Pergamon

Tetrahedron Letters, Vol. 35, No. 19, pp. 3147-3150, 1994
Elsevier Science Ltd
Printed in Great Britain
0040-4039/94 $6.00+0.00

0040-4039(94)E0469-E

UNUSUAL NUCLEOPHILIC SUBSTITUTION REACTION OF TETRACHLOROPYRIDINE N-OXIDE

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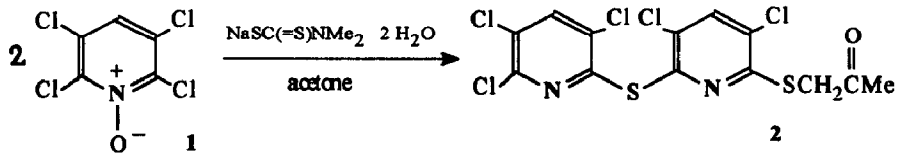
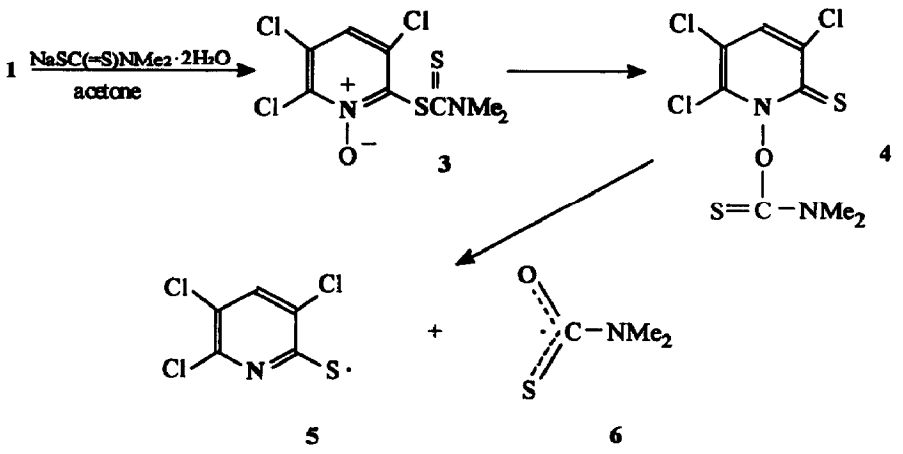
Abstract. The reaction between 2,3,5,6-tetrachloropyridine *N*-oxide and sodium dimethyldithiocarbamate in acetone forms 1-[6-(3',5',6'-trichloropyrid-2'-ylthio)-3,5-dichloropyrid-2-ylthio]propan-2-one as the main product.

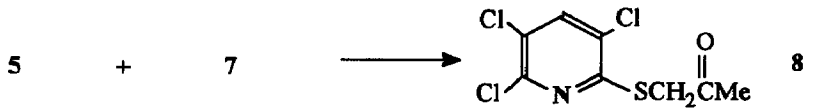
We have previously found that 4-cyano-2,3,5,6-tetrachloropyridine on reaction with sodium *N,N*-dimethyldithiocarbamate (SDDC) is substituted at position 2 and is further converted in 8-cyano-bis-1,3-dithiolo[4,5-*b*:4',5'-*e*]pyridine-2,6-dione[1]. In conjunction with our current synthetic investigations in the intramolecular substitution reactions of perchloropyridine derivatives with SDDC we studied the possibility of such conversions for 2,3,5,6-tetrachloropyridine *N*-oxide(1), which also undergoes nucleophilic substitution reactions at position 2 of the pyridine ring. Surprisingly, instead of the expected dialkyldithiocarbamate derivative of **1**, 1-[6-(3',5',6'-trichloropyrid-2'-ylthio)-3,5-dichloropyrid-2-ylthio]propan-2-one(**2**) was obtained in boiling acetone[2].

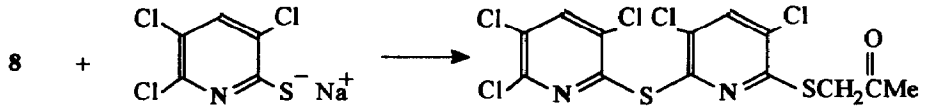


The formation of the dipyridylsulfide fragment and the unusual introduction of an *S*-acetonyl group in position 2 of the pyridine ring can be explained by data on the radical decomposition of *O*-acyl derivatives of *N*-hydroxy-2-thiopyridones[3] and *O*-thiocarbamoyloximes[4]. The reaction sequences probably proceeds as follows: first, substitution of 1 with dithiocarbamate moiety gives intermediate 3 which undergoes rearrangement to form a thermodynamically more stable product 4[3]:

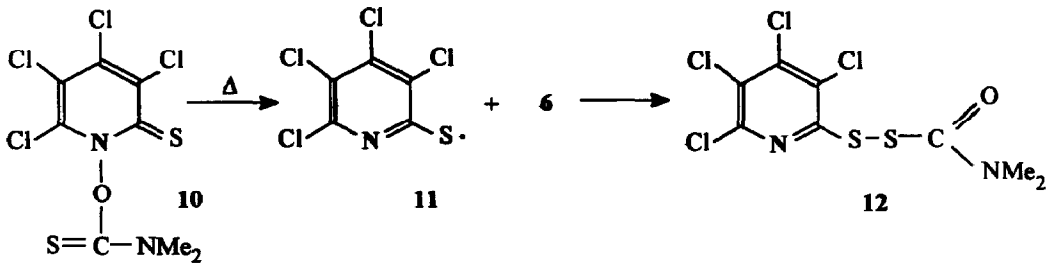


Upon heating compound **4** breaks down to the radicals **5** and **6**, and their reactivities determine further conversion pathways. Radical **5** reacts with radical $\dot{C}H_2COMe$ (**7**) (the latter can be formed from radicals **5** or **6** and acetone) to produce intermediate **8**. Then the chlorine atom at position 6 in the pyridine ring of **8** can be substituted with trichloropyridinethiolate anion **9** yielding the final product **2**.

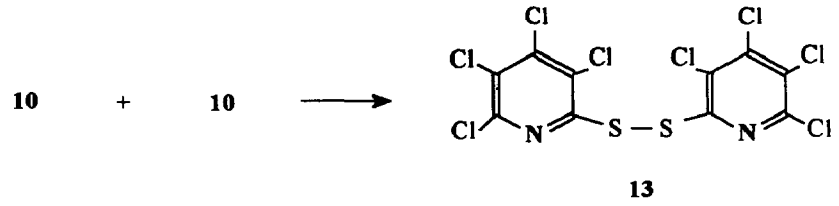




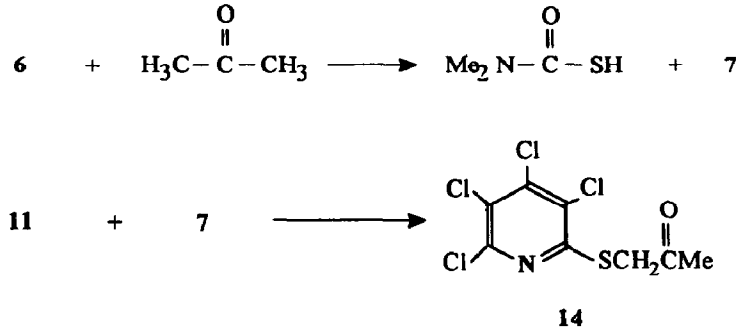
The formation of intermediate **9** probably takes place by the radical stabilization of **5** in the reaction medium. The proposed mechanism seems likely in the light of our current results on the reaction of pentachloropyridine *N*-oxide with SDDC in acetone, which gives product **10**[5] (with structure analogous to **4**) as yellow solid. The structure and radical mechanism of further chemical conversions of **10** are confirmed by the structure of the products of its thermal transformations as well as its ability to initiate olefine polymerisation (acrylonitrile). In particular, upon heating in $CHCl_3$, **10** gave the product of thermal rearrangement **12**[6], which could be formed by recombination of radicals **6** and **11**.



In the ethylacetate medium, the stabilization of radicals proceeds by another pathway, to yield bis(3,4,5,6-tetrachloropyrid-2-yl)disulfide (13)[7] which is the main product of the reaction.



One more route demonstrating the reactivity of radicals 6 and 11 was realized in the case of reflux 10 in acetone.



Unlike the conversions of 1 outlined above, this process is limited to the interaction of intermediates 7 and 11 leading to (3,4,5,6-tetrachloropyrid-2-ylthio)acetone (14)[8] with a 58% yield.

The structure of compound 2 was determined by ^{1}H and ^{13}C NMR. The values of the ^{1}H and ^{13}C chemical shifts and the ^{13}C- ^{1}H coupling constants are given in the Table. The ^{13}C chemical shifts were assigned on the basis of additivity rules, by comparison with 2- and 3-substituted pyridines and analysis of the long range ^{13}C- ^{1}H coupling constants. The geometrically equivalent carbon atoms C-3', C-5', C-3,C-5 and C-2' and C-6' with close chemical shift values and ^{13}C- ^{1}H coupling constants were assigned using selective heteronuclear decoupling (see Table). A significant increase in the ^{13}C-^{1}H constants $^{2}J_{34}$, $^{2}J_{5'4'}$,$^{2}J_{34}$ and $^{2}J_{54}$ as compared with 2- and 3-chloro-substituted pyridines[9-14] is probably caused by the electron-donor influence of sulfur atoms on the electron density distribution in the pyridine ring. C-2 in the coupled spectrum exhibits a characteristic interaction with H-4' and the protons of the CH_2-group.

Table. NMR data for compound 2

Atom	δC, ppm	δH, ppm	J, Hz		Atom	δC, ppm	δH, ppm	J, Hz
C-2'	150.59		7.08 ($^3J_{7'4'}$)		C-3	127.79		4.00 ($^2J_{34}$)
C-3'	129.73		4.00 ($^2J_{3'4'}$)		C-4	136.69	7.64	172.57 ($^1J_{CH}$)
C-4'	139.00	7.86	173.84 ($^1J_{CH}$)		C-5	128.54		3.63 ($^2J_{54}$)
C-5'	132.37		3.63 ($^2J_{5'4'}$)		C-6	149.99		6.72 ($^3J_{64}$)
C-6'	146.79		8.369 ($^3J_{6'4'}$)		C=O	201.97		
C-2	154.59		6.54 ($^3J_{24}$)		CH_2	40.55	3.64	
			5.09 ($^3J_{2CH_3}$)		CH_3	28.41	2.12	

References and Notes

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2. Compound **2** was obtained as a pale yellow solid by column chromatography on silica gel (benzene-hexanes = 9:1), yield 25%, m.p. 94- 95° C(methanol). The molar ratio of **1** to SDDC was 1: 1.5.
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5. Compound **10** was synthesized by reaction of pentachloropyridine *N*-oxide and SDDC dihydrate at room temperature (molar ratio 1:1,5). Yield **80%**, m.p. 130-132°C (decomp.). NMR ^1H ($CDCl_3$): 3,53 s, 3,56 s (NMe_2). Compound **10** is unstable in solution and its conversion into **12** was observed, while recording of a ^{13}C NMR spectrum of **10.**
6. Compound **12** was obtained by heating of **10** in chloroform for 10 min. The product was purified on column packed with silica gel (eluent benzene-hexanes = 4:1). Yield 57% as white crystals., m.p. 101-103°C. NMR ($CDCl_3$) ^1H: 3,15 (broad singlet, NMe_2); ^{13} C: 37,6 (NMe_2); 126,7; 127,1 (C-3,C-5); 142,5 (C-4); 147,5 (C-6); 154,8 (C-2); 162,9 (C=O). IR ($CHCl_3$): 1702 cm^{-1} (C=O)
7. Compound **13** was obtained by refluxing of **10** in ethylacetate for 5 min. The product was filtered. Yield 60%, m.p. 233°C (230-232 °C)[9].
8. Compound **14** was synthesized by refluxing of **10** in acetone for 10 min. The residue was purified on column with silica gel (eluent benzene-hexanes =2:1), m.p. 95-95.5°C (94-95°C)[9].
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(*Received in UK* 28 *October* 1993; *revised* 23 *February* 1994; *accepted* 4 *March* 1994)