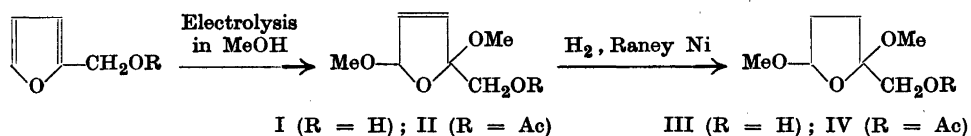


## 2,5,5-Trimethoxytetrahydropyran

NIELS CLAUSON-KAAS, PAUL DIETRICH and  
JØRGEN TORMOD NIELSEN

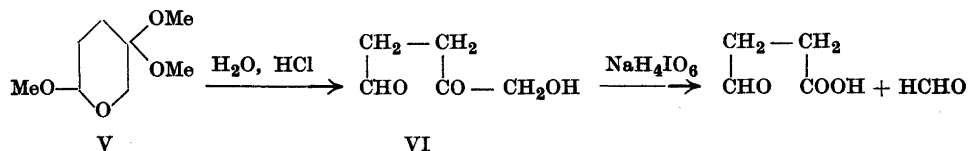
Centrallaboratoriet, Sadolin & Holmblad A/S Copenhagen, Denmark

The preparation of 2,5-dimethoxy-2-hydroxymethyl-2,5-dihydrofuran (I) and 2,5-dimethoxy-2-acetoxymethyl-2,5-dihydrofuran (II) from furfuryl alcohol and furfuryl acetate, respectively, has recently been described<sup>1</sup>. These dihydrofurans have been catalytically hydrogenated to the corresponding new tetrahydrofurans III and IV. Their structures follow from synthesis and from analyses.



When III or IV are heated under reflux with methanolic hydrogen chloride a compound with the formula  $C_5H_7O(OCH_3)_3$  is formed. It is a colorless liquid with a characteristic terpene-like odor. We believe this compound to be the hitherto unknown 2,5,5-trimethoxytetrahydropyran (V) since: (a) refluxing over sodium under atmospheric pressure as well as shaking with Raney nickel in methanol under 100 atmospheres of hydrogen at 80° for four hours leaves it unaffected (b) hydrolysis with boiling *N*/10 sulfuric acid for one minute gives a neutral compound, which is cleaved by oxidation with one mole of sodium periodate into  $\beta$ -formylpropionic acid and formaldehyde.

If one accepts formula V for the new compound, the neutral compound formed by hydrolysis should be 1-hydroxy-2,5-dioxo-pentane (VI). The formation of  $\beta$ -formylpropionic acid and formaldehyde from V may therefore be formulated as follows:



## EXPERIMENTAL

Microanalyses by A. Grossmann, E. Boss and K. Glens.

*2,5-Dimethoxy-2-hydroxymethyl-tetrahydrofuran (III)*. 2,5-Dimethoxy-2-hydroxymethyl-2,5-dihydrofuran<sup>1</sup> (I) (50.0 g) and methanol (75 ml) were shaken (3 h) with Raney nickel (2.0 g) under hydrogen (100 atm). The product was isolated by distillation.

Fraction (g)	B.p. 13 °C	$n_D^{25}$	OCH <sub>3</sub> Calc. 38.3 %
1 (7.0)	104–105	1.4472	37.2
2 (14.0)	104–106	1.4472	37.7
3 (15.2)	106–107	1.4477	38.1
4 (12.4)	107–110	1.4477	38.0

The yield (all fractions) was 48.6 g (96 %) of III (colorless liquid). A portion of fraction 3 was also analyzed for carbon and hydrogen.

$C_5H_8O_2(OCH_3)_2$  (162.2) Calc. C 51.8 H 8.7  
Found » 52.3 » 8.6

*2,5-Dimethoxy-2-acetoxymethyl-tetrahydrofuran (IV)*. 2,5-Dimethoxy-2-acetoxymethyl-2,5-dihydrofuran<sup>1</sup> (II) (20.2 g) and methanol (25 ml) were shaken (2 h) with Raney nickel (0.5 g) under hydrogen (100 atm). The product was isolated by distillation.

Fraction (g)	B.p. 13 °C	$n_D^{25}$
1 (0.8)	113–114	1.4355
2 (7.0)	114–115	1.4356
3 (6.4)	114–115	1.4358
4 (5.0)	115–116	1.4359

The yield (all fractions) was 19.2 g (96 %) of IV (colorless liquid). A portion of fraction 3 was analyzed.

$C_5H_7O_2(OCH_3)_2(COCH_3)$  (204.2) Calc. C 52.9 H 7.9 OCH<sub>3</sub> 30.4 COCH<sub>3</sub> 21.1  
Found » 53.3 » 8.0 » 30.7 » 21.7

*2,5,5-Trimethoxytetrahydropyran (V)*. (a) *Preparation from III*. III (16.2 g, 0.10 mole) was heated under reflux (1 h) with methanol (80 ml, dried with magnesium) to which had been added acetyl chloride (2.00 ml). Sodium (3.0 g) was added and the dark-

red mixture heated further under reflux (20 h); this treatment with sodium methoxide, which probably causes the destruction of some carbonyl compounds, was necessary in order to obtain a pure product. After cooling, the precipitated sodium chloride was removed by filtration and the methanol distilled through a Vigreux column. Ether (50 ml) was added to the residue and a voluminous precipitate removed by centrifugation. The precipitate was washed twice with ether and the combined ethereal solutions distilled. The yield was 12.2 g (69 %) of V (colorless liquid, b.p.<sub>13-14</sub> = 79–84°,  $n_D^{25}$  = 1.4352). 2–4 g of a black residue remained in the flask.

$C_5H_7O(OCH_3)_3$ (176.2)	Calc.	C 54.5	H 9.2	$OCH_3$ 52.8
	Found	» 54.5	» 9.1	» 52.5

Upon redistillation of the above product through a 48 cm fractionating column packed with Dixon gauze rings the boiling point and the refractive index remained constant throughout the whole distillation.

40 g of V was recovered unaffected (b.p.<sub>760</sub> = 203–205°,  $n_D^{25}$  = 1.4351) after reflux (5 min) over sodium under atmospheric pressure followed by distillation.

10 g of V was recovered unaffected ( $n_D^{25}$  = 1.4352) after shaking (2 h) with methanol (20 ml) and Raney nickel (0.8 g) under hydrogen (100 atm, 80°).

(b) *Preparation from IV.* IV (20.4 g, 0.10 mole) was heated under reflux with methanolic hydrogen chloride as above. Sodium (700 mg) was added, a precipitate of sodium chloride removed by filtration, and the low-boiling products distilled through a Vigreux column. This was done in order to remove the methyl acetate formed during the reaction. The residue was heated under reflux (20 h) with a solution of sodium methoxide (from 1.5 g of sodium) in methanol (50 ml) and worked up as above. The yield was 12.8 g (73 %) of V (colorless liquid, b.p.<sub>12</sub> = 82–84°,  $n_D^{25}$  = 1.4352).

	Found	C 54.7	H 9.2	$OCH_3$ 52.6
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(c) *Hydrolysis and reaction with periodate.* V (1.00 g, 0.00568 mole) was heated under reflux (1 min) with sulfuric acid (0.1 N, 13.0 ml) and the colorless solution allowed to stand (30 min, room temperature). Monosodium paraperiodate (0.00568 mole) was added and dissolved. After standing (30 min) at room temperature half of the solution was continuously extracted (4 h) with ether and the extract evaporated in vacuum (200 mm, 45°). A solution of 2,4-dinitrophenylhydrazine (0.80 g) in perchloric acid (30 %, 34 ml) was added and the mixture allowed to stand overnight. Filtration, washing — first with perchloric acid (30 %) and then with water — and drying gave 0.69 g (86 %) of  $\beta$ -formylpropionic acid dinitrophenylhydrazone [m.p. 196–198° (Hershberg apparatus, corr.)]; previously found 198–200°<sup>2</sup>.

$C_{10}H_{10}N_4O_6$ (282.2)	Calc.	C 42.6	H 3.6	N 19.9
	Found	» 42.5	» 3.4	» 20.1

Crystallization from acetone-ligroin did not change the m.p. or the analytical values.

To the second half of the above solution was added 5 ml of water. About 8 ml was distilled into a solution of dimedone (1.00 g) in water (300 ml) and the resulting precipitate of the dimedone derivative of formaldehyde isolated in the usual way<sup>3</sup>. The yield was 0.77 g (93 %) (white crystals, m.p. 189–190°).

$C_{17}H_{24}O_4$ (292.4)	Calc.	C 69.8	H 8.3
	Found	» 69.6	» 8.1

In a parallel experiment it was found that 12.9 ml of *N*/10 sodium hydroxide was necessary to neutralize the hydrolysate of V (phenolphthalein indicator). Hence no acid products were formed by hydrolysis.

## SUMMARY

2,5-Dimethoxy-2-hydroxymethyl-2,5-dihydrofuran (I) and 2,5-dimethoxy-2-acetoxymethyl-2,5-dihydrofuran (II) have been catalytically hydrogenated to 2,5-dimethoxy-2-hydroxymethyl-tetrahydrofuran (III) and 2,5-dimethoxy-2-acetoxymethyl-tetrahydrofuran, respectively. Both tetrahydrofurans gave the new 2,5,5-trimethoxytetrahydropyran (V) upon boiling with a methanolic solution of hydrogen chloride.

## REFERENCES

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