



A Publication
of Reliable Methods
for the Preparation
of Organic Compounds

Working with Hazardous Chemicals

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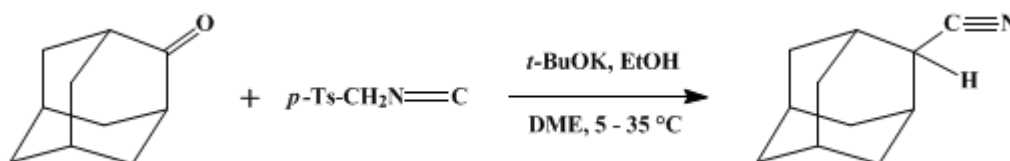
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These paragraphs were added in September 2014. The statements above do not supersede any specific hazard caution notes and safety instructions included in the procedure.

Organic Syntheses, Coll. Vol. 6, p.41 (1988); Vol. 57, p.8 (1977).

2-ADAMANTANECARBONITRILE

[Tricyclo[3.3.1.1^{3,7}]decane-2-carbonitrile]



Submitted by O. H. Oldenzil, J. Wildeman, and A. M. van Leusen¹.

Checked by Teresa Y. L. Chan and S. Masamune.

1. Procedure

A 500-ml., three-necked, round-bottomed flask equipped with a mechanical stirrer, a thermometer, and a calcium chloride drying tube is charged with 15.0 g. (0.100 mole) of **adamantanone** (Tricyclo[3.3.1.1^{3,7}]decan-2-one), (Note 1), 25.4 g. (0.130 mole) of *p*-tolylsulfonylmethyl isocyanide (Note 2), (Note 3), 10 ml. (0.17 mole) of absolute **ethanol** (Note 4), and 350 ml. of **1,2-dimethoxyethane** (Note 5). The stirred solution is cooled in an ice bath to 5°, and 28 g. (0.25 mole) of **potassium *tert*-butoxide** is added in portions at such a rate that the temperature is kept between 5° and 10° (Note 6)(Note 7). After the addition is complete, the ice bath is removed and stirring is continued for 30 minutes. The reaction mixture is heated for 30 minutes at 35–40°, the stirred suspension is cooled to room temperature, and the precipitated **potassium *p*-toluenesulfinate** is removed by filtration. The precipitate is extracted with three 50-ml. portions of **1,2-dimethoxyethane**, and the combined **1,2-dimethoxyethane** solutions are concentrated to a volume of 25–35 ml. on a rotary evaporator. The concentrated solution is chromatographed (Note 8) through a short column of alumina using distilled petroleum ether (b.p. 40–60°) as the eluent. The combined fractions are refluxed for 15 minutes with 1 g. of activated **carbon** (Note 9). After removal of the **carbon**, the solution is concentrated to dryness in a rotary evaporator. The white solid residue is dried overnight in a vacuum desiccator over silica gel, yielding 13.5–14.5 g. (84–90%) of analytically pure **2-adamantanecarbonitrile**, m.p. 170–177° (Note 10).

2. Notes

1. Commercial **adamantanone** (Aldrich Chemical Company, Inc.) was used; the synthesis of **adamantanone** is described in *Org. Synth.*, **Coll. Vol. 6**, 48 (1988).
2. The synthesis of *p*-tolylsulfonylmethyl isocyanide is described in *Org. Synth.*, **Coll. Vol. 6**, 987 (1988).² The light-brown compound, m.p. 111–114°, was used without further purification.
3. *p*-Tolylsulfonylmethylisocyanide was used in slight excess to effect complete conversion of the **adamantanone**, which otherwise is difficult to remove from the final product.
4. Commercial absolute **ethanol** was used.
5. Commercial **1,2-dimethoxyethane**, "zur Synthese" quality, was purchased from E. Merck, Darmstadt.
6. Scoops of solid **potassium *tert*-butoxide** (purchased from E. Merck, Darmstadt, and specified to be at least 95% pure) were added over 20–30 minutes by temporarily removing the drying tube. At the beginning of the reaction much heat is evolved; therefore, the base should be added in small portions in order to keep the temperature below 10°. During the addition of the base, a precipitate is formed.
7. The reaction has also been carried out successfully with **sodium ethoxide**.³
8. The submitters recommend using a 5 cm. by 10 cm. column packed with 200 g. of neutral alumina (activity I) in petroleum ether (b.p. 40–60°), and eluting with 250-ml. of this solvent. The checkers have found that the elution may require more solvent depending on the amount of residual **1,2-dimethoxyethane**: they recommend following the chromatography by GC analysis (see (Note 9)).
9. Treatment with activated **carbon** (purchased from J. T. Baker Chemical Company) can be omitted. In that case, removal of the solvent will provide 14–15 g. (87–93%) of a near-white product with a melting range of 160–180° (see (Note 10)). Despite this wide range, this material is over 99.8% pure, according to a GC analysis carried out at 190° on a 2-m. SE-30 column. This high degree of purity was confirmed

on three different types of column.

10. Melting points of 2-adamantanecarbonitrile were determined in sealed tubes to prevent sublimation. Varying values were found for the melting point which apparently is not a very reliable indication of the purity of this compound. Occasionally, a value as high as 184–187° has been found by following the same procedure. Spectral properties of this product: IR (CHCl₃) cm.⁻¹: 2240 (CN); ¹H NMR (CDCl₃), δ (multiplicity, number of protons): 1.4–2.4 (m, 14H), 2.9 (m, 1H).

3. Discussion

The procedure described is an example of a more general synthetic method for the direct conversion of ketones into cyanides.^{3,4,5,6} The reaction has been carried out successfully with acyclic and cyclic aliphatic ketones, including numerous steroidal ketones and aryl-alkyl ketones. The conversion of diaryl or highly hindered ketones such as camphor and β,β-dimethyl-α-tetralone requires the use of a more polar solvent. In those cases, the dimethoxyethane used in the present procedure should be replaced by dimethyl sulfoxide.⁶ By introduction of a slight modification, the method applies to aldehydes also.⁷

2-Adamantanecarbonitrile was prepared previously by a more laborious method,⁸ also starting from adamantanone, in 46% overall yield.

The hydrolysis of 2-adamantanecarbonitrile with hydrogen bromide in acetic acid provides a useful route to 2-adamantanecarboxylic acid (m.p. 143–144°),⁹ which the submitters obtained in 95% yield. Stetter and Tillmans⁸ reported a yield of 62% starting with impure 2-adamantanecarbonitrile.

This preparation is referenced from:

- Org. Syn. Coll. Vol. 6, 334
- Org. Syn. Coll. Vol. 6, 987

References and Notes

1. Department of Organic Chemistry, Groningen University, Nijenborgh 16, 9747 RG Groningen, The Netherlands.
 2. A. M. van Leusen, G. J. M. Boerma, R. B. Helmholdt, H. Siderius, and J. Strating, *Tetrahedron Lett.*, 2367 (1972); A. M. van Leusen, R. J. Bouma, and O. Possel, *Tetrahedron Lett.*, 3487 (1975).
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 6. O. H. Oldenzien, D. van Leusen, and A. M. van Leusen, *J. Org. Chem.*, **42**, 3114 (1977).
 7. A. M. van Leusen and P. G. Oomkes, *Synth. Commun.*, **10**, 399 (1980).
 8. H. Stetter and V. Tillmans, *Chem. Ber.*, **105**, 735 (1972).
 9. For other syntheses, see A. H. Alberts, H. Wynberg, and J. Strating, *Synth. Commun.*, **2**, 79 (1972) and D. Farcasiu, *Synthesis*, 615 (1972).
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Appendix

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

silica gel

petroleum ether

ethanol (64-17-5)

acetic acid (64-19-7)

hydrogen bromide (10035-10-6)

carbon (7782-42-5)

sodium ethoxide (141-52-6)

camphor (21368-68-3)

dimethyl sulfoxide (67-68-5)

1,2-dimethoxyethane (110-71-4)

dimethoxyethane (534-15-6)

2-ADAMANTANECARBONITRILE,
Tricyclo[3.3.1.1^{3,7}]decane-2-carbonitrile (35856-00-9)

Adamantanone,
Tricyclo[3.3.1.1^{3,7}]decan-2-one (700-58-3)

β,β -dimethyl- α -tetralone

2-adamantanecarboxylic acid (15897-81-1)

p-Tolylsulfonylmethyl isocyanide,
p-Tolylsulfonylmethylisocyanide (36635-61-7)

potassium tert-butoxide (865-47-4)

potassium p-toluenesulfinate