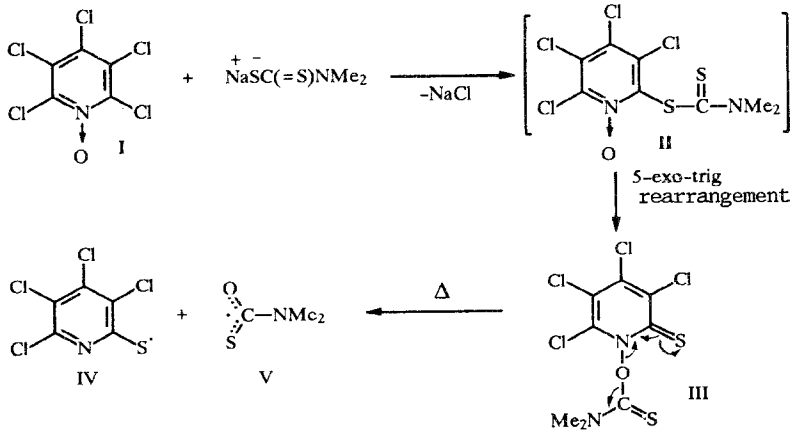
REACTIONS OF POLYHALOPYRIDINES. 2. NEW SUBSTITUTION REACTION OF PENTACHLORO-PYRIDINE N-OXIDE

A. M. Sipyagin, V. V. Kolchanov, and S. V. Pal'tsun

The thermally induced conversions of the α-dimethyldithiocarbamate derivative of 3,4,5,6-tetrachloropyridine N-oxide have been studied under various conditions.

We discovered previously that 2,3,5,6-tetrachloro-4-cyanopyridine reacts with sodium N,N-dimethyldithiocarbamate by substituting a chlorine atom at position 2 of the pyridine ring with subsequent thermal cyclization leading to bis-1,3-dithiolo[4,5-b:4′,5′-e]pyridine [1]. In continuation of investigations on the synthesis of new heterocyclic compounds using intramolecular nucleophilic substitution reactions in perchloropyridines, we studied the possibility of similar conversions using pentachloropyridine N-oxide (I) for which nucleophilic substitution processes at the α-position are characteristic [2] and obtained unexpected results.

A yellow solid is formed on reacting pentachloropyridine N-oxide with sodium dimethyldithiocarbamate in acetone. This compound is insoluble in organic solvents and is probably the rearrangement product (III). The structure of compound (III) and the radical mechanism of its subsequent conversions were confirmed by analysis of the structure of the thermal reaction products (VI), (VII), and (VIII). This agrees with the work of Barton on the radical decomposition of O-acyl derivatives of N-hydroxy-2-thiopyridones [3-5], and with the data on the thermal rearrangement of O-thiocarbamoylated derivatives of hydroxamic acids [6, 7]. The route of the chemical conversion may be represented in the following way. Nucleophilic substitution at position 2 of compound (I) by the dithiocarbamate leads to the formation of the intermediate (II) which undergoes a 5-exo trig rearrangement to the thermodynamically more stable derivative (III).

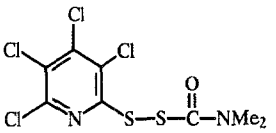


Compound (III) decomposes homolytically on heating to the radicals (IV) and (V), the stabilization of which determine the further routes of chemical conversion.

The first route (A), which predominates in chloroform, is the recombination of the radicals (IV) and (V) leading to the thermally induced rearrangement product (VI).

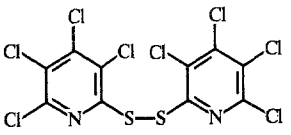
Institute of Chemical Physics in Chernogolovka, Russian Academy of Sciences, Chernogolovka 142432. Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 9, pp. 1216-1218, September, 1993. Original article submitted August 2, 1993.

0009-3122/93/2909-1038$12.50

A IV + V ⟶ 

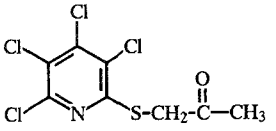
VI

The second route (**B**) occurs in ethyl acetate with the recombination of the radicals (IV) with the formation of the disulfide (VII).

B IV + IV ⟶ 

VII

The third route (**C**), leading to the S-acetonyl derivative (VIII), is effected on carrying out the reaction in acetone and is a recombination of the radicals (IV) and $CH_3COCH_2^{\cdot}$. The latter is formed from the reaction of radical (V) with acetone. The further conversions of dimethylthiocarbamic acid have been studied previously [6-8].

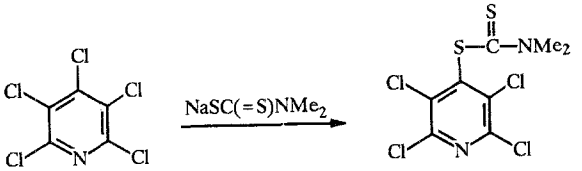
C IV + CH_2COCH_3 ⟶ 

VIII

V + CH_3COCH_3 ⟶ $Me_2N\text{-}COSH + \dot{C}H_2COCH_3$

2 Me_2NCOSH ⟶ $COS + Me_2NCOS^{-}H_2\overset{+}{N}Me_2$

In contrast to the conversions of compound (I) given above, pentachloropyridine itself reacts with sodium dimethyldithiocarbamate in a different way. Nucleophilic replacement of the chlorine atom at position 4 of the pyridine ring occurs with the formation of 2,3,5,6-tetrachloro-4-pyridyl N,N-dimethyldithiocarbamate (IX) which does not undergo further conversion (see Ref. 1 in [1]).



IX

Attempts to extend the reactions given above to other dithiocarboxylic acids (ethyl xanthate and potassium isopropyl trithiocarbonate) were not crowned with success. In these cases intermolecular processes, linked with the ready deoxygenation of the N-oxide and oxidation of sulfur-containing reactants, predominated.

In conclusion, it must be noted that the reactions described may be applied to the synthesis of S-alkylated derivatives of pentachloropyridine.

EXPERIMENTAL

The IR spectra of compounds were measured on a Specord M 80 instrument in chloroform, NMR spectra were recorded in $CDCl_3$ solution on a Bruker AC 200 instrument with an operating frequency of 200 MHz (PMR) and 50 MHz (^{13}C NMR),

internal standard was TMS. The mass spectral measurements were carried out on a Finnegan 4021 instrument (direct insertion, ionization energy 70 eV.

O-(3,4,5,6-Tetrachloro-2-thioxo-1,2-dihydro-1-pyridyl) N,N-Dimethylthiocarbonate (III) $C_8H_6Cl_4N_2OS_2$. Sodium dimethyldithiocarbamate dihydrate (2.68 g: 0.015 mole) was added with stirring to a solution of pentachloropyridine N-oxide (2.68 g: 0.01 mole) in acetone (200 ml). The mixture was stirred at room temperature for 15 min, the solid was removed by filtration, washed on the filter with acetone, with water, with acetone again, and dried in vacuum. Compound (III) (2.82 g: 80%) was obtained as yellow crystals of mp 130-132°C (with decomposition). PMR spectrum: 3.53, 3.56 ppm (6H, s, NMe_2). Compound (III) is unstable in solution and after recording the ^{13}C spectrum was converted into compound (VI).

3,4,5,6-Tetrachloro-2-pyridyldisulfanyl-N,N-dimethylformamide (VI) $C_8H_6Cl_4N_2OS_2$. Compound (III) (1.06 g: 0.003 mole) was boiled under reflux in chloroform (40 ml) with stirring for 10-15 min. The solvent was removed, and the residue chromatographed on a column of silica gel (eluent was benzene—hexane, 4:1). The yield of white crystals of mp 101-103°C was 0.6 g (57%). Found: M^+ 350. IR spectrum: 1702 cm^{-1}. PMR spectrum: 3.15 ppm (6H, br.s, NMe_2). ^{13}C NMR: 37.6 (s, NMe_2), 126.7 (s, $C_{(3)}$, $C_{(5)}$), 142.5 (s, $C_{(4)}$), 147.5 (s, $C_{(6)}$), 154.8 (s, $C_{(2)}$), 162.9 ppm (s, C=O).

Bis(tetrachloro-2-pyridyl) Disulfide (VII). Compound (III) (1.8 g: 0.005 mole) was boiled under reflux in ethyl acetate (20 ml) for 5 min and cooled. The solid was filtered off, washed with water, then with acetone, and dried. Compound (VII) (1.07 g: 60%) was obtained as white crystals of mp 233°C (literature 230-232°C [2]). Found: M^+ 492.

(Tetrachloro-2-pyridylthio)acetone (VIII). Compound (III) (1.06 g: 0.003 mole) was boiled in acetone (50 ml) for 15 min. After evaporation of the solvent the residue was chromatographed on a column of silica gel (eluent was benzene—hexane, 2:1). The yield of white crystals of mp 95-95.5°C (hexane, literature 94-95°C [2]) was 0.53 g (58%). Found: M^+ 303. IR spectrum: 1738 cm^{-1}. PMR spectrum: 2.34 (3H, s, Me), 3.90 ppm (2H, s, CH_2). ^{13}C NMR: 29.5 (s, Me), 41.2 (s, CH_2), 125.2, 126.3 (2s, $C_{(3)}$, $C_{(5)}$), 142.2 (s, $C_{(4)}$), 146.5 (s, $C_{(6)}$), 155.1 (s, $C_{(2)}$), 201.2 ppm (s, C=O).

REFERENCES

1. A. M. Sipyagin and Z. G. Aliev, Khim. Geterotsikl. Soedin., No. 9, 1207 (1993).
2. B. Iddon, H. Suschitzky, A. W. Thomspon, and E. Ager, J. Chem. Soc., Perkin Trans. 1, 2300 (1974).
3. D. H. R. Barton, W. B. Motherwell, and D. Crich, Tetrahedron, **41**, 3901 (1985).
4. D. H. R. Barton, B. Garcia, H. Togo, and S. C. Zard, Tetrahedron Lett., **27**, 1327 (1986).
5. D. H. R. Barton, B. Crich, and D. Kretschmar, J. Chem. Soc., Perkin Trans. 1, 39 (1986).
6. R. F. Hudson, A. J. Lawson, and E. A. C. Lucken, J. Chem. Soc., Chem. Commun., 807 (1971).
7. W. B. Ankers, C. Brown, R. F. Hudson, and A. J. Lawson, J. Chem. Soc., Chem. Commun., 935 (1972).
8. M. S. Newman and F. V. Hetzel, J. Org. Chem., **34**, 3604 (1969).