Life Expectancies of Radon Measurement Devices

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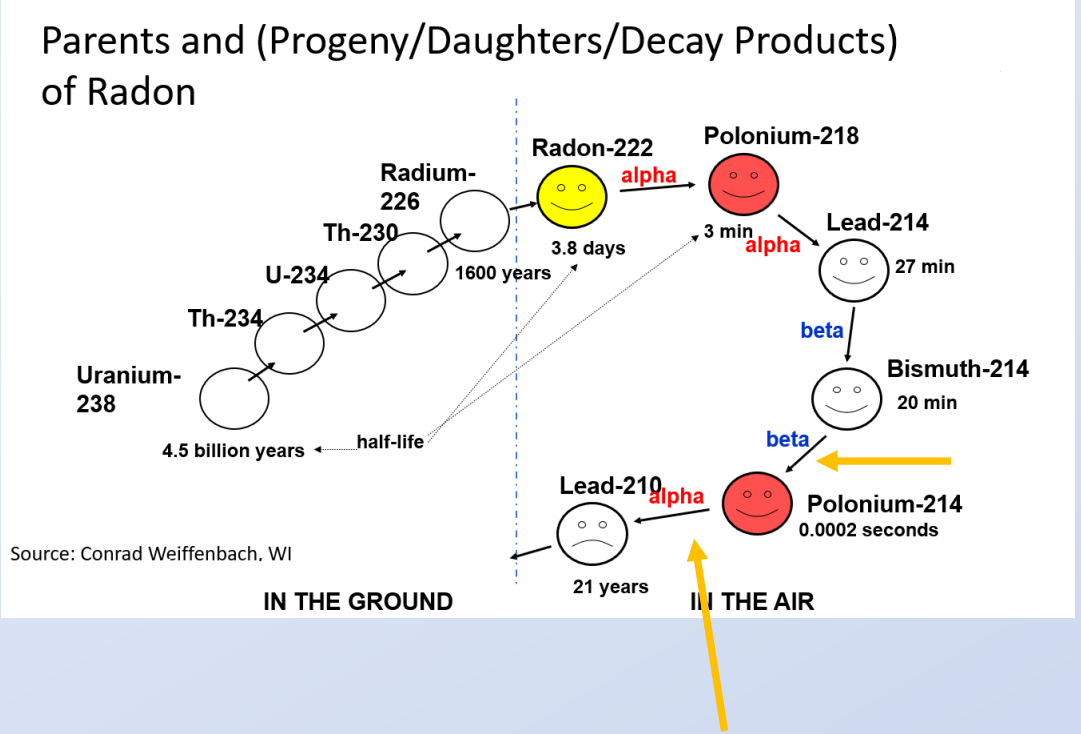
Overview

- Device Technologies
  - Passive Devices
    - Common Expiration Dates for passive devices
  - Continuous Radon Monitors
    - Detection Technologies
      - scintillation cell with a photomultiplier tube
      - pulsed ion chamber
      - silicon detector.
    - Prediction of degradation over time

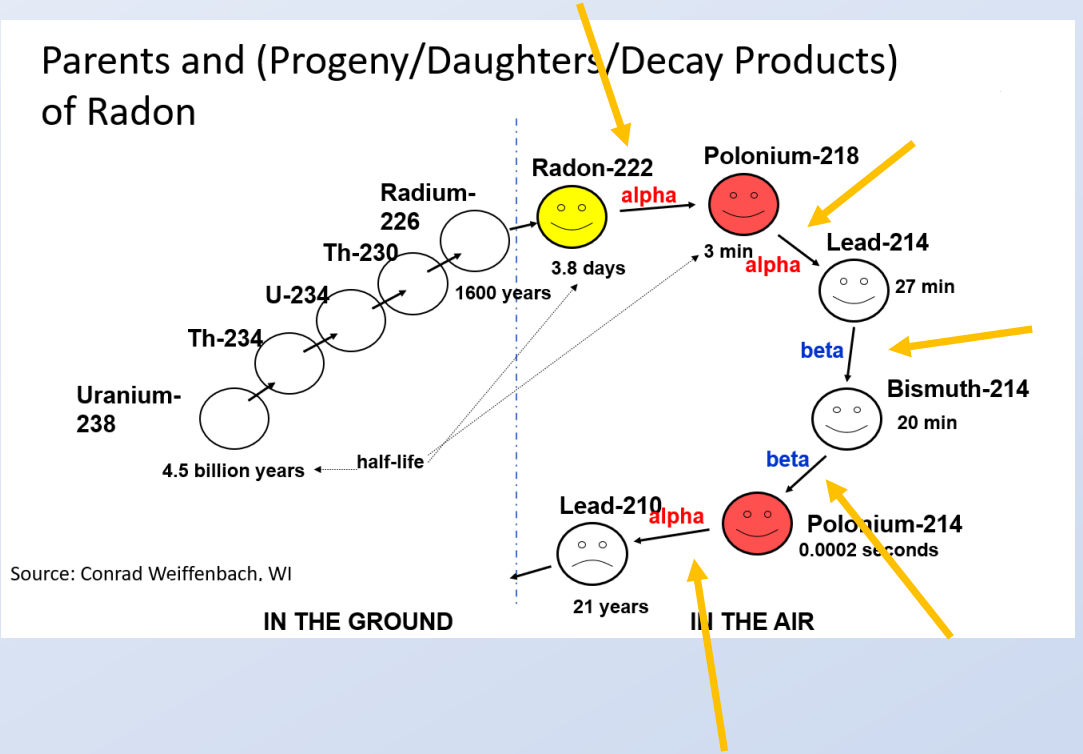
Passive Devices- Activated Charcoal

- Gamma decay from Pb-214 and Bi-214
- Expiration Date- None
  - Indefinite shelf life if kept sealed in original packaging and paper is not punctured
  - Avoid direct sunlight and moisture (suggested to store between 40 and 80 degrees Fahrenheit and a relative humidity of 50% or less)



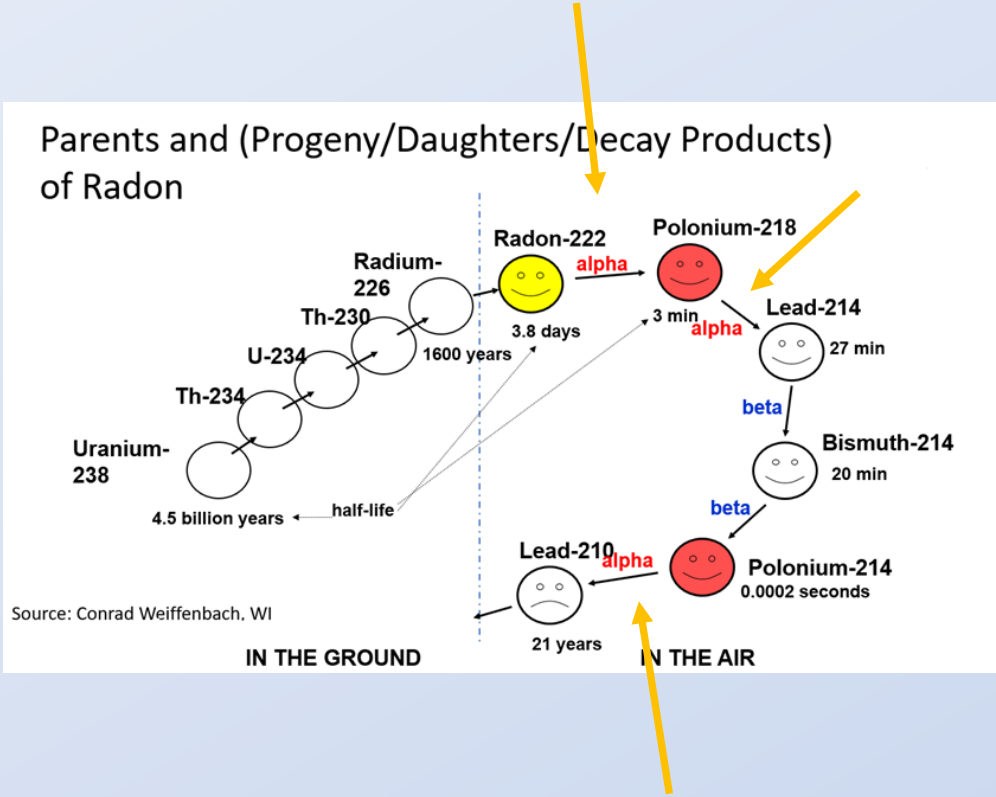
Passive Devices- Charcoal Liquid Scintillation

- Light pulse from α and β from radon decay and its products
- Expiration Date
  - Generally one year from shipment date
- Shelf life is influenced by:
  - Chemical stability of scintillation cocktail
    - Can reduce light yield impacting accuracy of radon measurements
  - Humidity
    - Can affect performance of scintillation cocktail
    - Charcoal can absorb moisture, reducing ability to adsorb radon



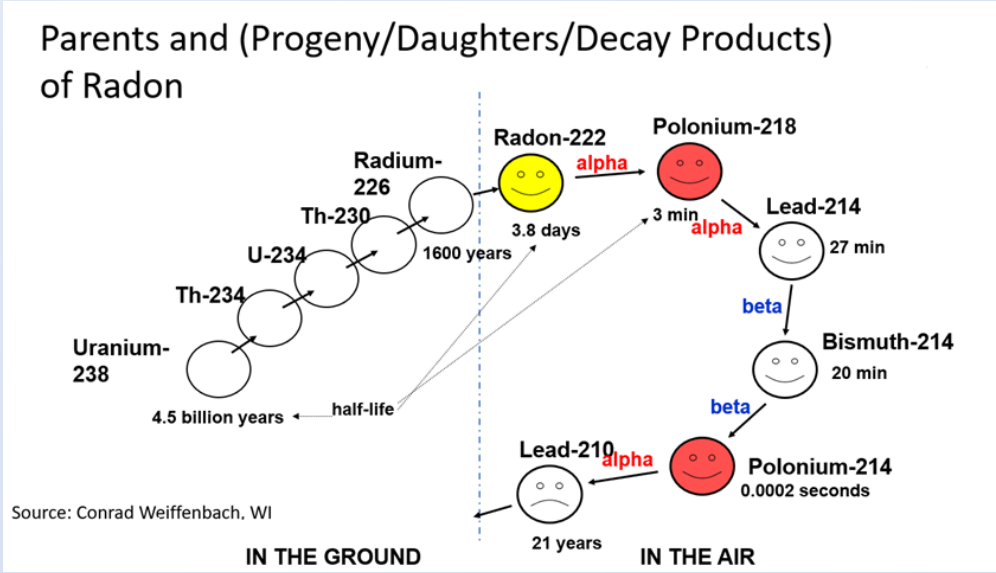
Passive Devices- Alpha Track Detectors

- Alpha particles emitted from Radon and it's decay products strike plastic within detector leaving 'latent tracks'
- Expiration Date
  - About one to two years
- Shelf life is influenced by:
  - Aging effects on the plastic material reduce sensitivity to alpha particles
  - Latent tracks become less distinct over time
    - Heat and other environmental conditions can increase fading



Passive Devices- Electret Ion Chambers

- Ionization of molecules from α and β interaction within ionization chamber
- Expiration Date
  - Short-term electrets can lose approx. 6 volts per month in storage
  - Long-term electrets can lose approx. 4 volts per month in storage
  - Electrets ARE reusable
  - Study done 2008 found half life of electrets is approx. 14 to 68 years

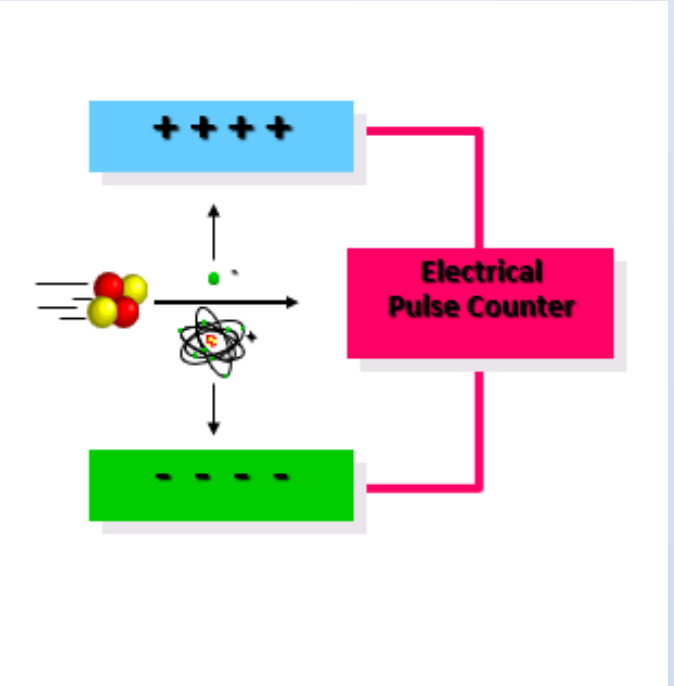


Continuous Radon Monitors- Scintillation Cell with PMT

- Surface of cell is covered with zinc sulfide coating that emits a pulse of light when hit by an alpha particle
- Expiration Date
  - Environmental factors like high humidity and extreme temperatures can lead to degradation
  - Radiation damage can cause some scintillators to degrade over time which can lead to reduced light output
  - Signs of degradation may include reduced light output, increased noise, and compromised energy degradation
  - Scintillation cells have a one year calibration period
    - Cell life can be 20+ years
      - Samples taken always dry and filtered
- Experience
  - KSU Radon Chamber uses two AB7s, but we have an additional AB5 we use for backup when we are calibrating equipment that is approximately 30+ years old

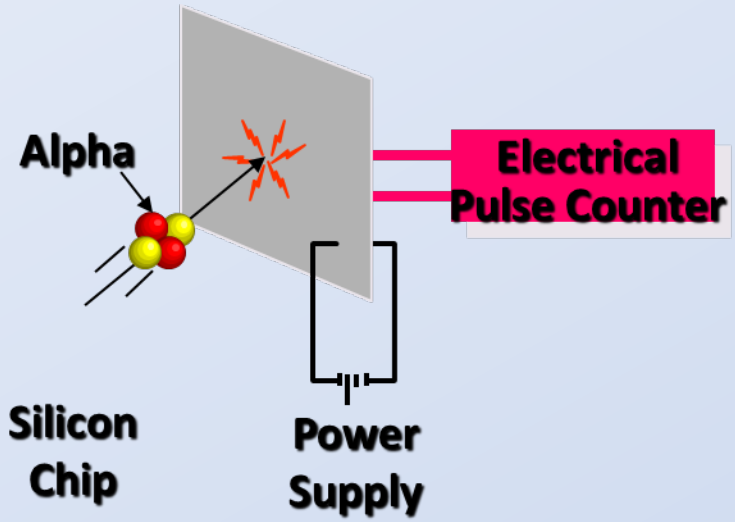
Continuous Radon Monitors- Pulsed Ion Chamber

- Alpha particles from Rn and RDPs ionize air molecules within chamber. These molecules are attracted to two oppositely charged electrodes resulting in a pulse that is counted
- Expiration Date
  - Temperature, humidity, and frequency of use can affect lifespan
    - High radiation exposure
  - Component Contamination
    - Interferes with collection of ion pairs, increased signal, increase ion recombination
  - Electret surface voltage drift
- Experience
  - Handful of monitors we calibrate we've seen over respond during calibration process
    - Approximate age of devices 3-5 years



Continuous Radon Monitors- Solid State Silicon Detector

- α particles from Rn and RDPs strike a solid state silicon chip that creates an electrical pulse
- Solid State Silicon chips can last decades, but can wear out from stress during operation
- Factors that influence lifespan
  - Performance affected by radiation (ionization) induced damage-reduces lifespan
    - Buildup of charge from high radiation environments
    - Alpha particles can pass through detector and displace silicon atoms from crystal lattice
  - High heat and humidity can affect longevity of electronic components



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Citations

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