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PHOTO-FRIES REARRANGEMENT OF 2-ALKYL-4-ARYL-SULPHONYLOXYPYRIMIDINES

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Abstract– UV irradiation of 2-alkyl-4-arylsulphonyloxypyrimidines. in cyclohexane or isopropanol affords the corresponding 2-alkyl-5-arylsulphonylpyrimidines together with the parent 2-alkyl-4-hydroxypyrimidines. In contrast. 2-t-butyl-4-methylsulphonyloxypyrimidine fails to undergo a photo-Fries rearrangement; it is converted to 2-t-butyl-4-hydroxypyrimidine.

THE PHOTO-INDUCED Fries rearrangement occurs in aryl esters. aromatic lactones. anilides, N-aryl carbamates and arylsulphones.[1–4] Besides rearrangement products, the parent phenols or anilines are formed in variable amounts in solvents such as cyclohexane, benzene, ethers or alcohols.[3–6] The presently favoured mechanism involves cleavage of the ester into aryloxy and acyl radicals held together in a solvent cage,[2, 5] the radical pair collapsing either to the starting material or to *ortho* and *para* rearrangement products; the free radicals escaping the cage yield the phenol ("solvolysis" product).

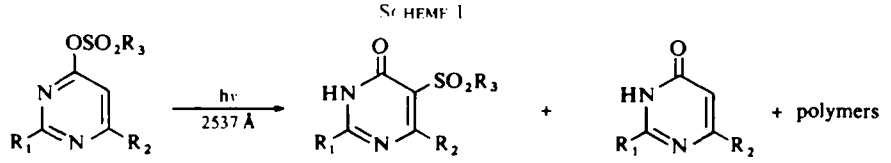
Irradiation of 2- and 3-benzoyloxypyridines[7] has been shown to give benzoylhydroxypyridines. Another example of a photo-Fries rearrangement of N-heteroaromatic compounds has been reported by Snell[8] who found that the photolysis of 2-dialkylamino-4-alkyl- or -arylsulphonyloxypyrimidines affords the corresponding 5-alkyl- or -arylsulphonyl-4-hydroxypyrimidines.

It was of interest to see whether or not a 2-dialkylamino group is of importance in the photo-Fries rearrangement of 4-arylsulphonyloxypyrimidines. A series of 4-arylsulphonyloxypyrimidines was synthesised,[9] and we describe here their behaviour on UV irradiation.

RESULTS AND DISCUSSION

The reaction investigated is represented in Scheme 1 and the results summarised in Table 1 (the nature of the sticky, ill-smelling polymeric material has not been investigated).

SCHEME 1



1 a-f 2 3

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The 5-arylsulphonyl-4-hydroxypyrimidines (**2a**, **2c**, **2d** and **2e**) were easily identified as follows. Their UV spectra, compared to the UV spectra of the corresponding esters (**1**),[9] are shifted towards longer wave lengths (*cf.* Table 3). Strong bands, due to carbonyl absorption are observed in the IR spectra. In the NMR spectra (*cf.* Table 2), no absorption occurs in the 6·0–7·3 ppm region, thus a group must be present in the 5 position of the pyrimidine ring.

TABLE 1. UV IRRADIATION OF 4-ARYLSULPHONYLOXYPYRIMIDINE (**1**)

Esters 1	Solvent	Irradiation time (hrs)	Recovered 1 (%)	Yield of 2 (%)	Yield of 3 (%)
1a R_3 = *p*-C_6H_4—Me	i-PrOH	25	28	1·7	63
R_1 = Me	cyclohexane	35	38	12	(traces)
R_2 = H	cyclohexane	18*	18	19	13
1b R_3 = *p*-C_6H_4—Me					
R_1 = H	i-PrOH	40	35	—	12
R_2 = Me					
1c R_3 = *p*-C_6H_4—Me	cyclohexane	45	39	11	10
R_1 = R_2 = Me	cyclohexane	18*	16	20	12
1d R_3 = Ph					
R_1 = R_2 = Me	cyclohexane	18*	23	14	10
1e R_3 = *p*-C_6H_4—Me	i-PrOH	20	23	10	30
R_1 = t-Bu	cyclohexane	48	30	22	10
R_2 = H	cyclohexane	18*	36	19	5
1f R_3 = Me					
R_1 = t-Bu	cyclohexane	18*	50	—	10

* Using special reactor (experimental).

TABLE 2. NMR SPECTRA OF THE 5-PYRIMIDINYLSULPHONES (**2**)

Sulphones 2	H_6 δ(ppm)	R_3 δ(ppm)		Alkyl substituents δ(ppm)		
2a	8·75 (s)	7·96* (d) 7·60* (d)	J_o = 8 Hz	2·38 (s)		2·35 (s)
2c	—	7·86* (d) 7·37* (d)	J_o = 8 Hz	2·73 (s)	2·39 (s)	2·30 (s)
2d	—	7·95 (m)	7·61 (m)	2·77 (s)		2·30 (s)
2e	8·61 (s)	7·91* (d) 7·60* (d)	J_o = 8 Hz	2·40 (s)		1·29 (s)

* Analysed in first approximation as an AB instead of an AA'BB' system. The low-field signals originate from the protons *ortho* to the sulphonyl group.

Photolysis in cyclohexane seems to reduce the extent of "solvolysis" as compared to irradiation in i-PrOH.

The irradiation of 4-*p*-tolylsulphonyloxy-6-methylpyrimidine (**1b**) in i-PrOH affords mainly a ring-opened compound, 3-formamido-N-*p*-tolylsulphonylcrotonamide* (29%) along with 4-hydroxy-6-methylpyrimidine (12%) and minor amounts

* Ester **1b** decomposes easily into 3-formamido-N-p-tolylsulphonylcrotonamide.[9] even in the dark.

of unidentified products. On the other hand, 2-t-butyl-4-methylsulphonyloxypyrimidine (**1f**) gives only "solvolysis" products; no trace of the rearranged methylsulphone could be detected.

TABLE 3. M.PS. UV. IR SPECTRA AND ELEMENTAL ANALYSIS OF THE 5-PYRIMIDINYLSULPHONES (2)

Compound	M.p.	UV (MeOH)	Analyses								IR (KBr)
			% required				% found				ν(cm^{-1})
		λ_{max} (ε) λ_{min}	C	H	N	S	C	H	N	S	$\nu_{as}SO_2$ $\nu_{s}SO_2$
1a*	236–240°	221 (8900) 292 (5920 (2560) 255	51·1	5·0	9·9	11·3	51·3	5·0	9·8	11·4	1292 1145 1310
2c	241–242°	224 (12800) 291 (7640) (3870) 255	56·1	5·1	10·1	11·5	55·7	5·3	10·3	11·4	1297 1155 1315
2d	240–244°	220 (12000) 292 (7000) (2300) 250	54·5	4·6	10·6	12·1	54·5	4·6	10·3	12·3	1315 1160
2e	254–255°	222 (11800) 293 (8000) (3850) 255	58·9	5·9	9·15	10·45	59·3	6·1	8·9	10·9	1322 1150 1330

* $C_{12}H_{12}N_2O_3S.H_2O$.

When the photolysis of 2,6-dimethyl-4-phenylsulphonyloxypyrimidine (**1d**) was monitored by UV spectroscopy and TLC, the reaction was found to be very fast at the beginning but to slow down after a short period. Indeed the products absorb light strongly; it appears also from independent experiments that sulphone **2d** undergoes subsequent photolysis leading to decomposition products.

It thus seems that a 2-dialkylamino group is not required for the photo-Fries rearrangement in 4-arylsulphonyloxypyrimidines. This rearrangement can lead to useful 2-alkyl-4-hydroxy-5-arylsulphonylpyrimidines although in moderate yields. There is, however, a noteworthy difference in behaviour in the case of the 4-pyrimidinyl esters of 4-methanesulphonic acid; in the presence of a 2-dialkylamino group, the rearrangement predominates (in alcohol, the sulphone is isolated in 46% yield),[8] whereas in the presence of a 2-t-butyl- substituent "solvolysis" is the only observed process. This discrepancy might be ascribed to the smaller size and mass of the methane–sulphonyl radical which would leave the solvent cage removing most of the excess energy as kinetic energy. This excess is probably smaller in the case of the 2-amino-derivative, as suggested by its first $S_0 \rightarrow S_1$ transition, which is shifted to longer wave length compared to the corresponding absorption band in 2-t-butyl-4-methylsulphonyloxypyrimidine (**1f**).

EXPERIMENTAL

Materials and apparatus. Irradiations were performed with an Hanovia NK 6 low-pressure mercury arc using a quartz immersion well or a special reactor designed to avoid direct contact between the lamp and the solution (Fig 1) by placing the lamp horizontally above the solution surface. Any precipitate forming during photolysis was thus prevented from coating the light source. Although much light was lost because of bad geometry, the reactions were much faster, the well remaining perfectly clean. The solutions ($\simeq 3 \cdot 10^{-3}$ M) were irradiated under N_2 bubbling and magnetic stirring. TLC was performed on silica gel plates

(Merck GF 254) eluted with EtOAc or EtOH. UV spectra (MeOH) were recorded on an Unicam SP 1800 and IR spectra (KBr) on a Perkin-Elmer 237 spectrophotometer. NMR spectra (DMSO-d_6) were obtained on a Varian A-60 spectrometer. The 5-pyrimidinylarylsulphones were recrystallised from EtOH: m.ps measured on a Reichert hot-stage microscope, are uncorrected.

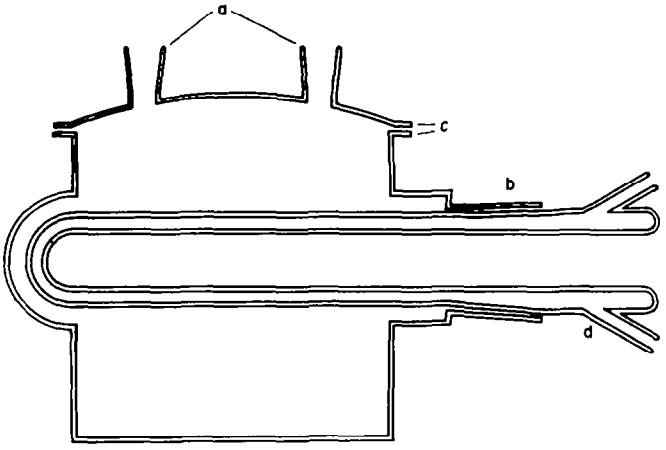

FIG 1. a: B 19 female joints for nitrogen inlet and condenser: b: B 55 female joint; c: Flat ground joint: d: Water-cooled pyrex or quartz well.

Typical experiment. A solution of 2-t-butyl-4-p-tolylsulphonyloxypyrimidine (1 g) in cyclohexane (250 ml) was irradiated with a quartz immersion low-pressure mercury lamp (9W). The reaction was followed by TLC. During the course of the photolysis, a solid separated, and the precipitate coated on the lamp well was periodically removed by scraping. After 48 hr the solvent was evaporated under reduced pressure. The remaining oily solid, triturated with EtOH, yielded almost pure 2-t-butyl-4-hydroxy-5-*p*-tolylsulphonyl-pyrimidine (0·18 g). The residue was then chromatographed on a silica gel column, eluted with three different solvent systems containing $CHCl_3$, EtOAc and EtOH, of increasing polarity. The starting material (0·3 g), 2-t-butyl-4-hydroxy-5-*p*-tolylsulphonylpyrimidine (0·04 g) and 2- -butyl-4-hydroxypyrimidine (0·05 g) were isolated.

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REFERENCES

[1] D. Bellus, K. Schaffner and J. Hoigne, *Helv. Chim. Acta* **51**, 1980 (1968)
[2] H. Shizuka, T. Morita, Y. Mori and I. Tanaka, *Bull. Chem. Soc. Japan* **42**, 1831 (1969)
[3] D. Bellus and P. Hrdlovic, *Chem. Rev.* **67**, 599 (1967)
[4] J. L. Stratenus and E. Havinga, *Rec. Trav. Chim.* **85**, 434 (1966)
[5] H. Kobsa, *J. Org. Chem.* **27**, 2293 (1962)
[6] R. A. Finnegan and J. J. Mattice, *Tetrahedron* **21**, 1015 (1965)
[7] R. Beugelmans and M. T. Le Goff, *Bull. Soc. Chim. France* 1106 (1972)
[8] B. K. Snell, *J. Chem. Soc.* (C), 2367 (1968)
[9] J. Gubin, M. Durant, R. Nasielski-Hinkens and R. Promel, (submitted for publication)