

4. CHEMICAL, PHYSICAL, and RADIOLOGICAL INFORMATION

4.1 CHEMICAL IDENTITY

Information regarding the chemical identity of cesium is located in Table 4-1.

4.2 PHYSICAL, CHEMICAL, AND RADIOLOGICAL PROPERTIES

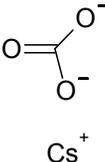
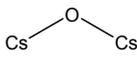
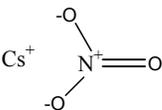
Information regarding the physical and chemical properties of cesium is located in Table 4-2.

Cesium is a silvery white, soft, ductile metal with only one oxidation state (+1). At slightly above room temperature, cesium exists in the liquid state. Compared to the other stable alkali metals, cesium has the lowest boiling point and melting point, highest vapor pressure, highest density, and lowest ionization potential. These properties make cesium far more reactive than the other members of the alkali metal group. When exposed to air, cesium metal ignites, producing a reddish violet flame, and forms a mixture of cesium oxides. Pure cesium reacts violently with water to form cesium hydroxide, the strongest base known, as well as hydrogen gas. The burning cesium can ignite the liberated hydrogen gas and produce an explosion. Cesium salts and most cesium compounds are generally very water soluble, with the exception of cesium alkyl and aryl compounds, which have low water solubility.

There are several radioactive isotopes of cesium ranging from ^{114}Cs to ^{145}Cs (Helmers 1996). The radioactive isotopes have a wide range of half-lives ranging from about 0.57 seconds (^{114}Cs) to about 3×10^6 years (^{135}Cs) (Helmers 1996). The radioactive isotopes ^{137}Cs and ^{134}Cs are significant fission products because of their high fission yield, and their relatively long half-lives. The fission yield of ^{137}Cs in nuclear reactions is relatively high; about 6 atoms of ^{137}Cs are produced per 100 fission events (WHO 1983). ^{137}Cs has a radioactive half-life of about 30 years and decays by beta decay either to stable ^{137}Ba or a meta-stable form of barium ($^{137\text{m}}\text{Ba}$). The meta-stable isotope ($^{137\text{m}}\text{Ba}$) is rapidly converted to stable ^{137}Ba (half-life of about 2 minutes) accompanied by gamma ray emission whose energy is 0.662 MeV (ICRP 1983). Figure 4-1 illustrates this decay scheme. The first beta decay mode that forms $^{137\text{m}}\text{Ba}$ accounts for roughly 95% of the total intensity, while the second mode accounts for about 5% (WHO 1983). Radioactive ^{134}Cs primarily decays to stable ^{134}Ba by beta decay accompanied by gamma ray emissions or less frequently to stable ^{134}Xe by electron capture (EC) accompanied by a single gamma ray

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Table 4-1. Chemical Identity of Cesium and Compounds

Characteristic	Cesium (metal)	Cesium chloride	Cesium carbonate	Cesium hydroxide	Cesium oxide	Cesium nitrate
Synonym(s)	Caesium	Cesium monochloride	Dicesium salt	Cesium hydrate		
Registered trade name(s)	No data	No data	No data	No data	No data	No data
Chemical formula	Cs	CsCl	Cs ₂ CO ₃	CsOH	Cs ₂ O	CsNO ₃
Chemical structure	Cs	Cs—Cl	 Cs ⁺	Cs—OH		 Cs ⁺
Identification numbers:						
CAS registry	7440-46-2	7647-17-8	534-17-8	21351-79-1	20281-00-9	7789-18-6
NIOSH RTECS	FK9225000	FK9625000	FK9400000	FK9800000	No data	
EPA hazardous waste	No data	No data	No data	No data	No data	No data
OHM/TADS	No data	No data	No data	No data	No data	No data
DOT/UN/NA/IMCO shipping	No data	No data	No data	No data	No data	No data
HSDB	No data	No data	No data	No data	No data	No data
NCI	No data	No data	No data	No data	No data	No data

CAS = Chemical Abstracts Services; DOT/UN/NA/IMCO = Department of Transportation/United Nations/North America/International Maritime Dangerous Goods Code; EPA = Environmental Protection Agency; HSDB = Hazardous Substances Data Bank; NCI = National Cancer Institute; NIOSH = National Institute for Occupational Safety and Health; OHM/TADS = Oil and Hazardous Materials/Technical Assistance Data System; RTECS = Registry of Toxic Effects of Chemical Substances

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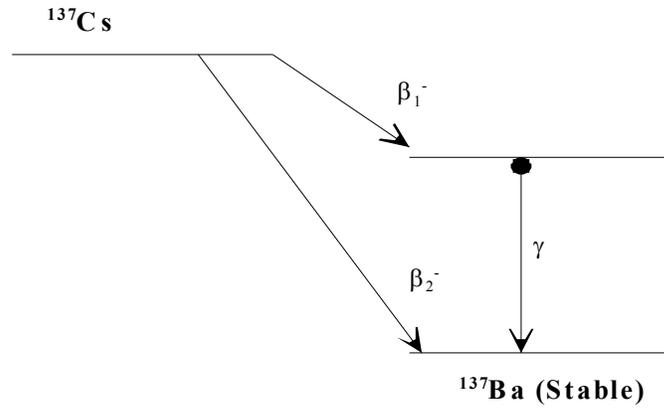
Table 4-2. Physical and Chemical Properties of Cesium and Compounds

Property	Cesium (metal)	Cesium chloride	Cesium carbonate	Cesium hydroxide	Cesium oxide	Cesium nitrate
Molecular weight	132.906	168.36	325.82	149.91	281.81	194.91 ^b
Color	Silvery-white	White	White	Colorless	Golden-yellow	White ^b
Physical state	Solid (liquid slightly above room temperature)	Solid	Solid	Solid	Solid	Solid ^b
Melting point	29 °C	646 °C	610 °C	272 °C	490 °C	414 °C ^b
Boiling point	685 °C	1290 °C	No data	No data	No data	No Data
Density, g/cm ³	1.93 (20 °C) ^b	3.988 (20 °C) ^b	4.24 (20 °C) ^b	3.68 (20 °C) ^b	4.65 (20 °C) ^b	3.66 (20 °C) ^b
Odor	No data	No data	No data	No data	No data	No data
Odor threshold:						
Water	No data	No data	No data	No data	No data	No data
Air	No data	No data	No data	No data	No data	No data
Solubility:						
Water	Reacts violently with water	1.87 kg/L (20 °C)	2.1 kg/L	4 kg/L (15 °C)	Very soluble in water ^b	Soluble ^b
Organic-solvent(s)		Soluble in ethanol ^b	Soluble in ethanol and ether ^b	Soluble in ethanol ^b		
Partition coefficients:						
Log K _{ow}	N/A	N/A	N/A	N/A	N/A	N/A
Log K _{oc}	N/A	N/A	N/A	N/A	N/A	N/A
Vapor pressure	0.0075 mmHg at 144.5 °C	No data	No data	No data	No data	No data
Henry's Law constant	N/A	N/A	N/A	N/A	N/A	N/A
Autoignition temperature	No data	No data	No data	No data	No data	No data
Flashpoint	No data	No data	No data	No data	No data	No data
Flammability limits	No data	No data	No data	No data	No data	No data
Conversion factors	No data	No data	No data	No data	No data	No data
Explosive limits	No data	No data	No data	No data	No data	No data

^aData from Burt 1993 unless otherwise specified.^bLide 1998

N/A = not applicable

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Figure 4-1. The Decay Scheme of ^{137}Cs 

β = beta decay; γ = γ -ray emission

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emission as depicted in Figure 4-2. The energy of the various gamma rays are in the range of 0.24–1.4 MeV. The half-life average energy of the beta transitions and intensity of the transitions for both ^{134}Cs and ^{137}Cs are summarized in Table 4-3.

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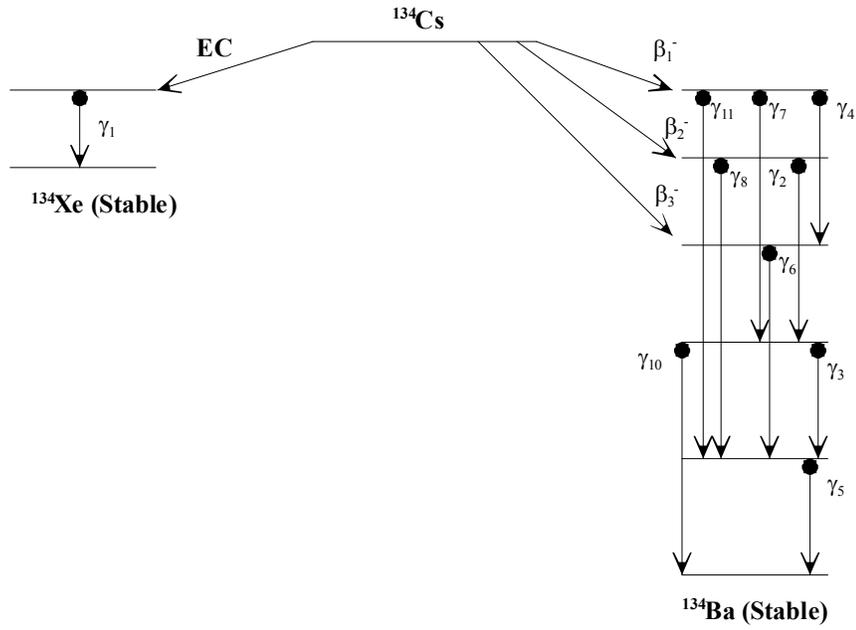
Table 4-3. Decay Properties of the Radioactive Isotopes of Cesium

Isotope	Half-life (years)	Decay mode	Intensity percent	Beta particle energy (MeV)
¹³⁴ Cs	2.062	β_1^-	27	0.02309
		β_2^-	2.5	0.1234
		β_3^-	70	0.2101
¹³⁷ Cs	30	β_1^-	94.6	0.1734
		β_2^-	5.4	0.4246

^aICRP 1983^bThe ¹³⁴Xe daughter yield from the electron capture decay of ¹³⁴Cs is approximately 3x10⁻⁶.

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Figure 4-2. The Decay Scheme of ^{134}Cs



EC = electron capture; β = beta decay; γ = gamma-ray emission