_2\text{O} + 3\text{O}_2 = 3\text{H}_2\text{O} + 2\text{CO}_2$	

Conversion of 3:5-Dichloro-2:4-dimethoxypyridine into 3:5-Dichloro-2:4-dihydroxypyridine.—Two grams of 3:5-dichloro-2:4-dimethoxypyridine were heated in a sealed tube with 20 c.c. of concentrated hydrochloric acid to 175° for four hours. The product was evaporated to remove excess of acid, and the substance, when crystallised from water, was identified as 3:5-dichloro-2:4-dihydroxypyridine, melting at 294° (uncorr.). (Found, $\text{C}=32.96$; $\text{H}=1.74$; $\text{Cl}=39.0$. Calc., $\text{C}=33.33$; $\text{H}=1.66$; $\text{Cl}=39.44$ per cent.)

Conversion of 3:5-Dichloro-4-hydroxy-2-methoxypyridine into 3:5-Dichloro-2:4-dihydroxypyridine.—This compound was treated in a similar manner to the preceding one, and gave precisely similar results, the product melting at 294° .

Conversion of 3:4:5-Trichloro-2-hydroxypyridine and 2:3:5-Trichloro-4-hydroxypyridine respectively into 3:5-Dichloro-2:4-dihydroxypyridine.—A specimen of each of these compounds weighing 2 grams was heated in a sealed tube with methyl alcohol, in which 2 grams of sodium had been dissolved, for four hours to 180° . On dissolving the contents of each tube in water, and acidifying the solution, the precipitates obtained from each, after being purified by crystallisation, were found to have identical properties and to melt at 293 — 294° .