Evidence for the Intermolecular Nature of the Meisenheimer Rearrangement of Amine *N*-Oxides

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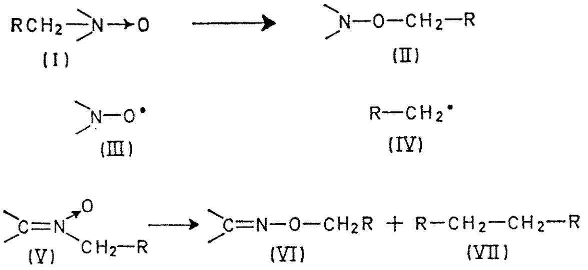
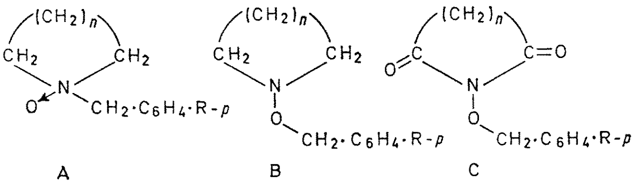
Summary Thermolysis of mixtures of structurally similar amine *N*-oxides leads to intermolecular rearrangement products, thus calling into question the previously favoured intramolecular mechanism as the exclusive process for the Meisenheimer rearrangement; the results are consistent with a mechanism involving homolytic fission to intermediates which recombine to produce the *N*-alkoxy-amines.

Recent evidence concerning the nature of the Meisenheimer rearrangement[1] of amine *N*-oxides (I) to the corresponding *N*-alkoxy-amines (II) strongly supports homolytic thermolysis of (I) to the nitroxide radical (III) and carbon radical (IV) followed by radical recombination to yield (II).[2,3] This reaction pathway is analogous to that suggested[4] for the thermally induced rearrangement of nitrones (V) to *N*-alkoxy-amines (VI). In the latter case, the coupling product (VII) resulting from the combination of two carbon radicals was isolated in addition to (VI), thus suggesting that the radicals are sufficiently long-lived for the reaction to be described as an intermolecular process, in contrast to the intramolecular process generally accepted for the mechanism of the Meisenheimer rearrangement.[5] We now report incontrovertible evidence that the thermally induced rearrangements of the *N*-oxides (VIII—XI) proceed to a significant extent by an intermolecular mechanism.

Rearrangement of the individual *N*-oxides (VIII—XI) took place readily at 214° in the Pyrex glass flash heater[3,6] of the g.l.p.c. apparatus (Barber–Colman, column 2 m × 5 mm, 5·6% P.E.G. 20,000 on firebrick) and produced in each case the corresponding *N*-alkoxy-amine (XII—XV) as the major product.† These alkoxy-amines were also isolated as their picrate salts from preparative thermolysis of the *N*-oxides in a short-path distillation apparatus. Identification of the alkoxy-amines was achieved by comparison of retention times and picrate m.ps and mixed m.ps with those of authentic samples prepared by aluminium hydride reduction of the corresponding 1-alkoxy-imides (XVI—XIX). The difference in retention times of the alkoxy-amines (XII—XV) resulting from the pyrolysis of the four individual *N*-oxides (VIII—XI) (Table) permitted identification of each component in the presence of the others should cross-over products be produced during the pyrolysis of mixtures. When a mixture of (VIII) and (IX) in acetone was injected into the flask heater, the resulting g.l.p.c. tracing did indeed show all four alkoxy-amines (XII—XV) (Table). In order to substantiate this observation, the opposite mixture, *N*-oxides (X) and (XI), was shown to produce the same four products but with the expected difference in ratios (Table). These results clearly establish that intermolecular processes occur as part of the reaction, and are consistent with the radical mechanism previously suggested by other workers. Further support for the intermediary roles of the benzyl and *p*-xylyl radicals was obtained by identifying bibenzyl (XX) as a minor product resulting from the thermolysis of *N*-oxide (VIII) or (XI) and bitolyl (XXI) from that of *N*-oxide (IX) or (X). As expected, the pyrolysis of any mixture of *N*-oxides consisting of both the *N*-benzyl and *N*-tolyl types produced all three expected radical-coupling products, (XX), (XXI), and the cross-coupling product 1-phenyl-2-*p*-tolylethane



	A	B	C
n = 3, R = H	(VIII)	(XII)	(XVI)
n = 2, R = Me	(IX)	(XIII)	(XVII)
n = 3, R = Me	(X)	(XIV)	(XVIII)
n = 2, R = H	(XI)	(XV)	(XIX)


A B C

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† Additionally, small amounts of arylaldehydes and tertiary amines were obtained. These details will be discussed in the full paper.

Relative yields of alkoxy-amines from thermolysis of N-*oxides*[a]

	Alkoxy-amines (retention times in min.)			
	(XV) (6·08)	(XII) (8·18)	(XIII) (8·97)	(XIV) (12·30)
Reactant(s)	Relative yields (percentage of total)			
(VIII)	—	88·6	—	—
(IX)	—	—	85·6	—
(X)	—	—	—	89·0
(XI)	76·4	—	—	—
(VIII) and (IX) ..	10·9	33·3	33·3	10·9
(X) and (XI) ..	20·3	10·5	7·8	43·4

[a] Determined by g.l.p.c. analysis of acetone solutions and excluding minor products.

(XXII). The retention times of these compounds were identical with those of authentic samples on two different g.l.p.c. systems.

Furthermore, g.l.p.c. analysis of the same mixtures previously heated in a high-boiling solvent such as xylene or dimethylformamide at temperatures known to effect the rearrangement in solution[2] gave qualitatively the same products.

Financial support from the U.S. Public Health Service and the National Institutes of Health (National Institute of General Medical Sciences) is gratefully acknowledged.

(*Received, August 17th*, 1970; *Com.* 1392.)

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