Organic Syntheses

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). 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.

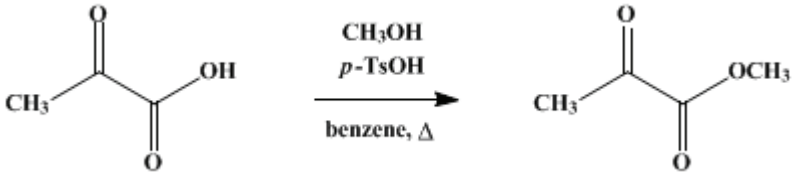
*These paragraphs were added in September 2014. The statements above do not supersede any specific hazard caution notes and safety instructions included in the procedure.*

DOI:10.15227/orgsyn.024.0072

*Organic Syntheses, Coll. Vol. 3, p.610 (1955); Vol. 24, p.72 (1944).*

# METHYL PYRUVATE

## [Pyruvic acid, methyl ester]

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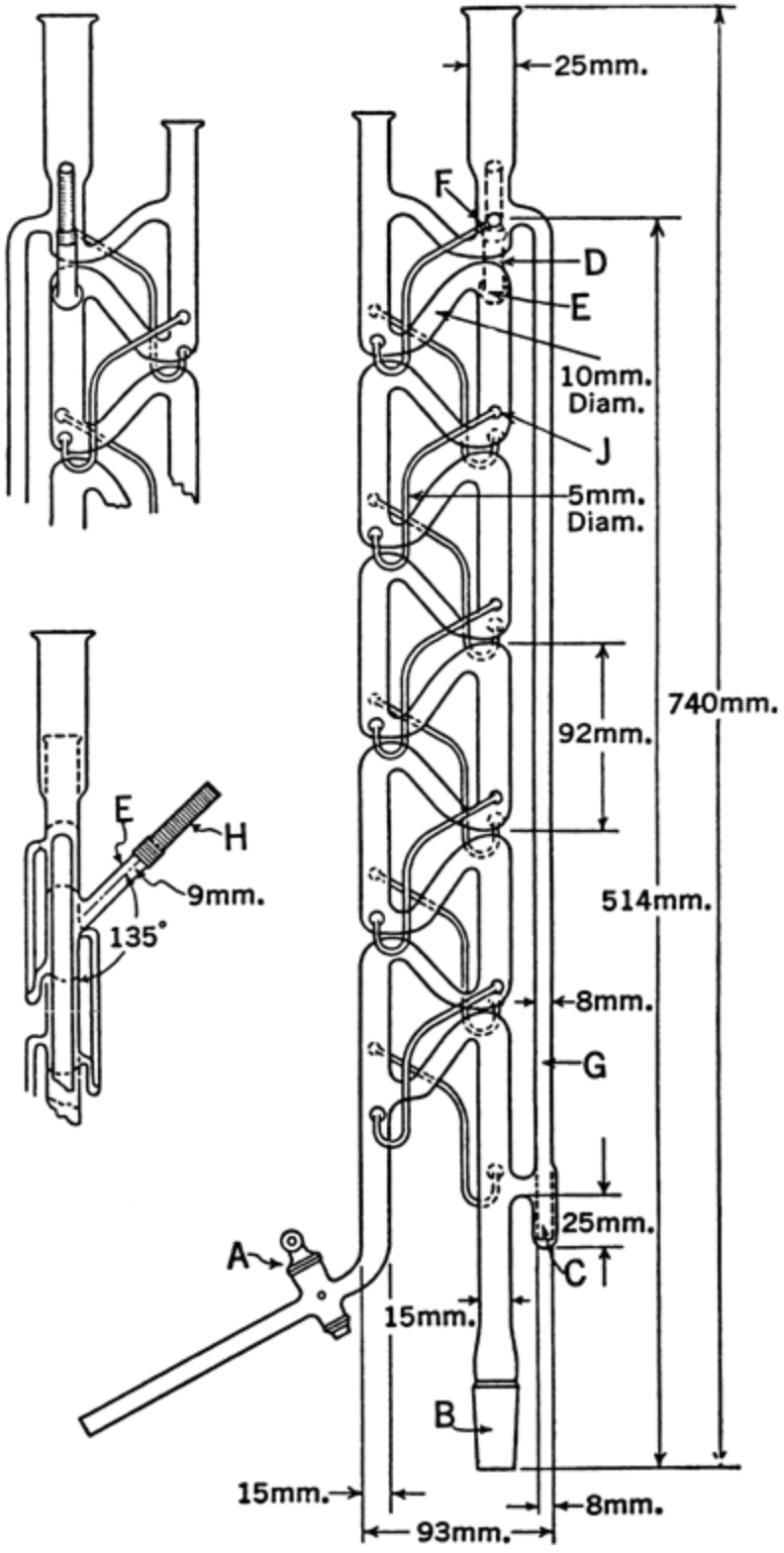
## 1. Procedure

A solution of 88 g. (1 mole) of freshly distilled pyruvic acid,[1] 128 g. (4 moles) of absolute methanol, 350 ml. of benzene, and 0.2 g. of *p*-toluenesulfonic acid is placed in a 1-l. round-bottomed flask connected through a ground-glass joint (Note 1) to a methyl ester column shown in Fig. 20[2] (Note 2). The column is fitted at the top with a cold finger, a thermometer, and an efficient condenser. The solution is refluxed vigorously using an oil bath maintained at 150–155°. The temperature at the top of the column is 59–60°. After refluxing overnight, the liquid in the lower bubbler becomes cloudy and separates into two layers. The lower layer is removed as fast as it is formed (i.e., every 20–30 minutes) throughout the day. Refluxing is continued overnight, and the next morning the lower layer is again removed until cloudiness persists in the upper bubblers (Note 3). The ester is then isolated by fractional distillation of the remaining liquid. The fraction boiling at 136–140° at atmospheric pressure is collected (Note 4). It weighs 66–73 g. (65–71%) (Note 5) and (Note 6).

**Fig. 20.**




## 2. Notes

1. A ground-glass joint is advisable on account of the long reflux period. Benzene attacks a rubber stopper, and pyruvic acid destroys cork.
2. The Clarke-Rahrs methyl ester column[2] is illustrated in Fig. 20. *A* is the stopcock, above which the aqueous phase collects and is drawn off as necessary. *B* is a standard-taper ground joint; *C* is a trap

whose outside diameter is 12 mm. At *D* the space between the consecutive bubblers is shown. *E* is the thermometer tube, set in at an angle of about 45°; it carries a piece of rubber tubing *H* which holds the thermometer. *F* is a solid spot in the top return tube *only*, where that tube has been sealed off; the apparatus will not function without this seal. It should be pointed out that the upper ends of all the return tubes should terminate just above the bends, as shown at *J*; otherwise there will be too great a pressure due to the height of the liquid. The overall length as given is not critical.
3. A total of about 300 ml. of liquid will have separated when cloudiness persists in the fourth and fifth bubblers. The liquid collected separates into two layers on cooling. It contains a trace of pyruvic acid.
4. A tarry residue of 10–17 g. is obtained. If an efficient column is not used in the distillation, the fore-runs will contain 5–10 g. of recoverable ester. The yield given is the total yield.
5. The difficulty in the preparation of methyl pyruvate is caused by the fact that this ester is very easily hydrolyzed and that the ester equilibrium is far on the side of the hydrolysis products.
6. Other methyl esters can be made by this procedure.

## 3. Discussion

Methyl pyruvate has been prepared from the silver salt of pyruvic acid and methyl iodide;[3] from the free acid, by the ethanol-vapor method without a catalyst,[4] by azeotropic removal of the water produced by the reaction of methanol in the presence of *p*-toluenesulfonic acid (the present method), and by refluxing with methanol in ethylene dichloride using ethanesulfonic acid as a catalyst (73% yield).[5] Pyruvic esters have also been prepared by the catalytic dehydrogenation of lactic acid esters[6] and by the oxidation of ethyl lactate with potassium permanganate.[7]

This preparation is referenced from:

- Org. Syn. Coll. Vol. 8, 212

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## References and Notes


1. *Org. Syntheses* Coll. Vol. **1**, 475 (1943).
2. Rahrs, *Synthetic Organic Chemicals*, Vol. XI, No. 1, The Eastman Kodak Company, February, 1938.
3. Oppenheim, *Ber.*, **5**, 1051 (1872).
4. Baker and Laufer, *J. Chem. Soc.*, **1937**, 1345.
5. Clinton and Laskowski, *J. Am. Chem. Soc.*, **70**, 3135 (1948).
6. U. S. pat. 1,614,195 [*C. A.*, **21**, 746 (1927)].
7. *Org. Syntheses*, **31**, 59 (1951).


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

Benzene (71-43-2)

methanol (67-56-1)

potassium permanganate (7722-64-7)

ethylene dichloride (107-06-2)

Methyl iodide (74-88-4)

Pyruvic acid (127-17-3)

ethyl lactate (687-47-8)

Methyl pyruvate,
Pyruvic acid, methyl ester (600-22-6)

ethanesulfonic acid (594-45-6)

p-toluenesulfonic acid (104-15-4)

silver salt of pyruvic acid