TABLE I

SULFONANILIDES

Compound	Yield,[a] %	M. p., °C.	Analyses, % Nitrogen Calcd.	Nitrogen Found	Sulfur Calcd.	Sulfur Found
3′,5′-bis-(Trifluoromethyl)-sulfanilanilide[b]	85	162–164	7.29	7.29	8.32	8.35
3′-Trifluoromethyl-sulfanilanilide[b]	87	115–117	8.85	8.83	10.12	10.20
3′,5′-Diiodosulfanilanilide	81	191–192	5.60	5.55	6.40	6.06
3′-Bromo-5′-chlorosulfanilanilide	76	142–143	7.75	7.12	8.86	8.77
3′,5′-Dibromo-4′-hydroxybenzenesulfonanilide	36	161–163	3.44	3.21		
3′,5′-Dibromo-4′-hydroxysulfanilanilide	80	199–200	6.64	6.94		
3′-Bromo-5′-chloro-4′-hydroxysulfanilanilide	55	207–208	7.41	7.30	8.48	8.10
3′,5′-Diiodo-4′-hydroxysulfanilanilide	45	192–194	5.43	5.43	6.19	6.09
3′,5′-Dibromo-*o*-aminobenzenesulfonanilide	62	158–160	6.90	6.91	39.3[c]	39.10[c]
3′,5′-Dibromo-*m*-aminobenzenesulfonanilide	61	173–175	6.90	6.95	39.3[c]	39.31[c]
N^4-Succinyl-3′,5′-dibromosulfanilanilide		217–218 (dec.)	5.61	5.79	253.1[d]	247[d]

[a] The yield is based on the amount of substituted aniline originally used. [b] L. H. Schmidt and C. L. Sesler, *J. Pharmacol.*, **87**, 313 (1946), makes reference to the preparation of this compound in other laboratories also. [c] % Bromine. [d] Acid number.

tives have been synthesized. The effect of a phenolic hydroxyl in the molecule has also been investigated. Further a pair of isomers of 3′,5′-dibromosulfanilamide has been prepared in which the para amino group has been shifted to the ortho and meta positions. This was done to complete the partly finished picture presented by the high antibacterial activity of 3′,5′-dibromobenzenesulfonanilide as compared to 3′,5′-dibromosulfanilanilide.

In vitro studies carried out by Dr. C. A. Lawrence and Mr. G. R. Goetchius in these laboratories showed that all the compounds described below have definite antibacterial action upon *Streptococcus pyogenes* C203, *Eberthella typhosa* "Hopkins" strain, *Clostridium perfringens, Mycobacterium tuberculosis* var. *hominis* H-37-Rv. Details of these results are being published elsewhere.

Experimental

All the necessary aniline intermediates were prepared according to methods recorded in the literature. *m*-Nitrobenzenesulfonyl chloride was prepared by the chlorosulfonation procedure of Hodgson.[2]

o-Nitrobenzenesulfonyl chloride was prepared according to the method of Wertheim.[3]

3′,5′-bis-Trifluoromethylsulfanilanilide.—To 11.45 g. (0.05 mole) of 3,5-bis-trifluoromethylaniline dissolved in 25 cc. of pyridine and 30 cc. of acetone, 12.85 g. (0.0525 mole) of *p*-acetaminobenzenesulfonyl chloride was added. The resulting solution was heated on a steam-bath under reflux for one hour and then poured into ice water. The crystalline product was filtered off, thoroughly washed with water and dried. The crude yield was 21.5 g. (slightly more than theoretical) but no purification was carried out at this point. The crude acetyl derivative was heated under a reflux condenser with 40 cc. of 35% sodium hydroxide on a steam-bath. The reaction mixture was charcoaled and filtered. After acidifying with glacial acetic acid, the precipitated product was filtered off and dried. Recrystallization of 16.2 g. of crude material from aqueous alcohol gave 15.6 g. of pure product, m. p. 162–164°.

All the other *p*-aminobenzenesulfonanilides were made in this way (see Table I).

3′,5′-Dibromo-*o*-aminobenzenesulfonanilide.—3,5-Dibromoaniline and *o*-nitrobenzenesulfonyl chloride were condensed in a manner exactly analogous to the procedure described above. The yield of crude 3′,5′-dibromo-*o*-nitrobenzenesulfonanilide was 92%. To a solution containing 27 g. of stannous chloride, 45 cc. of concentrated hydrochloric acid and 90 cc. of 95% ethanol was added 21.8 g. (0.05 mole) of the crude product. All were heated together for one hour under reflux. The solution was cooled and precipitated solid was filtered off, dissolved in sodium hydroxide, charcoaled and precipitated with acetic acid. Filtration gave 12.5 g. (62%) of product, m. p. 155–157°. Recrystallization from benzene raised the melting point to 158–160°.

The corresponding *m*-amino compound was prepared similarly.

N^4-Succinyl-3′,5′-dibromosulfanilanilide.—3′,5′-Dibromosulfanilanilide (30.45 g.) was heated to reflux in 150 cc. of absolute alcohol. To this was added with stirring eight grams of succinic anhydride. After refluxing one and one-half hours, the solution was cooled and filtered giving 28 g. of crude product. This was recrystallized from alcohol to give 20 g. of the succinyl derivative, m. p. 217–218° (dec.).

RENSSELAER, NEW YORK RECEIVED APRIL 16, 1947

Heat of Combustion and Formation of 1,3,5,7-Cycloöctatetraene and its Heat of Isomerization to Styrene

BY EDWARD J. PROSEN, WALTER H. JOHNSON AND FREDERICK D. ROSSINI

Using the apparatus and procedures described previously,[1,2,3] determination has been made of the heat of combustion of the hydrocarbon, 1,3,5,7-cycloöctatetraene.

The cycloöctatetraene made available for these measurements was a 15-g. sample submitted with the following description: "The material was prepared by the polymerization of acetylene under pressure in the presence of tetrahydrofuran and nickel cyanide. It was purified by two distillations under reduced pressure in an atmosphere of nitrogen, using a 10-inch column packed with 42-mesh platinum screen spiral at a reflux ratio of

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[2] H. H. Hodgson and J. S. Whitehurst, *J. Chem. Soc.*, 482 (1944).

[3] Wertheim, "Organic Syntheses," Coll. Vol. II, 471 (1943).

(1) E. J. Prosen and F. D. Rossini, *J. Research Natl. Bur. Standards*, **27**, 289 (1941).

(2) E. J. Prosen and F. D. Rossini, *ibid.*, **33**, 255 (1945).

(3) W. H. Johnson, E. J. Prosen and F. D. Rossini, *ibid.*, **36**, 463 (1946).

about 4 to 1. The sample was sealed under nitrogen. The sample had the following properties: boiling point at 66 mm. pressure, 69.5°; freezing point, −7.5°; refractive index, n_D at 25°, 1.5350."

Five calorimetric combustion experiments were performed.[1,2,3] The mass of hydrocarbon used in each experiment was about one gram and the amount of reaction was determined from the mass of carbon dioxide produced in the combustion. No evidence of incomplete combustion was found in any of the experiments. The following results were obtained:

For the reaction of combustion, C_8H_8 (liquid, 1,3,5,7-cycloöctatetraene) + 10 O_2 (gas) = $8CO_2$ (gas) + $4H_2O$ (liq.), the heat of combustion at 25° is $-\Delta Hc^{\circ}_{298.16}$ = 4537.84 ± 1.16 int. kj./mole or 1084.75 ± 0.28 kcal./mole.

For the reaction of formation, 8C(solid, graphite) + $4H_2$(gas) = C_8H_8(liq., 1,3,5,7-cycloöctatetraene), the heat of formation at 25° is $\Delta Hf^{\circ}_{298.16}$ = 247.10 ± 1.23 int. kj./mole or 59.07 ± 0.29 kcal./mole.

For this calculation, the recently reported selected values of the heats of formation of carbon dioxide and water were used.[4,5]

For the reaction of isomerization, in the liquid state, of cycloöctatetraene to styrene, C_8H_8 (liq., 1,3,5,7-cycloöctatetraene) = C_8H_8 (liq., styrene), the heat of isomerization at 25° is $\Delta H^{\circ}_{298.16}$ = −34.35 ± 0.34 kcal./mole. For this calculation, the value for the heat of formation of liquid styrene at 25° reported by Prosen and Rossini was used.[6]

These data indicate definitely that the cycloöctatetraene ring does not possess the stability inherent in the benzene ring, since, from the standpoint of the energy content, cycloöctatetraene is less stable than styrene by 34 kcal./mole.

(4) E. J. Prosen, R. S. Jessup and F. D. Rossini, *J. Research Natl. Bur. Standards*, **33**, 447 (1944).

(5) D. D. Wagman, J. E. Kilpatrick, W. J. Taylor, K. S. Pitzer and F. D. Rossini, *ibid.*, **34**, 143 (1945).

(6) E. J. Prosen and F. D. Rossini, *ibid.*, **34**, 59 (1945).

THERMOCHEMICAL LABORATORY
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WASHINGTON, D. C.
RECEIVED MAY 1, 1947

Modified Synthesis of Ethyl Trifluoroacetate[1]

BY JAMES C. REID

The straightforward synthesis of ethyl trifluoroacetate by esterification of trifluoroacetic acid[2] involves the somewhat tedious process of isolating the acid from the reaction mixture in which it is formed. This paper describes the direct esterification of the acid without isolating it from the reaction mixture. This is possible despite the large amount of water present because of the formation of a low boiling ternary azeotrope consisting of alcohol, water, and ester. The azeotrope contains 88 wt. per cent. of ester and boils at 54°.

Experimental

The quantities of materials specified are based on an oxidation of one mole of trichlorotrifluoropropene.

The oxidation mixture containing potassium trifluoroacetate filtered free of manganese dioxide is acidified with fourteen moles of sulfuric acid, then 1160 cc. of 95% ethanol is added and the mixture is fractionated through a thirty-plate column. About two-thirds of the ester can be distilled out as the azeotrope at 55–57° using a reflux ratio of 15:1. The head temperature then starts to climb and the ratio is increased to 30:1.

The temperature gradually reaches 78° and distillation is continued after this point has been reached until the total volume of distillate is half that of the alcohol used. The distilling time is ten hours.

Experiments with a sixty-plate column operating at a reflux ratio of 60:1 show that it is still necessary to distill out considerable alcohol after the temperature reaches 78° to get all the ester and so the more convenient thirty plate column is employed.

The distillate contains no hydrogen chloride but does contain sulfur dioxide if an excess has been used in reducing the excess permanganate employed in the oxidation.

The distillate is now redistilled through a thirty-plate column which separates the azeotrope from excess alcohol. The product coming over between 54–60° is collected as crude ester. A small amount of ester remains in the alcohol in the pot, which can be saved and used in the next esterification.

The alcohol and water are removed from the azeotrope by mixing it with half its volume of concentrated sulfuric acid, while cooling in an ice-bath, then distilling the ester out in a simple distillation apparatus. No water or alcohol escapes from the acid if the pot temperature does not exceed 120°.

The yield of purified ester is 73%, based on trifluorotrichloropropene.

RADIATION LABORATORY AND
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RECEIVED MARCH 24, 1947

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[1] This paper is based on work performed under Contract #W-7405-Eng-48 with the Atomic Energy Commission in connection with the Radiation Laboratory and the Department of Chemistry, University of California.

[2] Henne, Alderson and Newman, THIS JOURNAL, **67**, 918–919 (1945).

The Reaction of Thiuram Disulfide with Halomethyl Ketones

BY J. J. RITTER AND H. SOKOL[1]

In an attempt to prepare bis-(thiazyl-2) disulfides by the condensation of halomethyl ketones with thiuram disulfide, it was found that phenacyl bromides reacted smoothly with thiuram disulfide in acetone. Instead of the expected disulfides, however, excellent yields of 2-phenacylthio-4-arylthiazoles were obtained. This was particularly interesting in view of the fact that chloroacetone yielded no analogous product in an alcohol medium.[2]

When an acetone solution of thiuram disulfide and chloroacetone was allowed to stand overnight

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[1] Abstracted from a portion of the thesis submitted to the Graduate School of New York University in partial fulfillment of the requirements for the degree of Doctor of Philosophy. This work was done under the sponsorship of the Office of Rubber Reserve, Reconstruction Finance Corporation, in connection with the Government Synthetic Rubber Program.

[2] Buchman, Reims and Sargent, *J. Org. Chem.*, **6**, 764 (1941).