



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.

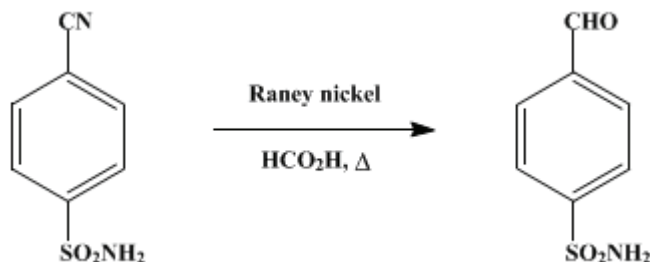
The procedures described in *Organic Syntheses* are provided as published and are conducted at one's own risk. *Organic Syntheses, Inc.*, its Editors, and its Board of Directors do not warrant or guarantee the safety of individuals using these procedures and hereby disclaim any liability for any injuries 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.

Organic Syntheses, Coll. Vol. 6, p.631 (1988); Vol. 51, p.20 (1971).

ALDEHYDES FROM AROMATIC NITRILES: 4-FORMYLBENZENESULFONAMIDE

[Benzenesulfonamide, 4-formyl-]



Submitted by T. van Es and B. Staskun¹.

Checked by A. Brossi, L. A. Dolan, and A. Laurenzano.

1. Procedure

A 2-l., two-necked, round-bottomed flask fitted with a mechanical stirrer and a reflux condenser is charged with 40.0 g. (0.232 mole) of 4-cyanobenzenesulfonamide (Note 1), 600 ml. of 75% (v/v) formic acid, and 40 g. of Raney nickel alloy (Note 2). The stirred mixture is heated under reflux for 1 hour (Note 3). The mixture is filtered with suction through a Büchner funnel coated with a filter aid (Note 4), and the residue is washed with two 160-ml. portions of 95% ethanol. The combined filtrates are evaporated with a rotary evaporator (Note 5). The solid residue (Note 6) is dissolved in 400 ml. of boiling water and freed from a small amount of insoluble material by decantation through a plug of glass wool placed in a filter funnel. The filtrate is chilled in an ice bath, and the precipitate is collected by filtration with suction, washed with a small amount of cold water, and dried at 50° under vacuum, yielding about 32 g. of crude product, m.p. 112–114°.

The product is dissolved in 800 ml. of hot 95% ethanol, 15.5 g. of activated carbon (Note 7) is added, and the mixture is swirled periodically while it is allowed to cool for 1 hour. The activated carbon is removed by filtration with suction through a bed of filter aid (Note 4), the filter cake is washed with 50 ml. of 95% ethanol, and the combined filtrates are evaporated with a rotary evaporator. The residue is dissolved in 225 ml. of boiling water, and the hot solution is decanted through glass wool placed in a filter funnel. The filtrate is cooled to 0°, the product is collected by filtration with suction, washed with a small amount of cold water, and dried in a vacuum oven at 50°, yielding 25.6–28.0 g. (62.9–68.8%) of 4-formylbenzenesulfonamide, m.p. 117–118° (Note 8).

2. Notes

1. The checkers used 4-cyanobenzenesulfonamide purchased from Aldrich Chemical Company, Inc., m.p. 167–169°. The submitters prepared this material by diazotization of the corresponding amine,² followed by cyanation.³ The product was crystallized from water, m.p. 152–154°.

2. The checkers used material purchased from Harshaw Chemical Company. The submitters used nickel–aluminum alloy (50% Ni, 50% Al) supplied by British Drug Houses Ltd.

3. The reaction proceeds with some frothing; this is more appreciable and vigorous in mixtures containing a higher proportion of water, as when the reduction is conducted in 50% formic acid.⁴

4. Hyflo Supercel, a filter aid purchased from Johns-Manville Corporation, was used by the checkers.

5. This procedure is to be avoided with steam-volatile aldehydes (e.g., 4-chlorobenzaldehyde), in which case the reduction product is isolated by solvent extraction.⁴

6. The product is contaminated with nickel salts; its IR spectrum showed little, if any, unchanged nitrile.

7. Norite A, purchased from Matheson, Coleman and Bell, was used.

8. The melting point of 4-formylbenzenesulfonamide has been reported as 118–120°,^{4,5} 122°,⁶ and 123–

3. Discussion

4-Formylbenzenesulfonamide has been prepared by chromic acid oxidation of *p*-toluenesulfonamide,⁵ the Sommelet reaction on 4-chloromethylbenzenesulfonamide,⁸ and by the Stephen reduction of 4-cyanobenzenesulfonamide.⁵ The present method provides a general procedure for the synthesis of substituted aromatic aldehydes as illustrated in Table I.

TABLE I
ALDEHYDES FROM AROMATIC NITRILES⁴

Nitrile	Aldehyde	Yield, % ^a
C ₆ H ₅ CN	C ₆ H ₅ CHO	97
4-ClC ₆ H ₄ CN	4-ClC ₆ H ₄ CHO	100
4-CH ₃ OC ₆ H ₄ CN	4-CH ₃ OC ₆ H ₄ CHO	93
2-C ₁₀ H ₇ CN	2-C ₁₀ H ₇ CHO	95

^a Determined as the 2,4-dinitrophenylhydrazone derivative.

Some studies seeking preferred conditions for this reaction have been made. Optimum yields are obtained when the amount of water present is appreciable, and it was noted that the rate of hydrogen evolution increases with increasing water content. A 75% formic acid system appears to be generally preferred. Under the reaction conditions examined by the submitters, olefins, ketones, esters, amides, and acids are inert, but nitro compounds are reduced to the formamide derivative.

A related method for the synthesis of aldehydes from nitriles has also been studied.⁹ This method, which has been found to be extremely effective for the reduction of hindered nitriles to aldehydes, uses moist, preformed Raney nickel catalyst in formic acid. Compounds synthesized by this method are illustrated in Table II.

TABLE II
ALDEHYDES FROM NITRILES WITH RANEY NICKEL
CATALYST IN FORMIC ACID⁹

Nitrile	Aldehyde	Yield, % ^a
C ₆ H ₅ CN	C ₆ H ₅ CHO	72
2-CH ₃ C ₆ H ₄ CN	2-CH ₃ C ₆ H ₄ CHO	65–75
2-ClC ₆ H ₄ CN	2-ClC ₆ H ₄ CHO	70–83
2-CH ₃ OC ₆ H ₄ CN	2-CH ₃ OC ₆ H ₄ CHO	80
2,6-(CH ₃ O) ₂ C ₆ H ₃ CN	2,6-(CH ₃ O) ₂ C ₆ H ₃ CHO	60–65
C ₆ H ₅ CH=CHCN	C ₆ H ₅ CH=CHCHO	64

^a Determined as the 2,4-dinitrophenylhydrazone derivative.

References and Notes

1. Department of Chemistry, University of the Witwatersrand, Johannesburg, South Africa.
2. C. H. Andrewes, H. King and J. Walker, *Proc. R. Soc. London, Ser. B*, **133**, 20 (1946).
3. R. C. Iris, R. D. Leyva, and C. Ramirez, *Rev. Inst. Salubr. Enferm. Trop. Mexico City*, **7**, 95 (1946) [*Chem. Abstr.* **41**, 4117g (1947)].
4. T. van Es and B. Staskun, *J. Chem. Soc.*, 5775 (1965).

5. H. Burtod P. F. Hu, *J. Chem. Soc.*, 601 (1948).
 6. S. Koizuka and K. Ichiriki, Japan. Pat. 180,234 (1949) [*Chem. Abstr.*, **46**, 5085e (1952)].
 7. T. P. Sycheva and M. N. Shchukina, *Sb. Statei Obshch. Khim.*, **1**, 527 (1953) [*Chem. Abstr.*, **49**, 932c (1955)].
 8. S. J. Angyal, P. J. Morris, J. R. Tetaz, J. G. Wilson, *J. Chem. Soc.* 2141 (1950).
 9. B. Staskun and O. G. Backeberg, *J. Chem. Soc.*, 5880 (1964).
-

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

Raney nickel alloy

ethanol (64-17-5)

hydrogen (1333-74-0)

formic acid (64-18-6)

aluminum (7429-90-5)

nickel,
Raney nickel (7440-02-0)

carbon,
activated carbon (7782-42-5)

chromic acid (7738-94-5)

4-Formylbenzenesulfonamide,
Benzenesulfonamide, 4-formyl- (3240-35-5)

4-cyanobenzenesulfonamide

4-chlorobenzaldehyde (104-88-1)

4-chloromethylbenzenesulfonamide

p-toluenesulfonamide (70-55-3)