



A Publication  
of Reliable Methods  
for the Preparation  
of Organic Compounds

## Working with Hazardous Chemicals

The procedures in *Organic Syntheses* are intended for use only by persons with proper training in experimental organic chemistry. All hazardous materials should be handled using the standard procedures for work with chemicals described in references such as "Prudent Practices in the Laboratory" (The National Academies Press, Washington, D.C., 2011; the full text can be accessed free of charge at [http://www.nap.edu/catalog.php?record\\_id=12654](http://www.nap.edu/catalog.php?record_id=12654)). All chemical waste should be disposed of in accordance with local regulations. For general guidelines for the management of chemical waste, see Chapter 8 of Prudent Practices.

In some articles in *Organic Syntheses*, chemical-specific hazards are highlighted in red "Caution Notes" within a procedure. It is important to recognize that the absence of a caution note does not imply that no significant hazards are associated with the chemicals involved in that procedure. Prior to performing a reaction, a thorough risk assessment should be carried out that includes a review of the potential hazards associated with each chemical and experimental operation on the scale that is planned for the procedure. Guidelines for carrying out a risk assessment and for analyzing the hazards associated with chemicals can be found in Chapter 4 of Prudent Practices.

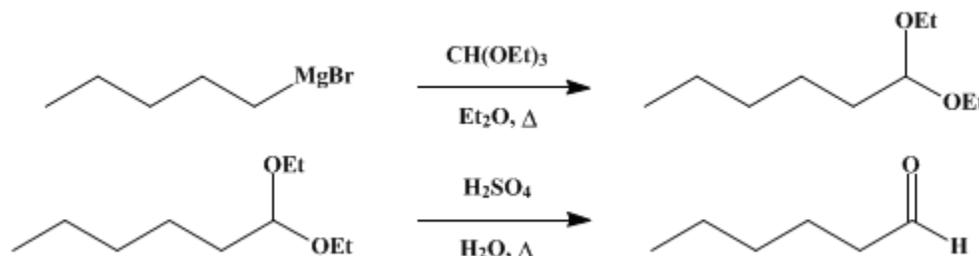
The procedures described in *Organic Syntheses* are provided as published and are conducted at one's own risk. *Organic Syntheses, Inc.*, its Editors, and its Board of Directors do not warrant or guarantee the safety of individuals using these procedures and hereby disclaim any liability for any injuries or damages claimed to have resulted from or related in any way to the procedures herein.

*These paragraphs were added in September 2014. The statements above do not supersede any specific hazard caution notes and safety instructions included in the procedure.*

*Organic Syntheses, Coll. Vol. 2, p.323 (1943); Vol. 16, p.41 (1936).*

## ***n*-HEXALDEHYDE**

### [Caproaldehyde]



Submitted by G. Bryant Bachman

Checked by C. R. Noller and W. S. Woon.

### 1. Procedure

In a 2-l. three-necked, round-bottomed flask, fitted with a liquid-sealed mechanical stirrer, a 250-cc. dropping funnel, and a reflux condenser to which is attached a calcium chloride tube, are placed 30 g. (1.25 gram atoms) of **magnesium turnings**, 50 cc. of dry **ether**, and a small crystal of **iodine**. Stirring is started, and 5 cc. (6 g.) of ***n*-amyl bromide** is added (**Note 1**). As soon as the reaction has started, 300 cc. of dry **ether** is added and then, more slowly, a solution of 183 g. (total, 189 g.; 1.25 moles) of ***n*-amyl bromide** in 150 cc. of dry **ether**. If external cooling is provided, all the alkyl halide may be added within half an hour; the solution is refluxed gently for another half-hour to complete the reaction. The heat is removed, the flask cooled to 50°, and 148 g. (1 mole) of **ethyl orthoformate** (*Org. Syn. Coll. Vol. I, 1941, 258*) is added during the course of fifteen to twenty minutes. The mixture is refluxed for six hours (**Note 2**); at the end of this time the condenser is arranged for distillation and the ether is removed completely with the aid of a steam bath.

The reaction mixture is cooled and treated carefully with 750 cc. of chilled 6 per cent **hydrochloric acid**. The contents of the flask are kept cool by the occasional addition of ice while the acid is being introduced. As soon as all the solid has dissolved (**Note 3**), the upper oily layer of hexaldehyde acetal is separated. The acetal is hydrolyzed by distilling it with a solution of 100 g. (55 cc.) of concentrated **sulfuric acid** in 700 cc. of water. The free aldehyde distils rapidly, and the distillation is complete when a sample of fresh distillate contains 5 per cent or less of immiscible oil. The distillate is collected in a solution of 100 g. (1 mole) of **sodium bisulfite** in 300 cc. of water. The mixture is shaken vigorously for several minutes; the oily layer remaining undissolved in the bisulfite solution is principally ***n*-amyl alcohol** and is discarded. To remove the remainder of the **amyl alcohol** and other impurities the bisulfite solution is steam-distilled until 200 cc. of distillate has been collected.

The residual aldehyde-bisulfite solution is cooled to 40–50°, a suspension of 80 g. of **sodium bicarbonate** in 200 cc. of water is added carefully, and the free aldehyde is removed by steam distillation. The upper layer of the distillate is separated, washed with three 50-cc. portions of water (**Note 4**), dried with 20 g. of anhydrous **sodium sulfate**, and distilled through a 20-cm. column. The yield of ***n*-hexaldehyde** b.p. 126–129°, is 45–50 g. (45–50 per cent of the theoretical amount).

### 2. Notes

1. The ***n*-amyl bromide** was prepared according to the general procedure in *Org. Syn. Coll. Vol. I, 1941, 25*, and distilled at 127–129°.
2. Sometimes a white precipitate begins to form immediately, but more often it does not appear until after twenty to thirty minutes of refluxing. If this period of heating is materially decreased, a sudden exothermic reaction occurs when the **ether** is removed and the yield may be seriously reduced. Longer periods of heating do not increase the yield of hexaldehyde.

3. Solution takes place slowly and is hastened considerably by the use of a mechanical stirrer.
4. The aldehyde dissolved by the wash water may be recovered by steam distillation, but this is scarcely worth while since hexaldehyde is not very soluble in water.

### 3. Discussion

Hexaldehyde has been prepared from [caproic acid](#) by passing it over [zinc](#) dust at 300°,<sup>1</sup> by reaction with [amylene](#) at 300° in the presence of [thorium oxide](#),<sup>2</sup> by passing it over [manganous oxide](#) at 300–360° with two volumes of [formic acid](#),<sup>3</sup> and by distillation of the calcium salt with [calcium formate](#).<sup>4</sup> It has also been prepared by heating  $\alpha$ -hydroxyheptoic acid or, better,  $\alpha$ -acetoxyheptoic acid,<sup>5</sup> and by the procedure described above.<sup>6</sup>

---

### References and Notes

1. Mailhe, Chem. Ztg. **33**, 243 (1909).
  2. Mailhe, *ibid.* **34**, 1174 (1910).
  3. Sabatier and Mailhe, Compt. rend. **158**, 986 (1914).
  4. Lieben and Janecek, Ann. **187**, 130 (1877).
  5. Bagard, Bull. soc. chim. (4) **1**, 313 (1907).
  6. Bachman, J. Am. Chem. Soc. **55**, 4281 (1933).
- 

### Appendix Chemical Abstracts Nomenclature (Collective Index Number); (Registry Number)

hexaldehyde acetal

Hexaldehyde

$\alpha$ -hydroxyheptoic acid

$\alpha$ -acetoxyheptoic acid

n-HEXALDEHYDE

[sulfuric acid](#) (7664-93-9)

[hydrochloric acid](#) (7647-01-0)

[ether](#) (60-29-7)

[sodium bicarbonate](#) (144-55-8)

[magnesium turnings](#) (7439-95-4)

[sodium sulfate](#) (7757-82-6)

[formic acid](#) (64-18-6)

[sodium bisulfite](#) (7631-90-5)

thorium oxide

iodine (7553-56-2)

zinc (7440-66-6)

Caproic acid (142-62-1)

Ethyl orthoformate

caproaldehyde

amyl alcohol,  
n-amyl alcohol (71-41-0)

amylene

manganous oxide

calcium formate (544-17-2)

n-amyl bromide (110-53-2)