



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.

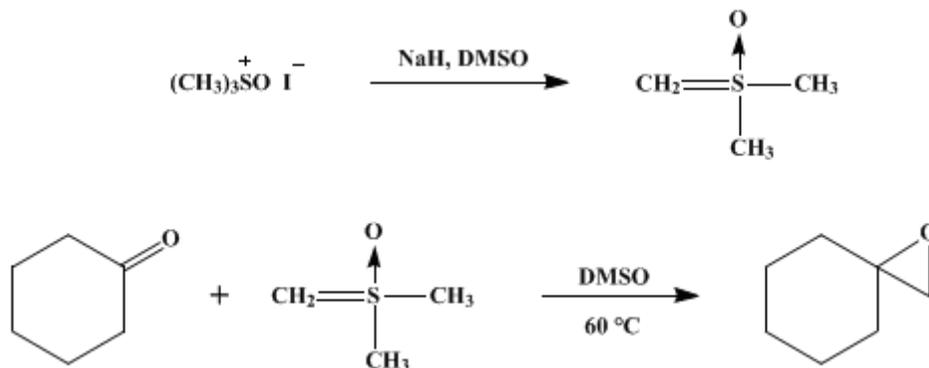
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*These paragraphs were added in September 2014. The statements above do not supersede any specific hazard caution notes and safety instructions included in the procedure.*

*Organic Syntheses, Coll. Vol. 5, p.755 (1973); Vol. 49, p.78 (1969).*

## METHYLENECYCLOHEXANE OXIDE

[Octane, 1-oxaspiro[2.5]-]



Submitted by E. J. Corey<sup>1</sup> and Michael Chaykovsky<sup>2</sup>.  
 Checked by William Washburn and Ronald Breslow.

### 1. Procedure

A. *Dimethyloxosulfonium methylide* (Note 1). In a 500-ml., three-necked, round-bottomed flask with a magnetic stirrer (Note 2) are placed 8.8 g. (0.22 mole) of sodium hydride (60% oil dispersion) (Note 3) and 150 ml. of petroleum ether (30–60°). The suspension is stirred, the hydride allowed to settle, the petroleum ether decanted (Note 4), and 250 ml. of dry dimethyl sulfoxide (Note 5) is added. The flask is immediately fitted with an inlet and outlet for nitrogen and a piece of Gooch tubing connected to a 125-ml. Erlenmeyer flask containing 50.6 g. (0.23 mole) of trimethyloxosulfonium iodide (Note 6). A gentle stream of dry nitrogen is then continuously passed through the system. With stirring, the oxosulfonium iodide is added, in portions, over a period of 15 minutes (Note 7) and stirring is then continued for an additional 30 minutes (Note 8).

B. *Methylenecyclohexane oxide*. The Gooch tubing is removed from the reaction flask and immediately replaced with a sealed, pressure-compensated dropping funnel containing 19.6 g. (0.2 mole) of cyclohexanone (Note 9), which is then added to the reaction mixture over a 5-minute period. After stirring for 15 minutes, the reaction mixture is heated to 55–60° for 30 minutes with an oil bath and then poured into 500 ml. of cold water and extracted with three 100-ml. portions of ether. The combined ether extracts are washed with 100 ml. of water, then with 50 ml. of saturated aqueous salt solution, dried over anhydrous sodium sulfate, and the ether is distilled at atmospheric pressure through a 20-cm. Vigreux column. The almost colorless residue is transferred to a 50-ml. round-bottomed flask and distilled under reduced pressure through a 5-cm. Vigreux column to yield 15–17 g. (67–76%) of the oxide as a colorless liquid, b.p. 61–62° (39 mm.);  $n_D^{25}$  1.4485 (Note 10). The n.m.r. spectrum ( $\text{CDCl}_3$ ;  $(\text{CH}_3)_4\text{Si}$  internal standard) showed a band at  $\delta$  1.58 (10H) and a sharp singlet at  $\delta$  2.53 (2H).

### 2. Notes

1. The reaction should be carried out in a well-ventilated hood because hydrogen is evolved.
2. The submitters used a mechanical stirrer, but the checkers found that the more convenient magnetic stirrer works as well.
3. The submitters used Alfa Inorganics Inc. sodium hydride dispersion.
4. The petroleum ether removes most of the oil from the hydride dispersion.
5. Matheson, Coleman and Bell anhydrous dimethyl sulfoxide was stirred over powdered calcium hydride overnight and then distilled under reduced pressure, b.p. 64–65° (4 mm.). Dimethyl sulfoxide should not be distilled at temperatures above 90° since at these higher temperatures appreciable disproportionation occurs producing dimethyl sulfone and dimethyl sulfide, the latter of which

contaminates the distilled solvent.

6. [Trimethyloxosulfonium iodide](#) was purchased from Aldrich Chemical Co. and was recrystallized from water, crushed, and dried in a desiccator over [phosphorus pentoxide](#) before use. The salt may be prepared by reaction of [dimethyl sulfoxide](#) with excess [methyl iodide](#).<sup>3</sup>

7. The reaction is only mildly exothermic. No cooling is necessary.

8. After this time the evolution of [hydrogen](#) is essentially complete.

9. Eastman Kodak white label [cyclohexanone](#) was used without further purification.

10. Reported physical constants are b.p. 62–63° (37 mm.),  $n_D^{20}$  1.4470;<sup>4</sup> b.p. 66–68° (50 mm.)  $n_D^{20}$  1.4506.<sup>5</sup>

### 3. Discussion

[Methylenecyclohexane oxide](#) has been prepared by the oxidation of [methylenecyclohexane](#) with [benzointrile-hydrogen peroxide](#) or with [peracetic acid](#);<sup>5</sup> by treatment of [1-chlorocyclohexylmethanol](#) with aqueous [potassium hydroxide](#);<sup>6</sup> and by the reaction of [dimethylsulfonium methylide](#) with [cyclohexanone](#).<sup>7</sup>

This reaction illustrates a general method for the conversion of ketones and aldehydes<sup>8</sup> into oxiranes using the methylene-transfer reagent [dimethyloxosulfonium methylide](#). The yields of oxiranes are usually high, and the crude products, in most cases, are of sufficient purity to be used in subsequent reactions (*e.g.*, rearrangement to aldehydes) without further purification.

This preparation is referenced from:

- [Org. Syn. Coll. Vol. 5, 751](#)

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### References and Notes

1. Department of Chemistry, Harvard University, Cambridge, Massachusetts.
2. Chemical Research Laboratories, Hoffman-La Roche Inc., Nutley, New Jersey.
3. R. Kuhn and H. Trischmann, *Ann.*, **611**, 117 (1958).
4. J. S. Traynham and O. S. Pascual, *Tetrahedron*, **7**, 165 (1959).
5. G. B. Payne, *Tetrahedron*, **18**, 763 (1962).
6. M. Tiffeneau, P. Weill, and B. Tchoubar, *Compt. Rend.*, **205**, 144 (1937).
7. V. Franzen and H. E. Driesen, *Ber.*, **96**, 1881 (1963).
8. E. J. Corey and M. Chaykovsky, *J. Am. Chem. Soc.*, **87**, 1353 (1965).

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### Appendix

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

petroleum ether

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

[hydrogen](#) (1333-74-0)

[benzointrile](#) (100-47-0)

[Cyclohexanone](#) (108-94-1)

sodium sulfate (7757-82-6)  
nitrogen (7727-37-9)  
potassium hydroxide (1310-58-3)  
hydrogen peroxide (7722-84-1)  
Methyl iodide (74-88-4)  
dimethyl sulfide (75-18-3)  
peracetic acid (79-21-0)  
sodium hydride (7646-69-7)  
dimethyl sulfoxide (67-68-5)  
calcium hydride (7789-78-8)  
Methylenecyclohexane (1192-37-6)  
dimethylsulfonium methylide  
Methylenecyclohexane oxide,  
Octane, 1-oxaspiro[2.5]- (185-70-6)  
trimethyloxosulfonium iodide (1774-47-6)  
dimethyl sulfone (67-71-0)  
1-chlorocyclohexylmethanol  
dimethyloxosulfonium methylide  
phosphorus pentoxide (1314-56-3)