



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.

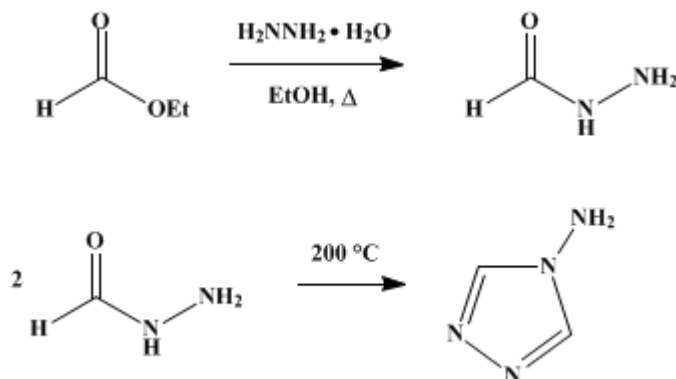
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These paragraphs were added in September 2014. The statements above do not supersede any specific hazard caution notes and safety instructions included in the procedure.

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4-AMINO-4H-1,2,4-TRIAZOLE

[4H-1,2,4-Triazole, 4-amino-]



Submitted by C. F. H. Allen and Alan Bell.

Checked by W. E. Bachmann and G. Dana Johnson.

1. Procedure

In a 1-l. round-bottomed flask equipped with an efficient water condenser are placed 148 g. (2 moles) of **ethyl formate** (b.p. 52–53°) and 150 ml. of 95% **ethanol**. One hundred and twenty grams (2 moles) of 85% **hydrazine hydrate** is added cautiously to this solution (**Note 1**) with shaking over a period of 10 minutes. After the reaction has subsided, the solution is refluxed on a steam bath for 18 hours. The bulk of the water and **ethanol** is now removed by evaporation under reduced pressure until the volume in the flask is about 150 ml. The resulting syrup, crude **formylhydrazide**, is heated under atmospheric pressure for 3 hours, during which time the temperature of the bath is raised from 150° to 200°. After cooling to about 100°, the oil is taken up in 50 ml. of 95% **ethanol**, and 5 g. of **Norite** is added. The filtered solution is then diluted with 75 ml. of **ether** and placed in an icebox to cool. The crystalline product is filtered, washed with 50 ml. of 1:2 **ethanol-ether**, and dried. The yield of **aminotriazole**, melting at 77–78°, is 55–60 g. (65–71%) (**Note 2**). If a purer product is desired, the crude, washed material may be recrystallized, using 2 ml. of warm 95% **ethanol** per gram of compound followed by the addition of 2.5 ml. of **ether**, and chilling. The melting point of the purified product is 81–82°.

The residual amine in the filtrate may be isolated in the form of the hydrochloride. The combined solutions are evaporated on a steam bath, 50 ml. of concentrated **hydrochloric acid** is added, and heating is continued for 2 hours. On cooling, the syrupy solution crystallizes. It is triturated with 50 ml. of **ethanol**, and the **4-amino-1,2,4-triazole hydrochloride** is filtered, washed with a little **ethanol**, and dried. The yield of the hydrochloride is 10–18 g. (8–15%); the salt melts at 147–148° and may be recrystallized from 95% **ethanol**, using 10 ml. per gram; the melting point is thus raised to 151–152°.

2. Notes

1. The reaction is very vigorous, but if the **hydrazine hydrate** is added carefully no difficulty of control is encountered.
2. The combined yield of base and hydrochloride is always about 80–81%. When the amount of base is low, that of the hydrochloride is high.

3. Discussion

4-Amino-1,2,4-triazole has been obtained from orthoformic ester and **hydrazine hydrate** in a sealed tube at 120°;¹ by heating **formylhydrazide** at 150–210°;^{2,3,4} by heating **N,N'-diformylhydrazine** at 160°;⁵

by decarboxylation of 4-amino-1,2,4-triazoldicarboxylic acid;⁶ by fusion of 1,2-dihydro-1,2,4,5-tetrazine;⁶ and by heating 1,2-dihydro-1,2,4,5-tetrazinedicarboxylic acid above its melting point.^{4,6,7}

A process in which hydrazine and carbon monoxide are heated under pressure has been patented.⁸

References and Notes

1. Stolle, *J. prakt. Chem.*, (2) **68**, 467 (1903).
 2. Ruhemann and Stapleton, *J. Chem. Soc.*, **75**, 1132 (1899).
 3. Ruhemann and Merriman, *J. Chem. Soc.*, **87**, 1772 (1905).
 4. Hantzsch and Silberrad, *Ber.*, **33**, 85 (1900).
 5. Pellizzari, *Atti accad. Lincei*, (5) **8** (I), 331 (*Chem. Zentr.*, **1899**, I, 1240); *Gazz. chim. ital.*, **39** (I), 530 (1909).
 6. Curtius, Darapsky, and Müller, *Ber.*, **40**, 835, 1194 (1907).
 7. Curtius and Lang, *J. prakt. Chem.*, (2) **38**, 549 (1888).
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Appendix

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

ethanol (64-17-5)

hydrochloric acid (7647-01-0)

ether (60-29-7)

carbon monoxide (630-08-0)

Norite (7782-42-5)

hydrazine hydrate (7803-57-8)

ethyl formate (109-94-4)

hydrazine (302-01-2)

4-Amino-4H-1,2,4-triazole,
4H-1,2,4-Triazole, 4-amino-,
4-Amino-1,2,4-triazole (584-13-4)

formhydrazide,
formylhydrazine (624-84-0)

aminotriazole

4-amino-1,2,4-triazole hydrochloride

4-amino-1,2,4-triazoldicarboxylic acid

1,2-dihydro-1,2,4,5-tetrazine

1,2-dihydro-1,2,4,5-tetrazinedicarboxylic acid (3787-09-5)

N,N'-diformylhydrazine