

REACTION OF THIONYL BROMIDE WITH SUBSTITUTED PHENOLS

S.D. SARAF* and Z.A. MALIK

Institute of Chemistry, University of Islamabad, Islamabad

(Received April 14, 1972; revised October 14, 1972)

Abstract: This paper deals with the reaction of thionyl bromide and some substituted phenols. In case of *o*, *m* and *p*-cresols, 4-bromo-*o*-cresol, 4-bromo-*m*-cresol and 2-bromo-*p*-cresols were isolated. Similarly 2-chlorophenol and 4-chlorophenol gave 4-bromo and 2-bromochlorophenols in moderate yields.

Until recent years thionyl bromide has been regarded as something of curiosity and very few references to its use in organic syntheses are to be found in literature. It can obviously never be considered as general reagent for bromination but it can, nevertheless, be used with advantage in certain cases. Thionyl bromide has been used successfully in the preparation of anhydrides, acid bromides and also in the preparation of dibromo compounds from the corresponding unsaturated compounds.¹ Similarly it has been used in the preparation of dibromo compounds in case of hydroquinone and catechol² in a similar manner to that of 2, 4-dibromophenol and 3,7-dibromotropolone.³

It is a well-known fact, that bromination of phenols with free bromine hardly gives a single product. Edward *et al.*⁴ has reported that bromination of *m*-cresol in chloroform at room temperature gave a mixture of brominated phenols from which 4-bromo-*m*-cresol, 6-bromo-*m*-cresol, 2-bromo-*m*-cresol and 2,4-dibromo-*m*-cresol were isolated.

Our experience with the reaction of thionyl bromide and phenols prompted us to study the reaction of some substituted phenols in the hope of isolating mono or dibromo products in the pure form. The

phenols chosen include cresols, chlorophenols and nitrophenols.

Addition of thionyl bromide to *o*-cresol, *m*-cresol and *o*-chlorophenol at 5° gave an immediate reaction with the evolution of hydrogen bromide, sulphur dioxide and the precipitation of sulphur. Work-up in the usual manner followed by distillation gave 4-bromo-*o*-cresol, 4-bromo-*m*-cresol and 4-bromo-*o*-chlorophenol in 37-40% yield. Their structures were confirmed by their b.p. and by preparing several of their derivatives. The gas liquid phase chromatography gave the same retention time to those of authentic specimens of 4-bromo-substituted compounds.

Addition of thionyl bromide to *p*-cresol and 4-chlorophenol at room temperature gave a slow reaction at first followed by a vigorous reaction on warming. Work-up in the usual manner gave the corresponding 2-bromo derivatives in 38% yield. Their structures were confirmed by preparing several of their derivatives. The gas liquid phase chromatography gave the same retention time to those of authentic specimens of 2-bromo-*p*-cresol and 2-bromo-4-chlorophenol.

TABLE 1

Starting material	Compound isolated	B.p/m.p. (°C/10 mm)	Reaction time (min)	Yield (%)
<i>m</i> -Cresol	4-Bromo- <i>m</i> -cresol ⁸	139/42	15	37
2-Chlorophenol	4-Bromo-2-chlorophenol ⁸	130/32	15	40
<i>p</i> -Cresol	2-Bromo- <i>p</i> -cresol ¹⁰	124/26	30	38
4-Chlorophenol	2-Bromo-4-chlorophenol ¹¹	120/22	30	38
4-Nitrophenol	No reaction		20 at 80°	
2-Nitrophenol	No reaction		20 at 80°	

TABLE 2

Derivative	M.p. (°C)	Formula	Br required	Br found
4-Bromo-3-methyl-1-phenoxy acetic acid ¹²	178-79	C ₉ H ₉ BrO ₃	32.6	32.8
4-Bromo-2-chloro-1-phenoxy acetic acid ²	144-45	C ₈ H ₆ BrClO	32.1	32.3
2-Bromo-4-methyl-1-phenoxy acetic acid	145-46	C ₉ H ₉ BrO ₃	32.6	32.9
2-Bromo-4-chlorophenyl benzoate ¹³	98-99	C ₁₃ H ₈ BrClO ₂	25.7	25.9

*Now at the Department of Chemistry, Middle East Technical University, Ankara, Turkey.

2-Nitro and 4-nitrophenols were shown to be inert towards thionyl bromide even when the reaction was carried out in boiling benzene. This shows, not only the lack of the reactivity of thionyl bromide towards compounds containing electron withdrawing groups but also a different behaviour from free bromine.

It was observed that the reaction of thionyl bromide with *o*- and *m*-substituted phenols was rapid as compared to *p*-substituted phenols.

Experimental

Thionyl bromide was prepared by the method of Ospenson; as an orange liquid, b.p. 58–60°C/40 mm.

4-Bromo-o-cresol. To *o*-cresol (10.8 g) was added thionyl bromide (7 ml), while the temperature was maintained at 5°C. A brisk reaction occurred with the evolution of HBr, SO₂ and precipitation of sulphur. After the reaction had slowed down, the reaction mixture was heated on a steam-bath for 15 min. Distillation of excess of thionyl bromide under reduced pressure left a brown residue, which was extracted with NaOH. The solution was filtered from precipitated sulphur and neutralised with HCl (dil). Extraction with ether followed by distillation gave 4-bromo-*o*-cresol as colourless oil, b.p. 235–37°C (lit.⁶ 235°C), yield 39%. The low yield of the product must be due to much charring. Its phenoxyacetic acid derivative was prepared by a known procedure. Crystallisation from aqueous ethanol gave 4-bromo-2-methyl-1-phenoxyacetic acid as colourless

needles, m.p. 122–24°C (lit.⁷ 118–24°C). (Found: Br, 32.9%. Calc. for C₂H₉BrO₃: Br, 32.6%).

Similarly the reaction of thionyl bromide with other substituted phenols was carried out. Details are given in Tables 1 and 2.

Acknowledgement. The authors are grateful to the Drug Research Laboratories, Islamabad, for providing facilities to carry out this work.

References

1. S.D. Saraf, Z.A. Malik and (Miss) Ather Zia, Pakistan J. Sci. Ind. Res., **15**, 43 (1972).
2. S.D. Saraf, Z.A. Malik and Z.I. Bhatti, Pakistan J. Sci. Ind. Res., **15**, 160 (1972).
3. S.D. Saraf, Can. J. Chem., **47**, 2803 (1969).
4. J.O.B. Edward, B.B. Richard and R. Starrer, J. Org. Chem., **35**, 16 (1970).
5. J.N. Ospenson, Chem. Abstr., **55**, 22736 (1961).
6. C. Jackson, *Beilstein's Handbook of Organic Chemistry* (1931), vol. VI, p. 360.
7. F.B. Ziently and G.W. Steahly, J. Am. Chem. Soc., **69**, 718 (1947).
8. N. Huston, J. Am. Chem. Soc., **57**, 2176 (1935).
9. K. Mortiz and D. George, Monatsch., **48**, 16 (1927).
10. N. Cain, Chemisches Zentralblatt., **89**, 239 (1906).
11. L. Hasckelberg, J. Org. Chem., **12**, 426 (1947).
12. L.C. Raiford and R.M. Glen, J. Am. Chem. Soc., **55**, 2125 (1933).
13. M. Kohn and K. Oskar, Chem. Abstr., **25**, 1190 (1931).