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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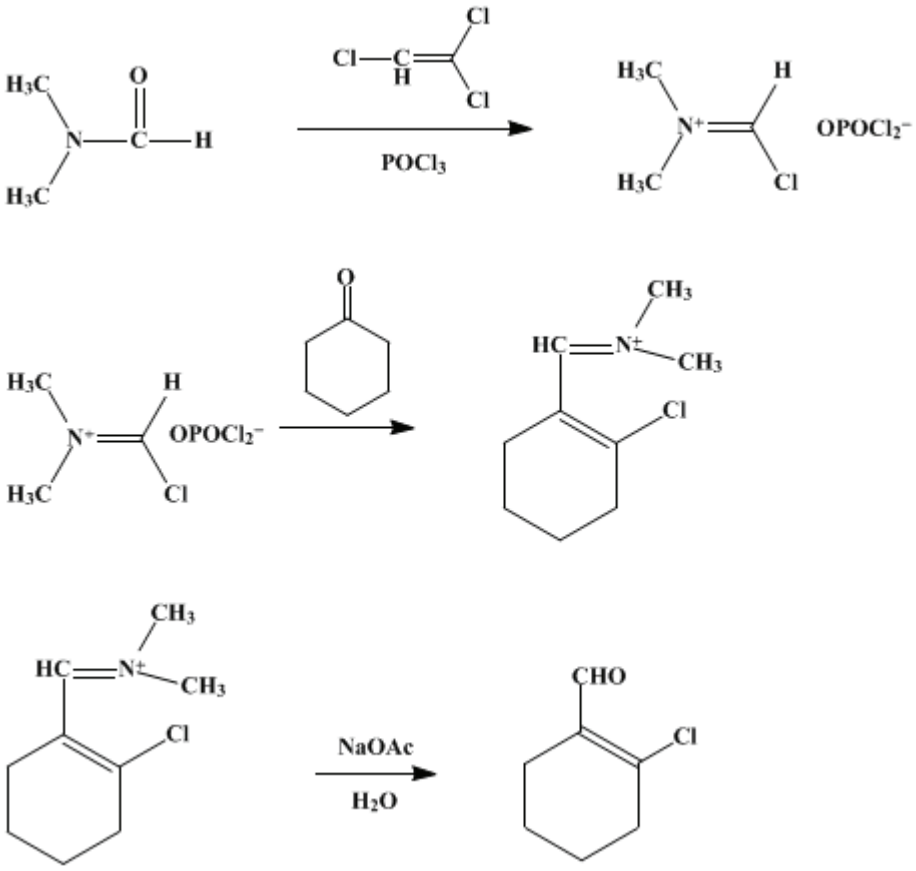
2-CHLORO-1-FORMYL-1-CYCLOHEXENE

[2-Chloro-1-cyclohexenealdehyde]



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1. Procedure

To a 12-l. three-necked flask (Note 1) fitted with a stirrer, thermometer, reflux condenser, dropping funnel, nitrogen inlet, and calcium chloride drying tube are added 310 g. (4.24 moles) of dimethylformamide and 800 ml. of trichloroethylene (Note 2). The stirred solution is cooled to 5° with an external ice bath, and the system is blanketed with nitrogen (Note 3). Phosphorus oxychloride (460 g., 3.0 moles) is added during approximately 1 hour through the dropping funnel, the temperature of the stirred reaction mixture being maintained below 10°. The mixture is then allowed to warm to room temperature.

A solution of 320 g. (3.26 moles) of cyclohexanone in 800 ml. of trichloroethylene is prepared and is added to the stirred reaction mixture at such a rate that the temperature does not rise above 60° (Note 4). When the addition is completed, the mixture is heated at 55–60° for 3 hours.

The solution is cooled to below 35° by use of an ice bath, and a solution of 1.2 kg. of anhydrous sodium acetate in 2.8 l. of water is cautiously added through the dropping funnel (Note 5) and (Note 6). The organic layer is separated and is washed twice with 1.5-l. portions of saturated aqueous salt solutions and once with 1.5 l. of deoxygenated water. The organic solution is dried over anhydrous sodium sulfate.

To the dried solution is added 10 g. of anhydrous sodium acetate. The solvent is evaporated under reduced pressure on a water bath heated to 50–60° (Note 7). The concentrate is distilled under nitrogen through a 14-in. vacuum-jacketed Vigreux column. The distillate is collected in receivers containing 1 g. of anhydrous sodium acetate per 100 ml. of flask capacity (Note 8). There is obtained 230–320 g. (53–74%) of colorless liquid, b.p. 86–88° (10 mm.), n^{20}D 1.5198 (Note 9) and (Note 10).

2. Notes

1. The checkers carried out this procedure using a 5-l. flask and employed five-twelfths of the quantities of reagents specified.
2. Du Pont extraction grade of trichloroethylene was employed throughout the course of this work.
3. A nitrogen atmosphere is maintained over the reaction mixture and the product at all times when possible.
4. Approximately 1.5 hours is required to complete the addition.
5. The temperature is maintained below 35° during this addition, which is of approximately 1-hour duration.
6. The resulting two-phase mixture appears to be stable and may be allowed to stand overnight or for several days at room temperature.
7. The concentrate may be conveniently stored at −45° or below before distillation.
8. The aldehyde is quite unstable and tends to decompose with some violence on standing at room temperature. However, when treated with 1 g. of anhydrous sodium acetate per 100 ml. of distilled product, the compound has remained stable for 2 weeks when stored in this condition at room temperature. It may be stored quite indefinitely in this condition at −45°.
9. Gas chromatography is a convenient method of monitoring the distillation. Early fractions contain trichloroethylene and an unidentified reaction by-product.
10. The product obtained by the checkers was pale yellow in color. The color was not removed by redistillation.

3. Discussion

2-Chloro-1-formyl-1-cyclohexene has been prepared only by the action of phosphorus oxychloride (or phosgene) and dimethylformamide on cyclohexanone.[3,4,5] 2-Bromo-1-formyl-1-cyclohexene has been synthesized by a method analogous to the above by the use of phosphorus oxybromide or phosphorus tribromide.[6]

4. Merits of the Preparation

The described procedure is useful for the conversion of ketones to chloroalkene aldehydes. Methyl ethyl ketone,[3,4] phenyl ethyl ketone,[3,4] cyclobutanone,[7] cyclopentanone,[3,4,5] cycloöctanone,[3,4,5] α-tetralone,[5] and benzosuberone[5] are illustrative of the wide variety of ketones which have been so treated. The yields are reported generally to be 65–80%.

The chlorovinyl aldehydes, although still a relatively new class of compounds, show great promise as useful synthetic intermediates.[5,7,8]

This preparation is referenced from:

- Org. Syn. Coll. Vol. 5, 76

References and Notes

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

sodium acetate (127-09-3)

Cyclohexanone (108-94-1)

sodium sulfate (7757-82-6)

phosphorus tribromide (7789-60-8)

nitrogen (7727-37-9)

Phosphorus Oxychloride (21295-50-1)

phosgene (75-44-5)

Cyclopentanone (120-92-3)

phosphorus oxybromide

phenyl ethyl ketone (93-55-0)

methyl ethyl ketone (78-93-3)

α-Tetralone (529-34-0)

dimethylformamide (68-12-2)

trichloroethylene (79-01-6)

Cyclooctanone (502-49-8)

2-Chloro-1-formyl-1-cyclohexene,
2-Chloro-1-cyclohexenealdehyde (1680-73-5)

2-Bromo-1-formyl-1-cyclohexene

Cyclobutanone (1191-95-3)

benzosuberone (826-73-3)