TABLE I

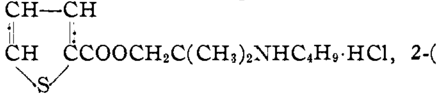
2-METHYL-2-MONOALKYLAMINOPROPYL FUROATE AND 2-THIOPHENECARBOXYLATE HYDROCHLORIDES[a] $RCOOCH_2C(CH_3)_2$-$NHR'\cdot HCl$

| R | R' | M.p., °C. (uncor.) | Formula | Chlorine, % Calcd. | Found[b] | |
|---|---|---|---|---|---|---|
| 2-Furan | $n$-$C_3H_7$ | 184–185 | $C_{12}H_{20}O_3NCl$ | 13.54 | 13.32 | 13.29 |
| 2-Furan | $n$-$C_4H_9$ | 146–147 | $C_{13}H_{22}O_3NCl$ | 12.86 | 12.58 | 12.63 |
| 2-Furan | $n$-$C_5H_{11}$ | 144–145 | $C_{14}H_{24}O_3NCl$ | 12.24 | 12.12 | 12.00 |
| 2-Thiophene | $n$-$C_3H_7$ | 165–166 | $C_{12}H_{20}O_2NClS$ | 12.76 | 12.87 | 12.81 |
| 2-Thiophene | $n$-$C_4H_9$ | 175–176 | $C_{13}H_{22}O_2NClS$ | 12.15 | 12.25 | 12.30 |
| 2-Thiophene | $n$-$C_5H_{11}$ | 130–131 | $C_{14}H_{24}O_2NClS$ | 11.59 | 11.54 | 11.49 |

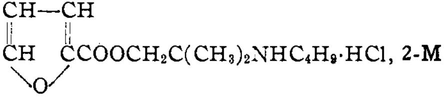
[a] These compounds will be tested for anesthetic activity by Dr. H. B. Haag of the Medical College of Virginia and the results reported elsewhere. [b] Analyses by R. L. Kersey.

ride and was isolated as the disulfate. Each of the 2-methyl-2-monoalkylaminopropyl aromatic carboxylates, in the process of purification, was converted into the free base, dissolved in isopropyl ether and precipitated as the salt by the addition of hydrogen chloride or concentrated sulfuric acid.

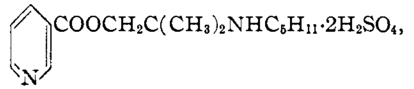
### Experimental



**2-(2-Methyl-2-$n$-butylaminopropyl) Thiophenecarboxylate Hydrochloride.**—To 13.1 g. (0.1 mole) of 2-methyl-2-$n$-butylamino-1-propanol was added 13.4 ml. (0.15 mole) of concentrated hydrochloric acid. The solution was evaporated to dryness in a vacuum. To the amino alcohol hydrochloride thus formed was added 14.6 g. (0.1 mole) of thiophenecarboxylyl chloride.[6] The mixture was heated on an oil-bath at 100° for 15 minutes, at 130° for 15 minutes and at 150° for 15 minutes. The reaction mixture was taken up in 50 ml. of alcohol, the solution was poured into 100 ml. of $N$ sodium hydroxide solution and the oil which separated was dissolved in isopropyl ether. The ethereal solution was saturated with dry hydrogen chloride. The solid formed was filtered with suction, washed with isopropyl ether and recrystallized to constant melting point from alcohol and isopropyl ether. The yield of purified 2-methyl-2-$n$-butylaminopropyl 2-thiophenecarboxylate hydrochloride was 7 g. or 24% of theory.



**2-Methyl-2-$n$-butylaminopropyl Furoate Hydrochloride.**—Tenth molar quantities of 2-methyl-2-$n$-butylamino-1-propanol and furoyl chloride were heated, as above. The reaction product was dissolved in 50 ml. of ethanol and poured into 100 ml. of $N$ sodium hydroxide solution. The free base separating was dissolved in isopropyl ether and precipitated as the crystalline hydrochloride by the addition of hydrogen chloride. 2-Methyl-2-$n$-butylaminopropyl furoate hydrochloride was obtained in 23% yield by washing with isopropyl ether and recrystallization from ethanol–isopropyl ether solution.



**2-Methyl-2-$n$-amylaminopropyl Nicotinate Disulfate.**[a]—Tenth molar quantities of 2-methyl-2-$n$-amylaminopropyl hydrochloride and nicotinyl chloride were refluxed in 50 ml. of chloroform for approximately 18 hours. The reaction mixture was poured into hot water, the chloroform evaporated off and the 2-methyl-2-$n$-amylaminopropyl nicotinate set free as a dark oil by the addition of sodium hydroxide solution. The oil was dissolved in isopropyl ether and treated dropwise with concentrated sulfuric acid. The oil which precipitated was converted into a crystalline hygroscopic solid in a yield of 78% by trituration with anhydrous ether, suction filtration and drying in a vacuum desiccator. On stirring the product with anhydrous acetone and suction filtration the product became less hygroscopic. Without further purification the product had a melting point of 135–142° and gave a sulfate analysis only 0.1% low in sulfur, the latter likely due to a balancing of errors. On three recrystallizations from absolute alcohol and anhydrous ether, the melting point was 153–153.5°. *Anal.* Calcd. for $C_{15}H_{24}O_2N_2\cdot 2H_2SO_4$: S, 13.93. Found: S, 14.05.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF RICHMOND
RICHMOND, VIRGINIA

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[6] Acknowledgment is made to Socony Vacuum Company for the 2-thiophene carboxylic acid used in the preparation of the acid chloride.

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## Alkyl Half Esters of *cis*-3,6-Endomethylene-$\Delta^4$-tetrahydrophthalic Acid

BY LEONARD M. RICE[1] AND E. EMMET REID[2]

RECEIVED APRIL 11, 1952

Due to the continuing interest in alkyl chain length as a function of melting point, it was desirable to prepare the half esters of *cis*-3,6-endomethylene-$\Delta^4$-tetrahydrophthalic acid and compare the melting points of these compounds with those of phthalic[3] and *cis*-$\Delta^4$-tetrahydrophthalic acids[4] previously prepared.

This series of half esters melted with a more regular pattern in the compounds of alkyl chain length from methyl to octyl than the corresponding half esters of phthalic or tetrahydrophthalic acids. The series has a minimum at 34° for the octyl ester and then rises in a general pattern by small increments to 70° at the octadecyl half ester. In general it can be said that the melting points of these compounds are intermediate between the analogous compounds derived from phthalic or tetrahydrophthalic acids. The compounds prepared are listed in Table I.

### Experimental

**The Half Esters of Methyl through Amyl.**—A mixture of an excess of the appropriate water-free alcohol and the anhydride was refluxed three hours. After cooling the excess alcohol was removed from a steam-bath under reduced pressure. The oily residue generally solidified to a crystalline mass on cooling. Recrystallization was effected by alternately using petroleum ether and "heptane" until a constant melting product was obtained after vacuum drying.

**The Half Esters of Hexyl through Dodecyl.**—A mixture of 0.5 mole of the appropriate alcohol and 0.5 mole of the anhydride was slowly heated with stirring until the temperature rose to around 135°. At this point heating was

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[1] Abstracted in part from the thesis submitted to Georgetown University in 1951, by Leonard M. Rice, in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

[2] Professor Emeritus, Johns Hopkins University, Baltimore, Md.

[3] J. F. Goggins, Jr., and J. F. Copenhaver, THIS JOURNAL, 61, 2909 (1939).

[4] White, Trigg, Sankins and E. E. Reid, private communication.

TABLE I

ALKYL HALF ESTER OF *cis*-3,6-ENDOMETHYLENE-$\Delta^4$-TETRAHYDROPHTHALIC ACID

| R | M.p., °C. | Formula | Carbon, % Calcd. | Carbon, % Found | Hydrogen, % Calcd. | Hydrogen, % Found | Acid no. Calcd. | Acid no. Found |
|---|---|---|---|---|---|---|---|---|
| $CH_3$[a] | 101–102 | $C_{10}H_{12}O_4$ | 61.21 | 61.35 | 6.17 | 6.08 | 196 | 195 |
| $C_2H_5$ | 74–75 | $C_{11}H_{14}O_4$ | 62.68 | 63.12 | 6.72 | 6.63 | 210 | 212 |
| $n$-$C_3H_7$ | 71–72 | $C_{12}H_{16}O_4$ | 64.31 | 64.44 | 7.19 | 7.10 | 224 | 226 |
| $n$-$C_4H_9$ | 65–66 | $C_{13}H_{18}O_4$ | 65.56 | 65.63 | 7.62 | 7.22 | 238 | 240 |
| $n$-$C_5H_{11}$ | 51–52 | $C_{14}H_{20}O_4$ | 66.64 | 66.95 | 7.99 | 7.73 | 252 | 254 |
| $n$-$C_6H_{13}$ | 52–53 | $C_{15}H_{22}O_4$ | 67.68 | 68.00 | 8.33 | 7.98 | 266 | 270 |
| $n$-$C_7H_{15}$ | 43–44 | $C_{16}H_{24}O_4$ | 68.59 | 68.88 | 8.63 | 8.28 | 280 | 279 |
| $n$-$C_8H_{17}$ | 32–33 | $C_{17}H_{26}O_4$ | 69.32 | 69.24 | 8.99 | 9.05 | 294 | 290 |
| $n$-$C_9H_{19}$ | 45–46 | $C_{18}H_{28}O_4$ | 70.10 | 70.01 | 9.15 | 9.13 | 308 | 310 |
| $n$-$C_{10}H_{21}$ | 50–51 | $C_{19}H_{30}O_4$ | 70.77 | 71.10 | 9.38 | 9.38 | 322 | 321 |
| $n$-$C_{11}H_{23}$ | 53–54 | $C_{20}H_{32}O_4$ | 71.39 | 71.60 | 9.62 | 9.46 | 336 | 333 |
| $n$-$C_{12}H_{25}$ | 52–53 | $C_{21}H_{34}O_4$ | 71.96 | 72.13 | 9.78 | 9.61 | 350 | 356 |
| $n$-$C_{13}H_{27}$ | 53–54 | $C_{22}H_{36}O_4$ | 72.46 | 72.08 | 9.95 | 9.98 | 364 | 365 |
| $n$-$C_{14}H_{29}$ | 59–60 | $C_{23}H_{38}O_4$ | 73.24 | 73.17 | 10.12 | 10.44 | 378 | 373 |
| $n$-$C_{15}H_{31}$ | 59–60 | $C_{24}H_{40}O_4$ | 73.42 | 73.26 | 10.27 | 10.18 | 392 | 389 |
| $n$-$C_{16}H_{33}$ | 63–64 | $C_{25}H_{42}O_4$ | 73.84 | 73.70 | 10.41 | 10.44 | 406 | 402 |
| $n$-$C_{17}H_{35}$ | 63–64 | $C_{26}H_{44}O_4$ | 74.24 | 73.98 | 10.54 | 10.48 | 420 | 414 |
| $n$-$C_{18}H_{37}$ | 69–70 | $C_{27}H_{46}O_4$ | 74.61 | 74.46 | 10.67 | 10.64 | 435 | 432 |

[a] Prepared by Morgan, Tipson, Lowy and Baldwin, THIS JOURNAL, 66, 404 (1944).

discontinued and the temperature rose spontaneously to 160° and was maintained at this degree by intermittent application of heat for 15 minutes. After cooling the oily half esters were purified by dissolving them in 10% sodium carbonate solution, followed by filtration. The filtrate was extracted twice with ether and acidified with 10% hydrochloric acid. The aqueous solution was decanted and the oily residue dissolved in benzene. After filtering the benzene solution was washed with water and extracted with 10% sodium bicarbonate solution. The extract was made acid with 10% hydrochloric acid and the free acid ester which separated was washed with water and dissolved in benzene. After drying over sodium sulfate the solvent was removed by distillation under vacuum. The half esters were further purified by dissolving them in petroleum ether and freezing them out by immersion in an acetone–Dry Ice mixture. This procedure was repeated until a constant melting compound was obtained after drying for 24 hours in a vacuum.

**The Half Esters Tridecyl through Octadecyl.**—A mixture of the appropriate alcohol and equivalent molar amount of the anhydride was heated for 12 hr. at 125°. The mixture was stirred occasionally during the heating to give a homogeneous liquid. The cooled mixture was poured into an excess of 10% sodium carbonate and stirred until the solid dissolved. The solution was extracted with benzene and filtered through a wetted filter. An excess of 10% hydrochloric acid was then added and the oily precipitate was allowed to harden, then filtered and dried. The product was recrystallized from petroleum ether until constant melting after drying 24 hr. in vacuum.

GEORGETOWN UNIVERSITY MEDICAL CENTER
WASHINGTON 7, D. C.

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## The Si–C Bond Distance in $Si(CH_3)_4$

BY W. F. SHEEHAN, JR., AND VERNER SCHOMAKER

RECEIVED MARCH 31, 1952

A reinvestigation of tetramethylsilane by electron diffraction[1] has led to the result Si–C = 1.888 ± 0.02 Å. (previous report[2]: 1.93 ± 0.03 Å.), in agreement with the values found for carborundum[3] (1.88–1.90 Å.), the three other methylsilanes[4] (1.87 Å.), and $Si_2(CH_3)_6$[5] (1.90 ± 0.02 Å.).

The observed diffraction pattern, which has eleven rings extending to $s = 32$, is well represented by the simplified intensity curve calculated with appropriate temperature factors for a symmetrical ($T_d$) model with the methyl groups in the staggered orientation, as held by independent 1.3 kcal./mole threefold potential barriers,[6] and with Si–C = 1.89, Si–H = 1.10, and $\angle$ Si–C–H = 110°; the average of the deviations $|(s_{\text{calcd}}/s_{\text{obsd}}) - (s_{\text{calcd}}/s_{\text{obsd}})|$ is 0.005 for the eleven well-located and reasonably symmetrical features used for the scale determination. Models with opposed methyl groups are unsatisfactory, both in the position and qualitative aspects of the first five or six rings, and it seems certain that the methyl groups are indeed predominantly staggered.

The final results are: $\angle$Si–C–H, 110 ± 3°; C–H, 1.10 ± 0.05 Å.[7]; and Si–C, 1.888 ± 0.02 Å.[7]

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[1] See K. Hedberg and A. J. Stosick, THIS JOURNAL, **74**, 954 (1952), for details of the methods used.

[2] L. O. Brockway and H. O. Jenkins, *ibid.*, **58**, 2036 (1936).

[3] N. W. Thibault, *Am. Mineral.*, **29**, 249, 327 (1944); L. S. Ramsdell, *ibid.*, **29**, 431 (1944); **30**, 519 (1945).

[4] L. O. Brockway and A. C. Bond, Second Int. Cong. Cryst., Stockholm (1951), Abstr. ED 12.

[5] L. O. Brockway and N. R. Davidson, THIS JOURNAL, **63**, 3287 (1941).

[6] J. G. Aston, R. M. Kennedy and G. H. Messerly, *ibid.*, **63**, 2343 (1941).

[7] Including 0.8% estimated limit of scale error.

CONTRIBUTION NO. 1671
GATES AND CRELLIN LABORATORIES OF CHEMISTRY
CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA 4, CALIFORNIA

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## Antitubercular Studies. III. Hydroxylamines and Thiosemicarbazones

BY PRICE TRUITT, E. H. HOLST AND MARGARET ROBBINS

RECEIVED APRIL 25, 1952

Our interest in antitubercular studies has led us to synthesize a number of compounds with varying structures for testing against tuberculosis. Among these substances there have been O-substituted