

***o*-Trifluoromethylthiophenol and Its Derivatives**

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The following compounds have been synthesized: *o*-trifluoromethylthiophenol; *o*-trifluoromethylthioanisole and its sulfone; *o*-trifluoromethylphenylmercaptoacetic acid and its ethyl ester, amide, hydrazide, and guanidine derivative; *o*-trifluoromethylphenylsulfonylacetic acid, its chloride, ethyl ester, and guanidine salt; β -*o*-trifluoromethylmercaptopropionic acid and 3-(*o*-trifluoromethylphenylmercapto) 1,2-propanediol and their sulfone derivatives; monothiobenzoic acid-*S*-(2-trifluoromethylphenyl) ester, 2,2-di(trifluoromethylphenyl) disulfide, *o*-trifluoromethylphenyl *p*-nitrophenyl sulfide, sulfone, and its amino derivative and acetylamino derivative, and 2-(2'-trifluoromethylthioanisyl)-4-quinolinecarboxylic acid, its 6-brominated, and their decarboxylated derivatives; and 7,7'-di-trifluoromethylthioindigo.

THE AUTHORS have prepared and studied recently fluorothiophenols and their derivatives (3).

The compounds listed in Table I were prepared to study and compare the behavior of the trifluoromethyl group in thiophenol series. *o*-Trifluoromethylthiophenol was prepared by the xanthate method. *o*-Trifluoromethylphenylmercaptoacetic acid was prepared in theoretical yield by careful addition of *o*-trifluoromethylphenyldiazonium chloride to a slight excess of a 10% solution of thioglycolic acid at 40° C. Oxidation of its ethyl ester with ordinary oxidizing agents was accompanied by hydrolysis to give *o*-trifluoromethylphenylsulfonylacetic acid, instead of its ethyl ester.

The sulfonyl ester was prepared by the acid chloride route. It is readily hydrolyzed and gives the guanidine salt in lieu of acylguanidine. These properties are in agreement with the relatively high acidic strength of the above acid (Table II).

The acid strengths were determined by the conductometric method.

o-Trifluoromethylthiobenzoic acid-*S*-phenyl ester was prepared by the addition of benzoyl chloride, at room temperature, to a pyridine solution of *o*-trifluoromethylthiophenol. Similar to thioesters of acetic acid (1), it is a reducing agent, giving quantitatively with cold concentrated sulfuric acid, 2,2'-di(*o*-trifluoromethylphenyl) disulfide, benzoic acid, and sulfur dioxide.

7,7'-Di-trifluoromethylthioindigo was prepared by heating *o*-trifluoromethylphenylmercaptoacetic acid with concentrated sulfuric acid in the presence of boric acid.













EXPERIMENTAL

The experimental data are summarized in Tables I and II.

***o*-Trifluoromethylthiophenol.** *o*-Trifluoromethylaniline (82.5 grams) was diazotized below 5° C., and the solution obtained was added drop by drop, with stirring, to a warm solution (45° to 50° C.) of 120 grams of potassium ethyl xanthate and 80 ml. of a 30% sodium hydroxide solution in 500 ml. of water. When the evolution of nitrogen ceased, the mixture was heated on a steam bath, and the oily xanthate ester was extracted with carbon tetrachloride. After removal of the solvent, the ester was hydrolyzed by refluxing with a solution of 75 grams of potassium hydroxide in 250 ml. of alcohol for 24 hours. The alcohol was removed by steam distillation, and the residue was diluted with 250 ml. of water and acidified with a 20% solution of sulfuric acid. The mixture was steam-distilled, and the *o*-trifluoromethylthiophenol was extracted from the distillate with carbon tetrachloride and, finally, was purified by vacuum distillation.

***o*-Trifluoromethylphenylmercaptoacetic Acid.** *o*-Trifluoromethylaniline (8.25 grams), after diazotization, was added

Table I. Derivatives

R	M.P., °C.	Yield, %	Analyses			
			Carbon, %		Hydrogen, %	
			Calcd.	Found	Calcd.	Found
-H ^{a, b}	...	35	47.19	47.26	2.80	2.73
-CH ₃ ^{c, d}	...	95	50.00	49.68	3.64	3.62
-O ₂ CH ₃	74	92	42.85	42.81	3.12	3.15
-CH ₂ COOH	84	99	45.76	45.69	3.40	3.35
-CH ₂ COOC ₂ H ₅ ^{e, f}	...	80	50.00	49.86	4.16	4.18
-CH ₂ CONH ₂ ^g	77	75	45.95	45.69	3.40	3.35
-CH ₂ CONHNH ₂ ^h	90	80	43.20	43.10	3.60	3.63
						
-CH ₂ CONHCNH ₂	148	85	43.32	42.99	3.61	3.60
-O ₂ CH ₂ COOH	164	68	40.29	39.89	2.61	2.62
-O ₂ CH ₂ COC1 ⁱ	...	85	37.69	37.60	2.09	1.95
-O ₂ CH ₂ COOC ₂ H ₅ ^j	...	70	44.59	44.38	3.71	3.70
						
-O ₂ CH ₂ COOH, H ₂ NCONH ₂	330	95	36.69	37.00	3.66	3.72
-CH ₂ CH ₂ COOH	72	65	48.00	47.95	3.60	3.58
-O ₂ CH ₂ CH ₂ COOH	140	71	42.55	43.01	3.19	3.17
-CH ₂ CHOHCH ₂ OH	40	67	47.61	47.82	4.36	4.26
-O ₂ CH ₂ CHOHCH ₂ OH	145	50	42.25	42.19	3.87	3.89
-COC ₆ H ₅	38	95	59.57	60.02	3.54	3.55
						
-S- 	62	98	47.45	47.45	2.25	2.32
	77	90	52.27	52.08	2.67	2.71
-O ₂ - 	110	82	47.12	47.50	2.41	2.42
-O ₂ - 	143	68	51.49	51.71	3.32	3.20
-O ₂ - 	240	90	52.63	52.53	3.50	3.54
-CH ₂ COCH ₃ ^{k, l}	...	95	51.28	51.31	3.84	3.69
	281(dec.)	80	59.50	61.12	3.30	3.33
	274(dec.)	88	48.41	49.80	2.48	2.42
	131	65	63.94	63.86	3.76	3.80
	122	68	51.25	51.08	2.76	2.75

^a n_D^{20} 1.4961. ^b B.P., 62-4° C., 10 mm. Hg. ^c n_D^{20} 1.5092, also prepared by autoclave heating of sodium methylmercaptide and *o*-bromobenzotrifluoride (2). ^d B.P., 82-8° C., 10 mm. Hg. ^e n_D^{20} 1.4984. ^f B.P., 142-5° C. 5 mm. Hg. ^g Xanthylamide, m.p. 170° C. Anal. Calcd. for C₂₂H₁₆F₃NO₂S: N, 3.37. Found: N, 3.35. ^h Benzal derivative, m.p. 125° C. Anal. Calcd. for C₁₆H₁₃F₃N₂OS: N, 8.34. Found: N, 8.42. ⁱ Thick oil. ^j n_D^{20} 1.5253. Semicarbazone, m.p. 172° C. Anal. Calcd. for C₁₁H₁₂F₃N₃OS: N, 14.43. Found: N, 14.51. Thiosemicarbazone, m.p. 139° C. Anal. Calcd. for C₁₁H₁₂F₃N₃S₂: N, 13.68. Found: N, 13.72. ^k B.P., 124° C., 4 mm. Hg. ^l Picrate, m.p. 224° C. Anal. Calcd. for C₂₃H₁₅F₃N₄O₇S: N, 10.22. Found: N, 10.27. ^m Picrate, m.p. 183° C. Anal. Calcd. for C₂₃H₁₄BrF₃N₄O₇S: N, 8.93. Found: N, 9.01.

Table II. Dissociation Constants at 25° C.

	K.
<i>o</i> -Fluorophenylmercaptoacetic (3)	2×10^{-4}
<i>m</i> -Fluorophenylmercaptoacetic (3)	1.56×10^{-4}
<i>p</i> -Fluorophenylmercaptoacetic (3)	1.17×10^{-4}
<i>o</i> -Trifluoromethylphenylmercaptoacetic	3.37×10^{-4}
<i>o</i> -Trifluoromethylphenylsulfonylacetic	1.17×10^{-3}
<i>o</i> -Trifluoromethylphenylsulfonylpropionic	8.9×10^{-5}

at room temperature to a solution of 6 grams of thioglycolic acid in 50 ml. of water. The reaction was slow, and after 4 hours, it was completed by heating the mixture on a steam bath. The acid was crystallized by refrigeration and recrystallized in a mixture of benzene and ligroin.

7,7'-Di-trifluoromethylthioindigo. A mixture of 2 grams of *o*-trifluoromethylphenylmercaptoacetic acid, 0.50 gram of boric acid, and 25 grams of sulfuric acid was heated on a steam bath for 1 hour. After being decomposed with crushed ice, 7,7'-di-trifluoromethylthioindigo was obtained as a crystalline powder which sublimed at 400° C. without melting.

Anal. Calcd. for $C_{18}H_6F_6O_2S_2$: C, 50.00; H, 1.38. Found: C, 49.62; H, 1.41.

***o*-Trifluoromethylthiobenzoic Acid-S-Phenyl Ester.** Benzoyl chloride (1.6 grams) was added at room temperature to a solution of 1.8 grams of *o*-trifluoromethylthiophenol in 5 ml. of dry pyridine. After standing 1 hour, the mixture was diluted with water and acidified with hydrochloric acid. An oily product was separated, which after cooling was solidified and recrystallized in dilute alcohol.

Acetyl *o*-Trifluoromethylphenyl Sulfide. A solution of 10 grams of *o*-trifluoromethylthiophenol in 30 ml. of ethanol

an hour with 1.5 grams of chloroacetone. The mixture was diluted with water and extracted with chloroform.

The quinolinecarboxylic acid derivatives (Table I) were prepared by refluxing this ketone for 20 hours with isatin or bromoisatin and alcoholic potassium hydroxide.

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RECEIVED for review December 6, 1965. Accepted April 29, 1966.

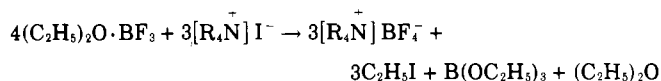
Some Organic Tetrafluoroborates

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The preparation of several new organic tetrafluoroborates by treatment of the corresponding methiodides with boron trifluoride etherate is reported. The preparation of trimethyl sulfonium tetrafluoroborate S-oxide is also discussed.

THE PREPARATION of tetrafluoroborates most frequently requires the use of tetrafluoroboric acid (3, 12, 17), metal salts of this acid such as silver and copper tetrafluoroborates (4, 11), boron trifluoride etherate (13, 16), or such reagents as triethyloxonium tetrafluoroborate (1, 5, 10). As part of a program to synthesize organic compounds for testing as herbicides and fungicides, and for other biological applications, a series of organic tetrafluoroborates have been prepared, presumably according to the following stoichiometry (16):



Pyridinium, picolinium, quinolinium, sulfonium, and pyrylium tetrafluoroborates have been prepared readily, by treating the corresponding methiodides with boron trifluoride etherate. The results of this work are summarized in Table I.

This paper also describes the preparation of trimethylsulfonium tetrafluoroborate S-oxide (14, 18) from the cor-

Table I. Organic Tetrafluoroborates, $[R]^+ [BF_4]^-$

[R]	M.P., °C.	Recrystg. Solvent	Yield, %	Formula	Calcd., %					Found %				
					C	H	B	F	N	C	H	B	F	N
	10-11.5 ^a	MeOH	49	$C_8H_9BF_4N$	39.8	4.5	6.0	42.0	7.7	40.1	4.1	6.4	42.4	8.0
	70-71.5	MeOH-Et ₂ O	61	$C_7H_{10}BF_4N$	43.1	5.2	5.5	39.0	...	43.2	4.9	5.8	38.8	...
	75-76.5	EtOH	82	$C_{10}H_{10}BF_4N$	52.0	4.4	4.7	32.9	6.0	52.2	4.4	4.7	33.0	6.1
	62-64	MeOH-Et ₂ O	59	$C_7H_{17}BF_4S$	38.2	7.8	4.9	34.5	^S 14.6	38.1	8.0	4.6	34.5	^S 14.4
	127-128 ^b	MeOH	59	$C_8H_{11}BF_4OS$	39.7	4.6	4.5	31.4	13.2	39.5	4.7	4.3	31.2	13.1
	273-275 ^c	CH ₃ CN	57	$C_8H_9BF_4OS$	20.0	5.0	6.0	42.3	17.8	20.1	5.2	6.2	41.9	17.6

^a1-Methylpyridinium tetrafluoroborate is a liquid at room temperature. With the exception of trimethylsulfonium tetrafluoroborate S-oxide [corresponding iodide melts 200° C. (7)] the tetrafluoroborates listed in Table I have significantly lower melting points than their corresponding iodides. ^bThis compound appeared to be considerably more stable on storage than did the known related 4-ethoxy-2,6-dimethylpyrylium tetrafluoroborate (11), a sample of which was prepared at the same time. None of the tetrafluoroborates listed in this table appeared hygroscopic; all remained unchanged in appearance after two months storage. ^cDecomposition.