Manganese

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Manganese is a chemical element with symbol **Mn** and atomic number 25. It is not found as a free element in nature; it is often found in minerals in combination with iron. Manganese is a metal with important industrial metal alloy uses, particularly in stainless steels.

Historically, manganese is named for various black minerals (such as pyrolusite) from the same region of Magnesia in Greece which gave names to similar-sounding magnesium, Mg, and magnetite, an ore of the element iron, Fe. By the mid-18th century, Swedish chemist Carl Wilhelm Scheele had used pyrolusite to produce chlorine. Scheele and others were aware that pyrolusite (now known to be manganese dioxide) contained a new element, but they were unable to isolate it. Johan Gottlieb Gahn was the first to isolate an impure sample of manganese metal in 1774, which he did by reducing the dioxide with carbon.

Manganese phosphating is used for rust and corrosion prevention on steel. Ionized manganese is used industrially as pigments of various colors, which depend on the oxidation state of the ions. The permanganates of alkali and alkaline earth metals are powerful oxidizers. Manganese dioxide is used as the cathode (electron acceptor) material in zinc-carbon and alkaline batteries.

In biology, manganese(II) ions function as cofactors for a large variety of enzymes with many functions.[2] Manganese enzymes are particularly essential in detoxification of superoxide free radicals in organisms that must deal with elemental oxygen. Manganese also functions in the oxygen-evolving complex of photosynthetic plants. The element is a required trace mineral for all known living organisms but is a neurotoxin. In larger amounts, and apparently with far greater effectiveness through inhalation, it can cause a poisoning in mammals with neurological damage that is sometimes irreversible.

Characteristics

Physical properties

Manganese, $_{25}$Mn

General properties	
Name, symbol	manganese, Mn
Appearance	silvery metallic
Manganese in the periodic table	
Atomic number (Z)	25
Group, block	group 7, d-block
Period	period 4
Element category	□ transition metal
Standard atomic weight (±) (A_r)	54.938044(3)[1]
Electron configuration	[Ar] $3d^5\ 4s^2$
per shell	2, 8, 13, 2
Physical properties	
Phase	solid
Melting point	1519 K (1246 °C, 2275 °F)

Electrolytically refined manganese chips and 1 cm^3 cube

Manganese is a silvery-gray metal that resembles iron. It is hard and very brittle, difficult to fuse, but easy to oxidize.[3] Manganese metal and its common ions are paramagnetic.[4] Manganese tarnishes slowly in air and oxidizes ("rusts") like iron in water containing dissolved oxygen.

Isotopes

Naturally occurring manganese is composed of one stable isotope, ^{55}Mn. Eighteen radioisotopes have been isolated and described, the most stable being ^{53}Mn with a half-life of 3.7 million years, ^{54}Mn with a half-life of 312.3 days, and ^{52}Mn with a half-life of 5.591 days. All of the remaining radioactive isotopes have half-lives of less than three hours, and the majority of less than one minute.

Manganese also has three meta states.[5] Manganese is part of the iron group of elements, which are thought to be synthesized in large stars shortly before the supernova explosion. ^{53}Mn decays to ^{53}Cr with a half-life of 3.7 million years. Because of its relatively short half-life, ^{53}Mn is relatively rare, produced by cosmic rays impact on iron.[6] Manganese isotopic contents are typically combined with chromium isotopic contents and have found application in isotope geology and radiometric dating. Mn–Cr isotopic ratios reinforce the evidence from ^{26}Al and ^{107}Pd for the early history of the solar system. Variations in $^{53}Cr/^{52}Cr$ and Mn/Cr ratios from several meteorites suggest an initial $^{53}Mn/^{55}Mn$ ratio, which indicates that Mn–Cr isotopic composition must result from *in situ* decay of ^{53}Mn in differentiated planetary bodies. Hence, ^{53}Mn provides additional evidence for nucleosynthetic processes immediately before coalescence of the solar system.[5] The isotopes of manganese range in atomic weight from 46 u (^{46}Mn) to 65 u (^{65}Mn). The primary decay mode before the most abundant stable isotope, ^{55}Mn, is electron capture and the primary mode after is beta decay.[5]

Boiling point	2334 K (2061 °C, 3742 °F)
Density near r.t.	7.21 g/cm^3
when liquid, at m.p.	5.95 g/cm^3
Heat of fusion	12.91 kJ/mol
Heat of vaporization	221 kJ/mol
Molar heat capacity	26.32 J/(mol·K)

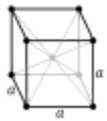
Vapor pressure

P (Pa)	**1**	**10**	**100**	**1 k**	**10 k**	**100 k**
at T (K)	1228	1347	1493	1691	1955	2333

Atomic properties

Oxidation states	**7**, 6, 5, **4**, 3, **2**, 1, −1, −2, −3 acidic, basic or amphoteric; depending on the oxidation state
Electronegativity	Pauling scale: 1.55
Ionization energies	1st: 717.3 kJ/mol 2nd: 1509.0 kJ/mol 3rd: 3248 kJ/mol (more)
Atomic radius	empirical: 127 pm
Covalent radius	Low spin: 139±5 pm High spin: 161±8 pm

Miscellanea

Crystal structure	body-centered cubic (bcc) 
Speed of sound thin rod	5150 m/s (at 20 °C)
Thermal	21.7 µm/(m·K) (at 25 °C)

Chemical properties

Manganese(II) chloride crystals – the pale pink color of Mn(II) salts is due to a spin-forbidden 3d transition.[7]

The most common oxidation states of manganese are +2, +3, +4, +6, and +7, though all oxidation states from −3 to +7 have been observed. Mn^{2+} often competes with Mg^{2+} in biological systems. Manganese compounds where manganese is in oxidation state +7, which are restricted to the unstable oxide Mn_2O_7 and compounds of the intensely purple permanganate anion MnO_4^-, are powerful oxidizing agents.[3] Compounds with oxidation states +5 (blue) and +6 (green) are strong oxidizing agents and are vulnerable to disproportionation.

The most stable oxidation state for manganese is +2, which has a pale pink color, and many manganese(II) compounds are known, such as manganese(II) sulfate ($MnSO_4$) and manganese(II) chloride ($MnCl_2$). This oxidation state is also seen in the mineral rhodochrosite (manganese(II) carbonate). Manganese(II) most commonly exists with a high spin, S = 5/2 ground state because of the high pairing energy for manganese(II). However, there are a few examples of low-spin, S =1/2 manganese(II).[8][8] There are no spin-allowed d–d transitions in manganese(II), explaining why manganese(II) compounds are typically pale to colorless.[9]

The +3 oxidation state is known in compounds like manganese(III) acetate, but these are quite powerful oxidizing agents and also prone to disproportionation in solution, forming manganese(II) and manganese(IV). Solid compounds of manganese(III) are characterized by its strong purple-red color and a preference for distorted octahedral coordination resulting from the Jahn-Teller effect.

expansion	
Thermal conductivity	7.81 W/(m·K)
Electrical resistivity	1.44 µΩ·m (at 20 °C)
Magnetic ordering	paramagnetic
Young's modulus	198 GPa
Bulk modulus	120 GPa
Mohs hardness	6.0
Brinell hardness	196 MPa
CAS Number	7439-96-5
	History
Discovery	Torbern Olof Bergman (1770)
First isolation	Johann Gottlieb Gahn (1774)

Most stable isotopes of manganese

iso	NA	half-life	DM	DE (MeV)	DP
^{52}Mn	syn	5.591 d	ε	–	^{52}Cr
			β^+	0.575	^{52}Cr
			γ	0.7, 0.9, 1.4	–
^{53}Mn	trace	3.74×10^6 y	ε	–	^{53}Cr
^{54}Mn	syn	312.3 d	ε	1.377	^{54}Cr
			γ	0.834	–
^{55}Mn	100%	is stable with 30 neutrons			

The oxidation state 5+ can be produced by dissolving manganese dioxide in molten sodium nitrite.[11] Manganate (VI) salts can be produced by dissolving Mn compounds, such as manganese dioxide, in molten alkali while exposed to air. Permanganate (+7 oxidation state) compounds are purple, and can give glass a violet color. Potassium permanganate, sodium permanganate, and barium permanganate are all potent oxidizers. Potassium permanganate, also called Condy's crystals, is a commonly used

laboratory reagent because of its oxidizing properties; it is used as a topical medicine (for example, in the treatment of fish diseases). Solutions of potassium permanganate were among the first stains and fixatives to be used in the preparation of biological cells and tissues for electron microscopy.[12]

Source

- Wikipedia: Manganese (https://en.wikipedia.org/wiki/Manganese)