Tetrahedron Vol. 42, No. 15, pp. 4133 to 4136, 1986
Printed in Great Britain.

0040-4020/86 $3.00+.00
Pergamon Journals Ltd.

STUDY OF ALKYL NITRITES OXIDATION WITH DMSO

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(*Received in USA* 28 *April* 1986)

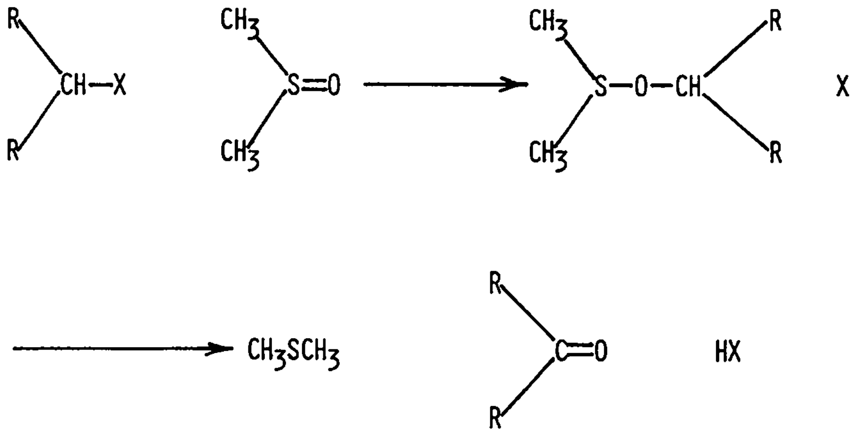
SUMMARY.

The oxidation of nine alkyl nitrites to the corresponding carbonyl compounds in yields of 76-96% by dimethyl sulfoxide (DMSO) is described; since oxidation with DMSO is very selective this method can be used to obtain aldehydes or ketones from alcohols which include other labile functional groups such as alkene, alkyne and aldehyde.

INTRODUCTION.

Dimethyl sulfoxide has been used successfully both as a reaction medium and as a reagent in several chemical processes. DMSO is capable of oxidizing different substrates such as alcohols, alkyl halides, etc. (1). In all these cases it has been demonstrated that the reaction starts with a nucleophilic attack of DMSO on the organic substrates. A dimethyl alkoxi sulfonium salt is formed as an intermediate, which then decomposes into the corresponding aldehyde or ketone (2).

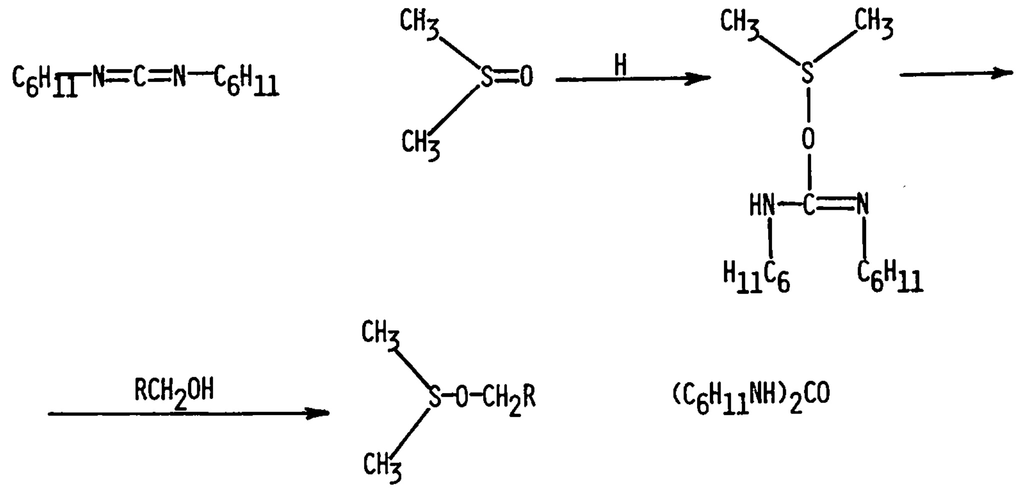
Previous workers have proposed the following mechanism for the reaction (3):



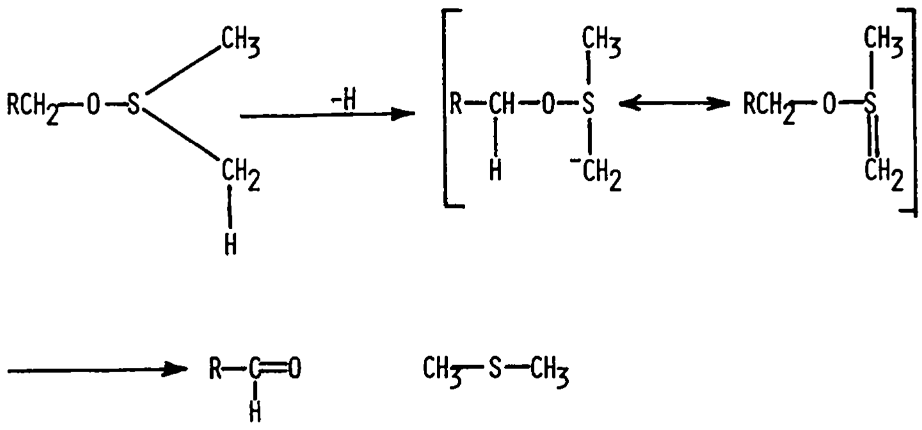
TYPE I REACTION

In presence of dicyclohexylcarbodimide the oxidation of alcohols by DMSO follows the reaction mechanism shown in scheme 1, as suggested by Moffart and Fenselau (4).

Although it is generally accepted that a thiouronium salt is formed, agreement has not been reached on the mechanism by which this salt decomposes. However, some studies utilizing a deuterated alcohol of the type RCD_2OH, suggest that the decomposition takes place by the scheme 2.



SCHEME 1



SCHEME 2

The presence of deuterium in the dimethyl sulfide molecule has been established.

From this it can be assumed that alkyl nitrites are compounds that can be react with DMSO in a oxidation-reduction type reaction. Preliminary evidence of this fact was the abnormal behaviour of phenol nitrosation with alkyl nitrites of DMSO (5). The experimental results can be explained by the initial formation of HNO_2. Therefore it was consider of interest to study the reaction of several alkyl nitrites with DMSO.

DISCUSSION

Table I shows the summary of the results obtained from the reaction of nine alkyl nitrites with DMSO. From these results it can be seen that this reaction can be useful in organic synthesis, since the yields are higher than those obtained in the oxidation of alcohols. Furthermore, since the reaction conditions are milder, some secondary reactions can be avoided.

It is not necessary to have a base present in the reaction mixture. In table II the results show that when a base like K_2CO_3 or $NaNO_2$ is added there is only a small increase in the reaction rate and no significant real change in the yield. Moreover, the addition on $NaNO_2$ showed a decrease in both the reaction rate and yield.

TABLE I. COMPARISON OF YIELDS OF DIFFERENT SUSTRATES OXIDATION WITH DMSO.

SUSTRATE	BASE	YIELD %
$CH_3CH_2CH_2OTs$	$NaHCO_3$	----- (8)
$CH_3CH_2CH_2ONO$	-----	92.21
$CH_3CH(ONO)CH_3$	-----	85.44
$CH_3(CH_2)_2CH_2OH$	Colidine	65.00 (9)
$CH_3(CH_2)_2CH_2ONO$	-----	87.06
$(CH_3)_2CHCH_2OH$	Colidine	70.00 (9)
$(CH_3)_2CHCH_2ONO$	-----	95.95
$CH_3CH(OH)CH_2CH_3$	Colidine	78.00 (10)
$CH_3CH(ONO)CH_2CH_3$	-----	90.64
$(CH_3)_2CHCH_2CH_2ONO$	-----	90.78
$CH_3CH(ONO)CH_2CH_2CH_3$	-----	88.92
$C_6H_{11}OH$	$(CHF_3CO)_2O$	65.00 (9)
$C_6H_{11}ONO$	-----	76.62
$C_6H_5CH_2OH$	O_2	80.00 (11)
$C_6H_5CH_2ONO$	-----	87.90
$C_6H_5CH_2Cl$	$NaHCO_3$	58.00 (12)

These findings are in agreement with the proposed mechanism of the type I reaction, where DMSO produces a nucleophilic displacement of the nitrite group. The decrease in the reaction rate in the presence of the nitrite ion is due to competition of this group and DMSO for 2-pentyl nitrite. However, it is not certain if the reaction is first or second order.

TABLE II. RELATIVE TRANSFORMATION OF 2-PENTYL NITRITE WITH DMSO IN PRESENCE OF ANHYDROUS K_2CO_3 AND $NaNO_2$.

TIME (min.)	CONTROL*	K_2CO_3	$NaNO_2$
112	1.0	0.977	0.832
210	1.0	0.999	0.844
360	1.0	1.01	0.869
522	1.0	1.014	0.899
555	1.0	1.035	0.908
FINAL YIELD	88.92	92.03	80.74

* Results obtained from the mixture of DMSO and 2-pentyl nitrite were assumed to be 1.0.

EXPERIMENTAL.

Alkyl Nitrites: These were prepared following the method described by

Vogel (6).

Alkyl nitrites Oxidation: 20 ml of the alkyl nitrite solution ind DMSO (10% v/v) were placed in a 50 ml round-bottom flask fitted with a reflux condenser. The mixture was heated and stirring in a water bath, at 70°C for 6 hours. It was then cooled, and 50 ml of methylene chloride was added, washed with two 100 ml portions of water, dried over magnesium sulfate, and diluted to 100 ml with methylene chloride. The carbonyl compound was determined by the method of Pesez (7).

2-Pentyl Nitrite Oxidation in Presence of Base: 2 g of 2-pentyl nitrite, 18 g of DMSO and 200 mg anhydrous K_2CO_3 (or $NaNO_2$) were placed in a 50 ml round bottom flask fitted with a reflux condenser. The mixture was then heated and stirred in a water bath at 70°C. 1 ml samples were periodically withdrawn and 2-pentanone was again determined by the method of Pesez (7).

Identification of Products: 2,4-dinitrophenyl hydrazone of the carbonyl compound obtained from the oxidation reaction was crystallized and the IR spectrum compared with that of a 2,4-dinitrophenylhydrazone obtained from a commercially available reagent. The identity of the compound obtained was established by comparison of their IR spectra.

Additionally the melting point of a mixture containing both compound remained unchanged.

ACKNOWLEDGMENTS.

We thank Dr. Roberto Cabrera and Dr. Octavio H. Carreón for reading and commenting on our manuscript prior to publication.

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