AMBIDENT NEIGHBOURING GROUPS, I.   THE ANCHIMERISM
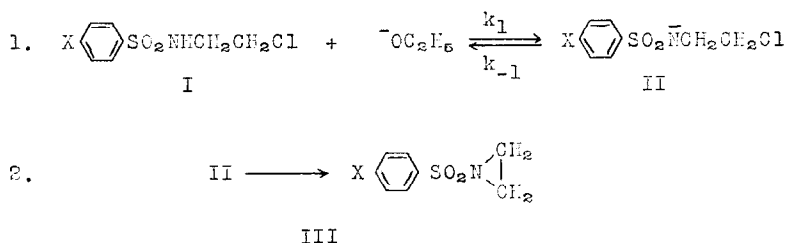
OF SULPHONAMIDO FUNCTIONS

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Sulphonamidoaziridines can be formed (1) by reaction of
a β-sulphonamidoethyl halide with base.   The process can be
represented as follows:

1. $X\langle\bigcirc\rangle SO_2NHCH_2CH_2Cl$ + $^-OC_2H_5$ $\underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}}$ $X\langle\bigcirc\rangle SO_2\bar{N}CH_2CH_2Cl$

$\qquad\qquad$ I $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ II

2. $\qquad\qquad$ II $\longrightarrow$ $X\langle\bigcirc\rangle SO_2N\begin{smallmatrix}CH_2\\ |\\ CH_2\end{smallmatrix}$

$\qquad\qquad\qquad\qquad\qquad$ III

We have now examined the rates of elimination of hydro-
halide from systems such as I.   The relevant kinetic data
(for 25°) are summarized in Table I.

These data, plotted as in Figure 1, and a similar set obtained
at 0° (Figure 2), reveal a negative salt effect in the react-
ions studied (2); an effect which gradually decreases to an
essentially constant level.   The accumulated rate data, taken
from the horizontal segments of the curves in Figure 1 corres-
pond to a ρ of -0.95 (3).   The value of ρ for the initial re-
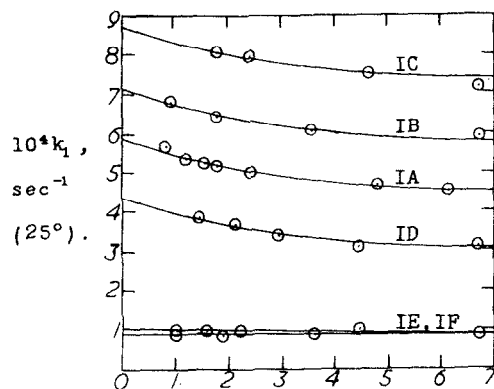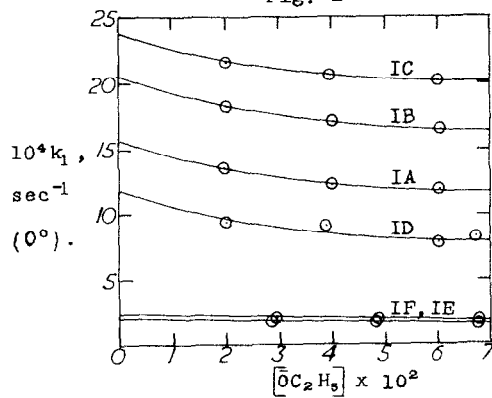action, that is the acidic dissociation of the substituted sul-

Fig. I

Fig. 2

TABLE I

Reactions of Sulphonamidoethyl Halides (I) with Ethoxide ion[a]

Substrate IA, X = H		Substrate ID, X = F	
$10^3 \left[OC_2H_5\right]^b$:	$10^4 k_1{}^c$, sec^{-1}	$10^3 \left[OC_2H_5\right]^b$:	$10^4 k_1{}^c$, sec^{-1}
8.4	5.64	14.7	3.82
12.0	5.31	21.3	3.62
15.8	5.23	29.0	3.38
17.6	5.20	43.8	3.12
24.0	5.00	67.0	3.11

Substrate IE, X = NO$_2$	

Substrate IA continued:

14.5[d]	4.67
48.0	4.66
61.7	4.55

Substrate IB, X = CH$_3$		Substrate IE, X = NO$_2$	
		10.5	0.97$_5$
9.4	6.78	15.6	0.98$_3$
17.7	6.44	22.0	0.927
35.4	6.12	44.2	0.953
67.0	5.87	67.0	0.807

Substrate IC, X = OCH$_3$		Substrate IF, X = m-NO$_2$	
17.8	8.06	10.4	0.882
23.4	7.89	18.5	0.876
46.8	7.55	35.8	0.839
67.0	7.21	67.0	0.804

a

   All reactions cited in this Table were conducted in ethanol at 25.0°, with the initial concentration of halide 1.2 x 10^{-2}M throughout.

b

   This column represents initial concentration (moles/litre) of ethoxide used.

c

   All rate constants were precise to within ± 1-2% .

d

   Plus 16.2 x 10^{-3}M sodium nitrate.

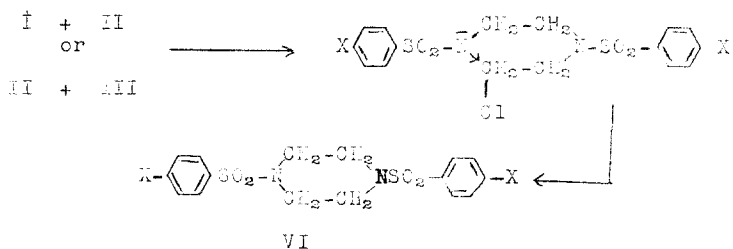## TABLE II

Substrate	IA	IB	IC	ID	IE	IF
$\Delta H^{\pm}$ (k.cal./mole)	23.0	22.5	22.7	22.8	24.8	24.2
$\Delta S^{\pm}$ (e.u)	+3.3	+2.1	+3.1	+1.8	+5.9	+4.1

phonamides is +1.53 (4).   Incidentally, if the added base were

converting more and more of a weakly acidic substrate into its

anion, then one would expect an increase in the observed rate values with increased initial quantities of base.   The observed rate data conform to first-order kinetics, analogous to those encountered in a recent neighbouring group study on substituted phenols (5), a species of comparable acidity to that employed in our present work.   Table II summarizes the activation parameters obtained from our data.   Lack of space precludes any further discussion of these here.

The products isolated in these various reactions were not always **solely** the expected azididines.   We also obtained materials derived from base-induced aziridine ring cleavage, e.g. $ArSO_2NHCH_2CH_2CO_2H_5$, (IV), and higher derivatives thereof such as $ArSO_2NHCH_2CH_2N(SO_2Ar)CH_2CH_2CO_2H_5$ (V) etc .   In some instances reasonable yields of substituted piperazines, (VI) were obtained. Control experiments have shown that the piperazines result from the reaction sequence in Figure 3 (*below*)

VI

The data concerned are summarized in Table III.   Where the piperazine yields are appreciable th current reactions represent time-saving routes to these materials compared to the multiple step process described recently (6).

TABLE III : Product Runs

Substrate	$10^3[I]$ [a,c]	$[I]/[OEt]$ [b]	(III) [d]	(VI) [d]	(IV) [d]	others [d,e]
IA	9.5	1	94	2	-	-
	21.3	1	60	8	15	13
	23.2	0.5	8	2	64	16
IB	11.5	1	94	2	-	-
	20.7	1	65	2	20	8
	23.2	0.5	10	2	60	20
IC	11.5	1	98	0	-	-
	20.7	1	63	1	20	5
	21.3	0.5	14	1	56	14
ID	9.5	1	92	3	-	--
	20.7	1	55	3	24	13
	23.2	0.5	10	2	60	14
IE	11.5	1	75	23	-	-
	20.7	1	-	28	20	41
	21.3	0.5	-	9	60	21
IF	9.5	1	81	13	-	-
	21.3	1	-	14	36	38
	23.2	0.5	-	6	70	8

a
    This column represents concentration of substituted sulph-
onamide, I.
b
    This represents the sulphonamide to base ratio used.
c
    We have found that replication of product data involves
careful control of work-up conditions. The three runs vertical-
ly listed for each sulphonamido halide in the Table represent
three sets of reaction conditions. The first run, (uppermost
figures), in each case involves the following procedure : main-
tenance of the solution of reactants at 25°C for 4 to 5 half-lives
(with compound IA, IB, IC and ID ; this represents a time of
1.5 to 2 hours, with compounds IE and IF the time allotted is
of the order of 6 hours). Any solid which separated is removed
and the mother liquor evaporated (using a rotary evaporator)
at 25° to dryness. The residual solid is extracted with
ether and the ethereal layer extracted with alkali to remove
any acidic substances. Evaporation of the dried ethereal
layer yields any aziridine present. The acidic substances
are recovered from the alkaline solution by acidification and
extraction with ether. The second run cited (in each case)
differs mainly from the run just detailed in the matter of the
reaction time. The second (middle figures) runs all involve
a time of 15 hours at 25° prior to work-up. The third run
is identical with the second runs save in the matter of base:
halide ratio used.

d

   Columns represent % yields.

e

   This column represents largely yields of resinous compounds save in the reactions with IE and IF where the yields cited are those of materials of type J.

This work was carried out during the tenure by one of the authors (B.F.) of a State Maintenance Allowance for Research. Satisfactory analyses have been obtained for all new compounds reported.

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3. The ρσ-plot was performed by the method of least squares, with the following results (a) for the data at 25°, $n = 6$, r (correlation coefficient) = -0.978; s (standard variance) = 0.04; (b) for the data at 0°C, $\rho = -1.03$, $n = 6$, $r = -0.994$, $s = 0.02$.

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