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DECOMPOSITION OF α-CHLORO-OXIMES IN DIMETHYL SULPHOXIDE

M.E.C. Biffin and D.B. Paul

Australian Defence Scientific Services, Department of Supply,
Defence Standards Laboratories, P.O. Box 50, Ascot Vale, Victoria, 3032.

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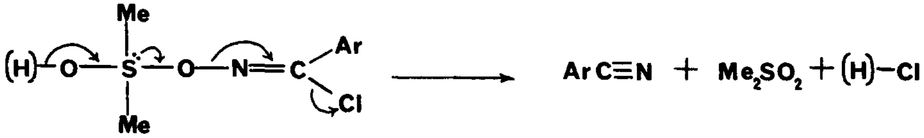
The function of dimethyl sulphoxide (DMSO) as both an electrophilic[1-4] and nucleophilic reagent[5,6] has been well established. However, its reactions with substrates which are similarly biphilic have attracted little comment, even though they are of potential mechanistic and preparative interest.

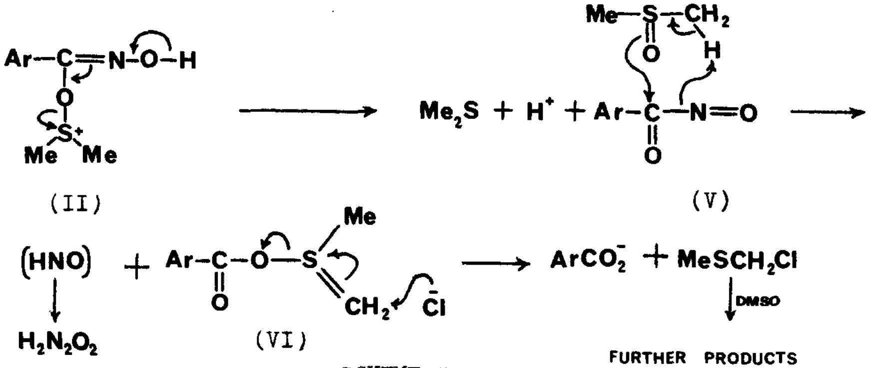
For example, two possible consequences of the interaction between DMSO and α-chloro-oximes may be envisaged. Nucleophilic attack of the oxime oxygen atom on the sulphur atom of DMSO would afford the coordination complex (I). Participation of the sulphur lone pair in the elimination of chloride ion from (I) would give a nitrile and dimethyl sulphone (Scheme A). This mechanism is analogous to one of the proposed pathways for deoxygenation of amine oxides by DMSO[1]. Conversely, displacement of the α-chloro substituent by the nucleophilic oxygen atom of DMSO would lead to the oxysulphonium intermediate (II) which is capable of further reaction. Similar displacements of the active chloro substituents of acyl chlorides[7,8], phosphorus chlorides[8,9] and chloronitrobenzenes[10] by DMSO acting as a nucleophile have been observed.



(I)

SCHEME A

It was found that when α-chloro-*p*-nitrobenzaldoxime (5 g) was heated



SCHEME B

at 150° in DMSO (20 ml) a vigorous reaction took place with the evolution of dimethyl sulphide and nitrogen^{IV} oxides. p-Nitrobenzoic acid was isolated from the reaction mixture in 80% yield, together with p-nitrobenzonitrile (5%). Similar reactions of other aromatic and heteroaromatic α-chloro oximes (Table 1) confirmed the generality of this procedure.

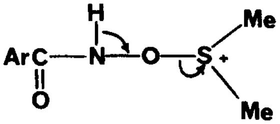
TABLE 1

ArC(Cl)=NOH	Yield (%) of $ArCO_2H$	Yield (%) of ArCN
Ar = C_6H_5-	71	7
p-$O_2NC_6H_4$-	80	5
o-$O_2NC_6H_4$-[a]	54	4
3-pyrido	88[b]	5
4-pyrido	88[b]	4

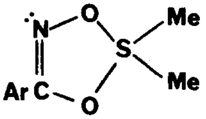
[a] The products are accompanied by a black tar; in the case where Ar = 2-pyrido a tar was the only product isolated. [b] Isolated as hydrochloride.

The isolation of the nitriles is consistent with the mechanism illustrated in Scheme A. It would be anticipated that the formation of a nitrile by this mechanism would be catalysed by acid since the conjugate acid of DMSO is a better electrophile than DMSO itself. This was demonstrated for α-chloro-p-nitrobenzaldoxime, which yielded 25% of nitrile and 54% of carboxylic acid when c. HCl (2 ml) was added to the reaction mixture.

In order to rationalise the formation of p-nitrobenzoic acid as the major product, consideration must be given to the decomposition pathways of the oxysulphonium intermediate (II). An attractive possibility is that the intermediate (II) loses dimethyl sulphide either directly (Scheme B) or *via* a rearranged or cyclic intermediate, (III) or (IV), to give an aroyl nitroso compound (V). Although compounds such as (V) have not been recorded in the chemical literature, it would be anticipated that they would react rapidly with DMSO in a similar manner to acid chlorides^{7,8}. Nucleophilic attack by DMSO on the α-carbon atom of (V) would afford (VI). It has previously been postulated^{8} that intermediates of this type collapse to carboxylic acids in the presence of DMSO and chloride ion (Scheme B). Evolution of nitrogen^{IV} oxides from the reaction is consistent with such a mechanism since hyponitrous acid ($H_2N_2O_2$) is generated and would be oxidized in DMSO (c.f. ref. 1) to higher oxyacids of nitrogen, which evolve nitrogen^{IV} oxides at 150° in the presence of air.



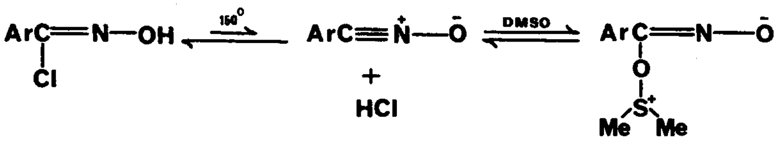
(III)



(IV)

As the conjugate base (VII) of the oxysulphonium intermediate (II) could result from nucleophilic attack of DMSO on a nitrile *N*-oxide, *p*-nitrobenzonitrile *N*-oxide (1 g) was added over 30 min to DMSO (30 ml) at 19°. An exothermic reaction took place and *p*-nitrobenzoic acid was formed in modest yield (57%)^{11}. The *o*-nitro analogue reacted similarly but afforded only 30% of *o*-nitrobenzoic acid; as with the ortho-substituted chloro-oximes a substantial quantity of tar was formed (c.f. Table 1). The formation of nitrile *N*-oxides *in situ* by thermal dehydrochlorination of α-chloro-oximes has been reported^{12}. In view of the rapid reaction between DMSO and nitrile *N*-oxides at ambient temperature, the rate-limiting step in the reaction of α-chloro-oximes at 150° may be thermal dehydrochlorination (Scheme C) rather than nucleophilic displacement of chloride ion by DMSO.

The possibility that the nucleophile which intercepts the acyl nitroso compound (V) is water rather than DMSO was investigated using *p*-nitrobenzonitrile



(VII)

SCHEME C

N-oxide and an 8 molar excess of O^{18} enriched water in DMSO at ambient temperature. The level of isotopic incorporation in the product indicated that only 17% of the carboxylic acid arose from attack by water; the nucleophile must therefore be DMSO.

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