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.

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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.

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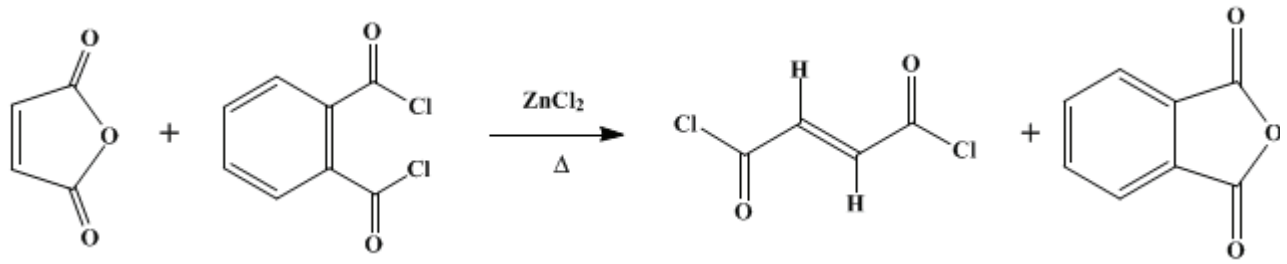
Organic Syntheses, Coll. Vol. 3, p.422 (1955); Vol. 20, p.51 (1940).

FUMARYL CHLORIDE



Submitted by L. P. Kyrides
Checked by C. F. H. Allen and F. P. Pingert.

1. Procedure

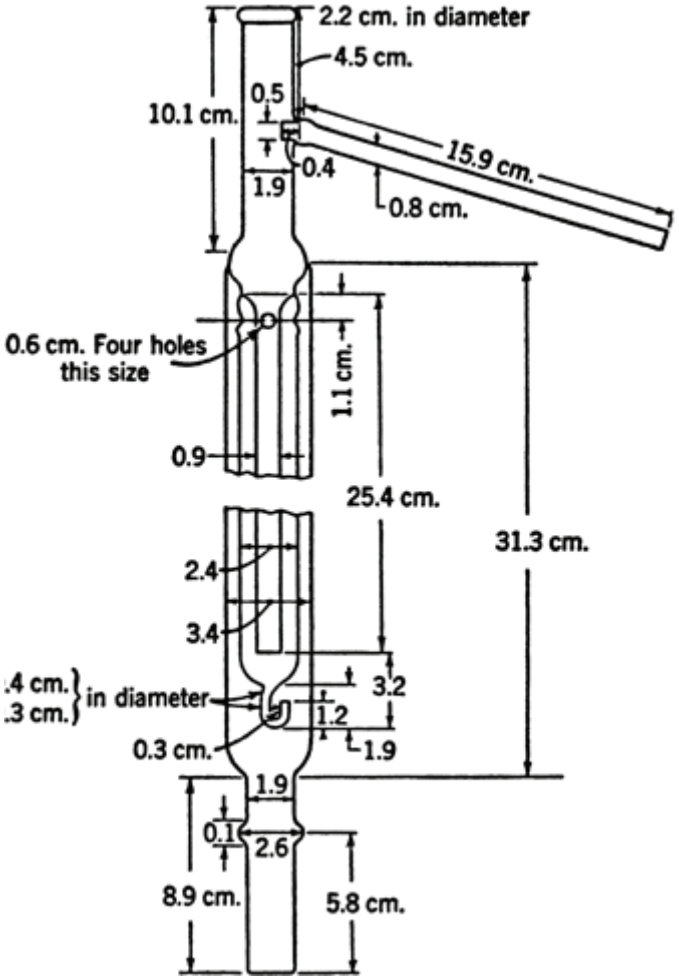
A mixture of 98 g. (1 mole) of maleic anhydride, m.p. 52–54°, 230 g. of commercial phthaloyl chloride (Note 1), and 2 g. of anhydrous zinc chloride is placed in a 500-ml. three-necked round-bottomed flask. The flask is provided with a thermometer, the bulb of which extends into the liquid nearly to the bottom, and an efficient fractionating column (Note 2), (Note 3), and (Note 4). A 500-ml. water-cooled distilling flask is connected to the side arm of the column to serve as a receiving vessel.

The reaction mixture is heated by means of an oil bath (inside temperature 130–135°) for 2 hours, care being taken to avoid overheating (Note 5), and then allowed to cool to 90–95°. The fumaryl chloride is distilled as rapidly as possible (20 minutes), and the portion boiling over a 25° range (60–85°/13–14 mm.) is collected. It is then redistilled slowly (1 hour), and the portion boiling over a 2° range (62–64°/13 mm.) is collected (Note 6). The yield is 125–143 g. (82–95%) (Note 7) and (Note 8).

2. Notes

1. Commercial phthaloyl chloride contains about 94% of halide and some phthalic anhydride. The amount of chloride specified corresponds to a slight molar excess.
2. The checkers employed a modified Widmer column[1] (Fig. 13) that has been used in many organic laboratories, but not officially described. They also used a Vigreux column (50 cm. effective length, 2.7 cm. inside diameter); the first distillation then required 1.5 hours, and the yield was 82–83%. The final temperature of the reaction mixture and observed boiling point will depend upon the type of apparatus used.

Fig. 13.



3. This procedure has also been checked using a fractionating column 30 cm. in length and 1.5 cm. in inside diameter packed with glass Wilson rings[2] and provided with the usual jackets for electrical heating. The distillation requires 3 hours. If this column is used, a single distillation gives a product pure enough for most purposes. An unpacked, indented column of about the same dimensions was unsatisfactory (checked by N. L. Drake).

4. Rubber stoppers are used throughout. Tightly fitting ground-glass connections are convenient but unnecessary. The third neck of the flask is used when acid chlorides are prepared from the corresponding acids (Note 9).

5. Above 135° the reaction is likely to get out of control; the ensuing decomposition seriously reduces the yield. For this reason the flask should be immersed only slightly in the oil bath (about one-third of the depth of the liquid layer).

6. With some lots of phthaloyl chloride, owing to the presence of an unknown impurity, the first few drops of the distillate have a reddish color. If the distillation is interrupted and air admitted to the system, the same phenomenon is observed on resuming the distillation.

7. The yield obtained is usually nearer the higher figure. The checkers carried out this preparation using five times these amounts and a 3-l. flask. The distillation times were 1 hour for the first and 3 hours for the final distillation.

8. Fumaryl chloride is best preserved in sealed glass containers. Bottles, closed by rubber stoppers free from sulfur, can be used for short periods. Ground-glass-stoppered bottles are unsuitable, the joints readily becoming "frozen," owing to hydrolysis of the chloride.

9. According to the submitters, yields of the order of 95% of other acid chlorides can be obtained by the use of phthaloyl chloride (1 mole of chloride to 1 mole of a monobasic acid, 2 moles of chloride to 1 mole of a dibasic acid). Zinc chloride, as catalyst, is not necessary in the reaction of most acids and their anhydrides with phthaloyl chloride. When acids are used, it is best to add one of the components slowly,

in order to avoid a too violent evolution of hydrogen chloride on warming.

3. Discussion

Fumaryl chloride has been prepared from fumaric acid and phthaloyl chloride,[3] from maleic acid by the action of thionyl chloride in the presence of zinc chloride, and from maleic anhydride by the use of phthaloyl chloride in the presence of zinc chloride.[4]

This preparation is referenced from:

- Org. Syn. Coll. Vol. 2, 47
- Org. Syn. Coll. Vol. 3, 248

References and Notes

1. Widmer, *Helv. Chim. Acta*, **7**, 59 (1927).
2. Wilson, Parker, and Laughlin, *J. Am. Chem. Soc.*, **55**, 2795 (1933).
3. Van Dorp and Van Dorp, *Rec. trav. chim.*, **25**, 96 (1906).
4. Kyrides, *J. Am. Chem. Soc.*, **59**, 207 (1937).

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

hydrogen chloride (7647-01-0)

thionyl chloride (7719-09-7)

sulfur (7704-34-9)

phthalic anhydride (85-44-9)

maleic acid (110-16-7)

zinc chloride (7646-85-7)

phthaloyl chloride (88-95-9)

Fumaric acid (110-17-8)

maleic anhydride (108-31-6)

Fumaryl chloride (627-63-4)