

CHAPTER 4. CHEMICAL AND PHYSICAL INFORMATION

4.1 CHEMICAL IDENTITY

Beryllium is a naturally occurring element found in earth's rocks at levels of 1–15 mg/kg. It appears in Group IIA of the periodic table and the most common oxidation state is Be(+2), although an oxidation state of (0) has been observed in certain compounds. Because of its high reactivity, beryllium is not found as the free metal in nature. There are approximately 45 mineralized forms of beryllium. The important beryllium minerals in the world are beryl ($3\text{BeOAl}_2\text{O}_3 \cdot 6\text{SiO}_2$) and bertrandite ($\text{Be}_4\text{Si}_2\text{O}_7(\text{OH})_2$). Beryl has been known since ancient times as the gemstones: emerald (green), aquamarine (light blue), and beryl (yellow). Beryllium, like other metals, can form organometallic complexes. Table 4-1 lists common synonyms, trade names, and other pertinent identification information for beryllium and its compounds.

Table 4-1. Chemical Identity of Beryllium and Beryllium Compounds^a

Characteristic	Beryllium	Beryllium chloride	Beryllium fluoride
Synonym(s) and registered trade name(s)	Beryllium-9; glucinium; glucinum; beryllium metallic	Beryllium dichloride	Beryllium difluoride
Chemical formula	Be	BeCl_2	BeF_2
CAS Registry Number	7440-41-7	7787-47-5 ^d	7787-49-7
Characteristic	Beryllium hydroxide	Beryllium oxide	Beryllium phosphate ($3\text{H}_2\text{O}$)
Synonym(s) and registered trade name(s)	Beryllium hydrate; beryllium dihydroxide	Beryllia; beryllium monoxide; Thermalox 995	Beryllium orthophosphate
Chemical formula	$\text{Be}(\text{OH})_2$	BeO	$\text{Be}_3(\text{PO}_4)_2 \cdot 3\text{H}_2\text{O}$
CAS Registry Number	13327-32-7	13044-56-9	35089-00-0 ^b
Characteristic	Beryllium nitrate	Beryllium sulfate	Beryllium carbonate (basic)
Synonym(s) and registered trade name(s)	Nitric acid, beryllium salt	Sulfuric acid, beryllium salt	Basic beryllium carbonate; bis[carbonato(2-)]dihydroxy triberyllium
Chemical formula	$\text{Be}(\text{NO}_3)_2$	BeSO_4	$\text{Be}_3(\text{OH})_2(\text{CO}_3)_2$ ^c

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Table 4-1. Chemical Identity of Beryllium and Beryllium Compounds^a

Characteristic	Beryllium nitrite	Beryllium sulfate	Beryllium carbonate (basic)
CAS Registry Number	13597-99-4 (anhydrous) 7787-55-5 (trihydrate) 13510-48-0 (tetrahydrate)	13510-49-1 (anhydrous) 7787-56-6 (tetrahydrate)	66104-24-3 ^b

^aAll information from NLM (2023a, 2023b, 2023c, 2023d, 2023e, 2023f, 2023g, 2023h, 2023i) except where noted.

^bEPA 2019

^cLide 2005

CAS = Chemical Abstracts Service

4.2 PHYSICAL AND CHEMICAL PROPERTIES

Beryllium is a solid at room temperature and atmospheric pressure. It is part of the metal family and consistent with the high charge-to-radius ratio, beryllium has a strong tendency to form compounds via covalent bonds, even compounds with the most electronegative elements (e.g., BeF₂). Its properties are characterized as stiffer than steel and lighter than aluminum; these make it attractive for aerospace and military parts and beryllium alloy applications such as in aircrafts and cell phones. No data are available on the vapor pressure of beryllium or its compounds as it is too low to be measured. Although beryllium belongs to Group IIA of the periodic table, it is chemically very similar to aluminum, which also has a high charge-to-radius ratio. Like aluminum, the hydroxide of beryllium can act as either a base or acid (Cotton and Wilkinson 1980; EPA 1978, 1998). The interaction of cosmic-ray particles in the atmosphere produces a number of radionuclides including beryllium-7 (Be-7) and beryllium-10 (Be-10). The radioactive half-life of Be-7 is 53.29 days, and the radioactive half-life of Be-10 is 1.51x10⁶ years (UNSCEAR 2000). Table 4-2 lists important physical and chemical properties of beryllium and its compounds.

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Table 4-2. Physical and Chemical Properties of Beryllium and Beryllium Compounds^a

Property	Beryllium metal	Beryllium chloride	Beryllium fluoride	Beryllium hydroxide	Beryllium oxide
Molecular weight	9.012	79.918	47.01	43.027	25.011
Color	Gray	White-yellow	White	White	White
Physical state	Solid; hexagonal crystals ^b	Orthorhombic crystals or needles	Glassy hygroscopic mass	Powder	Amorphous powder or hexagonal crystals
Melting point	1,287°C	415°C	555°C	138°C (decomposes)	2,578°C
Boiling point	2,468°C	482°C	1,283°C	Not applicable	3,787°C
Density	1.85 g/cm ^{3b}	1.90 g/cm ³	2.1 g/cm ³	1.92 g/cm ³	3.01 g/cm ³
Taste	No data	Sweet ^b	No data	No data	No data
Odor	Odorless	Sharp, acrid ^b	Odorless	None	Odorless
Odor threshold:	Not applicable	No data	Not applicable	Not applicable	Not applicable
Solubility:					
Water	Insoluble	71.5 g/100 mL water at 25°C	Very soluble	Very slightly soluble	2 µg/100 mL
Organic solvent(s)	No data	Soluble in ethanol, ethyl ether, pyridine	Slightly soluble in ethanol, more soluble in mixture of alcohol and ether	No data	No data
Inorganic solvent(s)	Soluble in acid and alkaline solutions ^b	No data	No data	Soluble in hot concentrated acid and alkali	Soluble in concentrated acids
Partition coefficients:					
Log K _{ow}	No data	No data	No data	No data	No data
Log K _{oc}	No data	No data	No data	No data	No data
Vapor pressure at 20°C	No data	No data	No data	No data	No data
Henry's law constant at 25°C	No data	No data	No data	No data	No data
Degradation half-life in air via reaction with OH radicals	No data	No data	No data	No data	No data
Dissociation constants:					
pK _{a,1}	No data	No data	No data	No data	No data
pK _{a,2}	No data	No data	No data	No data	No data
Autoignition temperature	No data	No data	No data	No data	No data
Flashpoint	No data	No data	No data	No data	No data
Flammability limits in air	No data	No data	No data	No data	No data
Conversion factors ^b	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Explosive limits	No data	No data	No data	No data	No data

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Table 4-2. Physical and Chemical Properties of Beryllium and Beryllium Compounds^a

Property	Beryllium phosphate	Beryllium nitrate	Beryllium carbonate (basic)	Beryllium sulfate	Beryllium sulfate (tetrahydrate)
Molecular weight	104.991	133.02	181.069 ^c	105.07	177.13
Color	White	White	White-yellow ^c	Colorless	Colorless
Physical state	Solid	Crystals	Powder ^c	Tetragonal crystals	Tetragonal crystals
Melting point	100°C (decomposes)	60°C	No data	550–600°C (decomposes)	100°C (loses 2H ₂ O) 400°C (loses 4H ₂ O)
Boiling point	No data	142°C (decomposes)	No data	No data	No data
Density	No data	1.557 g/cm ³	No data	2.443 g/cm ³	1.713 g/cm ³
Taste	No data	No data	No data	No data	No data
Odor	None	None	None	None	None
Odor threshold	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Solubility:					
Water	Slightly soluble ^e	Soluble	Insoluble (cold) Decomposes (hot)	Insoluble	41.3 g/ 100 mL ^c
Organic solvent(s)	Soluble in acetic acid	Soluble in alcohol	No data	No data	No data
Inorganic solvent(s)	No data	No data	Acid, alkali	No data	No data
Partition coefficients:					
Log K _{ow}	No data	No data	No data	No data	No data
Log K _{oc}	No data	No data	No data	No data	No data
Vapor pressure at 20°C	No data	No data	No data	No data	No data
Henry's law constant at 25°C	No data	No data	No data	No data	No data
Degradation half-life in air via reaction with OH radicals	No data	No data	No data	No data	No data
Dissociation constants:					
pK _{a,1}	No data	No data	No data	No data	No data
pK _{a,2}	No data	No data	No data	No data	No data
Autoignition temperature	No data	No data	No data	No data	No data
Flashpoint	No data	No data	No data	No data	No data
Flammability limits in air	No data	No data	No data	No data	No data
Conversion factors ^b	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable

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Table 4-2. Physical and Chemical Properties of Beryllium and Beryllium Compounds^a

Property	Beryllium phosphate	Beryllium nitrate	Beryllium carbonate (basic)	Beryllium sulfate	Beryllium sulfate (tetrahydrate)
Explosive limits	No data	No data	No data	No data	No data

^aAll information from NLM (2023a, 2023b, 2023c, 2023d, 2023e, 2023f, 2023g, 2023h, 2023i) except where noted.

^bThese compounds do not exist in the atmosphere in the vapor phase; therefore, an air conversion factor is not applicable.

^cLide 2005.