



Standard Guide for Understanding Cyanide Species¹

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1. Scope*

1.1 This guide defines guidance based on a consensus of viewpoints for interpretation of test results to identify various chemical forms of cyanide. It is intended to provide a general understanding of the chemical nature of distinct cyanide species as related to chemical analysis and environmental fate and transport.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

2. Referenced Documents

2.1 ASTM Standards:²

D1129 Terminology Relating to Water

D1426 Test Methods for Ammonia Nitrogen In Water

D3590 Test Methods for Total Kjeldahl Nitrogen in Water

D6888 Test Method for Available Cyanide with Ligand Displacement and Flow Injection Analysis (FIA) Utilizing Gas Diffusion Separation and Amperometric Detection

D7237 Test Method for Free Cyanide and Aquatic Free Cyanide with Flow Injection Analysis (FIA) Utilizing Gas Diffusion Separation and Amperometric Detection

3. Terminology

3.1 *Definitions*—For a definition of terms used in this guide, refer to Terminology **D1129**.

4. Significance and Use

4.1 This guide provides standard terminology for use in identifying and describing the different chemical forms of cyanide. The complex nature of cyanide chemistry, existence of numerous distinct chemical forms as well as the various regulatory distinctions that may be made can lead to confusion in technical discussions on cyanide and in the selection of

appropriate methods for its analysis. This guide is intended to provide clarification and a common framework of terms and definitions to facilitate discussions and referencing different cyanide chemical species and groups of cyanide compounds.

4.2 The use of such common terminology is particularly important from an environmental perspective because certain forms of cyanide are considered to be toxic. Therefore, their release into the environment is regulated by federal and state agencies. Thus a general understanding of cyanide chemistry and species definitions is needed for proper wastewater management and testing.

5. Cyanide Species Terms and Definitions

5.1 Chemistry Related Terms and Definitions:

5.1.1 *Cyanide Ion*—The term used to describe a negatively charged ion comprised of one carbon atom and one nitrogen atom triply bonded to each other ($\text{C}\equiv\text{N}^-$). The cyanide ion is reactive and readily forms neutral compounds or anionic complexes with most metals.

5.1.2 *Free Cyanide*—The form of cyanide that is bioavailable and known for its toxic effect on organisms (**1**).³ Free cyanide refers to the sum of molecular hydrogen cyanide (HCN) and cyanide ion (CN^-). Hydrogen cyanide is a colorless, poisonous gas having an odor of bitter almonds (mp = -13.4°C , bp = 25.6°C). It is readily soluble in water existing as HCN or CN^- , or both, depending on the pH conditions ($\text{pK}_a = 9.36$). At a pH of 7 or less in water, free cyanide is present entirely as HCN; the opposite is true at pH 11 or greater. Because of its toxicity, free cyanide is regulated in environmental wastewater discharges.

5.1.2.1 In Test Method **D7237**, sum of the free cyanide (HCN and CN^-) and cyanide bound in the metal-cyanide complexes that are easily dissociated into free cyanide under the test conditions described in Test Method **D7237** at pH 6 and room temperature.

5.1.3 *Aquatic Free Cyanide*—In Test Method **D7237**, free cyanide measured when the buffer or temperature is adjusted to mimic the receiving water environment.

5.1.4 *Simple Cyanide*—A neutral compound comprised of an alkali metal, alkaline earth metal or ammonium cation

¹ This guide is under the jurisdiction of ASTM Committee **D19** on Water and is the direct responsibility of Subcommittee **D19.06** on Methods for Analysis for Organic Substances in Water.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ The boldface numbers in parentheses refer to a list of references at the end of this standard.