

3. CHEMICAL AND PHYSICAL INFORMATION

3.1 CHEMICAL IDENTITY

The chemical formula and identification numbers for radon are listed in Table 3-1.

3.2 PHYSICAL AND CHEMICAL PROPERTIES

Important physical and chemical properties of radon are listed in Table 3-2. The radioactive properties of the important, short-lived daughters of radon-222 are listed in Table 3-3. The radon-222 decay series is depicted in Figure 3-1.

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TABLE 3-1. Chemical Identity of Radon

	Value	Reference
Chemical name	Radon	Windholz 1983
Isotopes	Radon-222 (Radon) Radon-220 (Thoron) Radon-219 (Actinon)	Cothorn 1987a
Trade name	No data	
Chemical formula	Rn	
Chemical structure	Not applicable	
Identification numbers:		
CAS Registry	14859-67-7 (radon-222) 22481-48-7 (radon-220) 14835-02-0 (radon-219)	EPA 1989
NIOSH RTECS	No data	
EPA Hazardous Waste	No data	
OHM/TADS	No data	
DOT/UN/NA/IMCO Shipping	No data	
HSDB	No data	
NCI	No data	

CAS = Chemical Abstract Service; NIOSH = National Institute for Occupational Safety and Health; EPA = Environmental Protection Agency; OHM/TADS = Oil and Hazardous Materials/Technical Assistance Data System; DOT/UN/NA/IMCO = Department of Transportation/United Nations/North America/International Maritime Dangerous Goods Code; HSDB = Hazardous Substance Data Base; NCI = National Cancer Institute

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TABLE 3-2. Chemical and Physical Properties of Radon

Property	Value	Reference
Molecular weight	222(radon), 220(thoron), 219(actinon)	Cothorn 1987a
Color	Colorless	Cothorn 1987a
Physical state	Gas	Cothorn 1987a
Melting point	-71°C	Cothorn 1987a
Boiling point	-61.8°C	Cothorn 1987a
Density at 20°C	9.96×10^{-3} gm/cm ³	Cothorn 1987a
Odor	Odorless	Cothorn 1987a
Odor threshold	No data	
Solubility:		
Water at 20°C	230 cm ³ /L	NCRP 1988
Organic solvents	Organic liquid, slightly soluble in alcohol	Weast 1980
Partition coefficients:		
Log octanol/water	No data	
Log K _{oc}	No data	
Vapor pressure at -71°C	395.2 mmHg	Cothorn 1987a
Henry's Law constant	No data	
Autoignition temperature	No data	
Flash point	No data	
Flammability limits	No data	
Half-life		
Radon-222	3.823 days	Cothorn 1987a
Radon-220	55 seconds	Cothorn 1987a
Radon-219	4 seconds	Cothorn 1987a
Decay modes and energy, MeV		
Radon-222	α , 5.4897 γ , 0.512	US DHEW 1970
Radon-220	α , 6.29	US DHEW 1970
Radon-219	α , 6.42 α , 6.55 α , 6.82	US DHEW 1970
Specific activity (Ci/gm)		
Radon-222	3.6×10^4	US DHEW 1970
Radon-220	9.3×10^8	US DHEW 1970
Radon-219	1.3×10^{10}	US DHEW 1970

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TABLE 3-2 (Continued)

Property	Value	Reference
Decay products		
Radon-222	Polonium-218 Lead-214 Bismuth-214 Polonium-214 Lead-210 Bismuth-210 Polonium-210 Lead-206	Cothorn 1987a
Radon-220	Polonium-216 Lead-212 Bismuth-212 Polonium-212 Thallium-208 Lead-208	Cothorn 1987a
Radon-219	Polonium-215 Lead-211 Bismuth-211 Thallium-207 Lead-207	Cothorn 1987a

MeV = Million electron volts

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TABLE 3-3. Radioactive Properties of Radon-222 and Its Short-lived Progeny^a

Element	Historical Symbol	Principal Radiation(s)	Decay Energies (MeV)	Half-Life	Specific Activity (Ci/gm)
Radon-222	Rn	α	5.5	3.82 days	3.6×10^4
Polonium-218 ^b	RaA	α	6.0	3.05 min	2.8×10^8
Lead-214	RaB	γ, β	1.0	26.8 min	3.3×10^7
Bismuth-214	RaC	γ, β	3.3	19.7 min	4.5×10^7
Polonium-214 ^b	RaC'	α	7.7	164 μ sec	3.2×10^{14}

^aSource: BEIR IV 1988; US DHEW 1970.

^bIsotopes of primary radiological interest due to the potential for retention in the lung and subsequent alpha decay.

MeV = million electron volts

min = minutes

max = maximum

μ sec = microseconds

	Uranium-238 Series						Thorium-232 Series				Uranium-235 Series					
Np																
U	^{238}U 4.5E9 yrs		^{234}U 2.5E5 yrs										^{235}U 7.1E8 yrs			
Pa	↓	^{234}Pa 1.2 min	↓										↓	^{231}Pa 3.2E4 yrs		
Th	^{234}Th 24 days		^{230}Th 8.0E4 yrs				^{232}Th 1.4E10 yrs		^{228}Th 1.91 yrs				^{231}Th 25.5 hrs	↓	^{227}Th 18.2 days	
Ac			↓				↓	^{228}Ac 6.13 hrs	↓				^{227}Ac 21.6 yrs	↓		
Ra			^{226}Ra 1600 yrs				^{228}Ra 5.8 yrs		^{224}Ra 3.64 days						^{223}Ra 11.4 days	
Fr			↓						↓						↓	
Rn			^{222}Rn 3.82 days						^{220}Rn 55 sec						^{219}Rn 4.0 sec	
At			↓						↓						↓	
Po			^{218}Po 3.05 min		^{214}Po 1.6E-4 sec	^{210}Po 138 days			^{216}Po 0.15 sec		^{212}Po 3.0E-7 sec				^{215}Po 1.8E-3 sec	
Bi			↓	^{214}Bi 19.7 min	↓	^{210}Bi 5.0 days			↓	^{212}Bi 60.6 min	↓			↓	^{211}Bi 2.15 min	
Pb			^{214}Pb 26.8 min		^{210}Pb 21 yrs	^{206}Pb stable			^{212}Pb 10.6 hrs	↓	^{208}Pb stable			^{211}Pb 36.1 min	↓	^{207}Pb stable
Tl									^{208}Tl 3.1 min						^{207}Tl 4.79 min	

↓ alpha decay ↗ beta decay

FIGURE 3-1. Uranium and Thorium Isotope Decay Series Showing the Sources and Decay Products of the Three Naturally-Occurring Isotopes of Uranium

Adapted from Aieta et al. 1987