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.

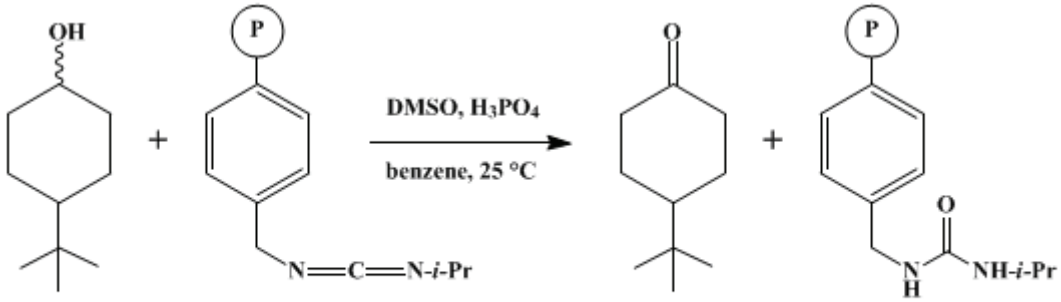
These paragraphs were added in September 2014. The statements above do not supersede any specific hazard caution notes and safety instructions included in the procedure.

DOI:10.15227/orgsyn.056.0099

Organic Syntheses, Coll. Vol. 6, p.218 (1988); Vol. 56, p.99 (1977).

POLYMERIC CARBODIIMIDE. MOFFAT OXIDATION: 4-*tert*-BUTYLCYCLOHEXANONE

[Cyclohexanone, 4-(1,1-dimethylethyl)-]



Submitted by Ned M. Weinshenker[1], Chah M. Shen, and Jack Y. Wong.
Checked by A. Fukuzawa and S. Masamune.

1. Procedure

Caution! Benzene has been identified as a carcinogen; OSHA has issued emergency standards on its use. All procedures involving benzene should be carried out in a well-ventilated hood, and glove protection is required

A 250-ml., three-necked, round-bottomed flask equipped with a mechanical stirrer, a gas-inlet, and a stopper is charged with 540 mg. (0.00346 mole) of a mixture of *cis*- and *trans*-4-*tert*-butylcyclohexanols (Note 1), 50 ml. of anhydrous benzene (Note 2), and 25 ml. of anhydrous dimethyl sulfoxide (Note 3). While a slight positive pressure of argon is maintained in the system, 13.19 g. of carbodiimide resin (Note 4) is added, followed by 0.2 ml. of dimethyl sulfoxide (Note 3) containing 98 mg. (0.0010 mole) of anhydrous orthophosphoric acid (Note 5). The resulting mixture is stirred at room temperature for 3.5 days. The beads are then separated by filtration and washed with three 100-ml. portions of diethyl ether, and the combined filtrates are washed with five 100-ml. portions of water. After evaporation of the organic phase to dryness, the residue crystallizes, providing 446–450 mg. (83–84%) of crude 4-*tert*-butylcyclohexanone, m.p. 42–45° (Note 6). The deactivated carbodiimide resin can be regenerated by treatment with triethylamine and 4-toluenesulfonyl chloride (Note 4).

2. Notes

1. This mixture is available from Aldrich Chemical Company, Inc. The checkers used a 7:93 mixture of the *cis*- and *trans*-isomers, prepared by lithium aluminum hydride reduction of 4-*tert*-butylcyclohexanone and recrystallization of the crude product. The ketone was purchased from Aldrich Chemical Company, Inc.
2. Benzene was dried by distillation from sodium.
3. The submitters dried dimethyl sulfoxide over Linde-type 3A molecular sieves. The checkers distilled this reagent from calcium hydride at 10 mm. prior to use.
4. The amount of resin used contains about 0.012 mole of active carbodiimide. Methods for preparing this reagent, determining its carbodiimide content, and regenerating spent resin are described in *Org. Synth.*, **Coll. Vol. 6**, 951 (1988).
5. Anhydrous orthophosphoric acid was prepared according to the equation: $P_2O_5 + 3H_2O \rightarrow 2H_3PO_4$

The submitters added 5.88 ml. of 85% phosphoric acid to 3.98 g. of phosphorous pentoxide and heated the mixture for 15 minutes or until all of the solid had dissolved. The checkers placed 71.0 g. of phosphorous pentoxide in a flask, cooled it in ice, and cautiously added 27 ml. of water.
6. IR($CHCl_3$) $cm.^{-1}$: 1712 (C=O). GC analysis (10% Carbowax 20M, 3 mm. by 1.8 m., 180°) showed the crude product to be 97% pure. 4-*tert*-Butylcyclohexanone has been reported to melt at 49.5–51°.[2]

3. Discussion

The general procedure described here was originally published by the submitters.[3] Both ketones and aldehydes may be prepared, and this method is particularly effective when the mild conditions of the Moffat oxidation are required, but the dicyclohexylurea by-product formed with the usual reagents causes purification problems.

This preparation is referenced from:

- Org. Syn. Coll. Vol. 6, 951

References and Notes

1. Dynapol, 1454 Page Mill Road, Palo Alto, California 94304.
2. E. L. Eliel and M. N. Rerick, *J. Am. Chem. Soc.*, **82**, 1367 (1960).
3. N. M. Weinshenker and C. M. Shen, *Tetrahedron Lett.*, 3285 (1972).

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

phosphorous pentoxide

cis- and trans-4-tert-butylcyclohexanols

Benzene (71-43-2)

diethyl ether (60-29-7)

sodium (13966-32-0)

phosphoric acid,
orthophosphoric acid (7664-38-2)

lithium aluminum hydride (16853-85-3)

dimethyl sulfoxide (67-68-5)

triethylamine (121-44-8)

argon (7440-37-1)

calcium hydride (7789-78-8)

dicyclohexylurea (2387-23-7)

carbodiimide

Cyclohexanone, 4-(1,1-dimethylethyl)-,
4-tert-Butylcyclohexanone (98-53-3)

4-toluenesulfonyl chloride (98-59-9)