Module - VI

What is Enlightenmen

Radioisotope Detection and Measurement

What are radioisotopes?

- A **radionuclide** (**radioactive nuclide**, **radioisotope** or **radioactive isotope**) is an atom that has excess nuclear energy, making it unstable.

- This excess energy can be either emitted from the nucleus as gamma radiation, or create and emit from the nucleus a new particle (alpha particle or beta particle), or

transfer this excess energy to one of its electrons, causing that electron to be ejected as a conversion electron.

- During those processes, the radionuclide is said to undergo radioactive decay.
- These emissions constitute ionizing radiation.
- Radioactive decay is a random process at the level of single atoms: it is impossible to predict when one particular atom will decay

Dosimetry

- Dosimetry is the measurement of the absorbed dose delivered by ionizing radiation, the term is better known as a scientific sub-specialty in the fields of health physics and medical physics, where it is the calculation and assessment of the radiation dose received by the human body.

- Internal dosimetry due to the ingestion or inhalation of radioactive materials relies on a variety of physiological or imaging techniques.

- External dosimetry, due to irradiation from an external source is based on measurements with a dosimeter, or inferred from other radiological protection instruments.

Dosimetry:

1. Ionization chambers

- The **ionization chamber** is the simplest of all gas-filled radiation detectors, and is widely used for the detection and measurement of certain types of ionizing radiation; X-rays gamma rays and beta particles.

- Device for detection of ionizing radiation by measuring the electric current generated when radiation ionizes the gas in the chamber and therefore makes it electrically conductive.

- Conventionally, the term "ionization chamber" is used exclusively to describe those detectors which collect all the charges created by *direct ionization* within the gas through the application of an electric field.
- It only uses the discrete charges created by each interaction between the incident radiation and the gas, and does not involve the gas multiplication mechanisms used by other radiation instruments, such as the Geiger-Müller counter or the proportional counter.

Principle of operation

- An ionization chamber measures the charge from the number of ion pairs created within a gas caused by incident radiation. It consists of a gas-filled chamber with two electrodes; known as anode and cathode.

- The electrodes may be in the form of parallel plates (Parallel Plate Ionization Chambers: PPIC), or a cylinder arrangement with a coaxially located internal anode wire.

- The essential components of the ionization chamber are its two collecting electrodes: the anode and cathode (the anode is positively charged with respect to the cathode).

- In most cases, but not all, the outer chamber wall serves as the cathode.

- The potential difference between the anode and cathode is often in the 100 to 500 volt range.

- The most appropriate voltage depends on a number of things such as the chamber size (the larger the chamber, the higher the required voltage).

- In general, the outer chamber wall (the cathode) is a cylinder or sphere while the anode is usually rod-shaped.

- Charged particle getting through a volume of a gas or noble liquid. The presence of radiation causes charged particles to traverse the gas inside the ionization chamber.

- These charged particles might be alpha or beta particles from a radioactive sample (if they have sufficient energy to penetrate the detector wall).

- Interaction proceed through ionization and end excitation of the molecules, electron-ion pairs are created

- A voltage potential is applied between the electrodes to create an electric field in the fill gas.

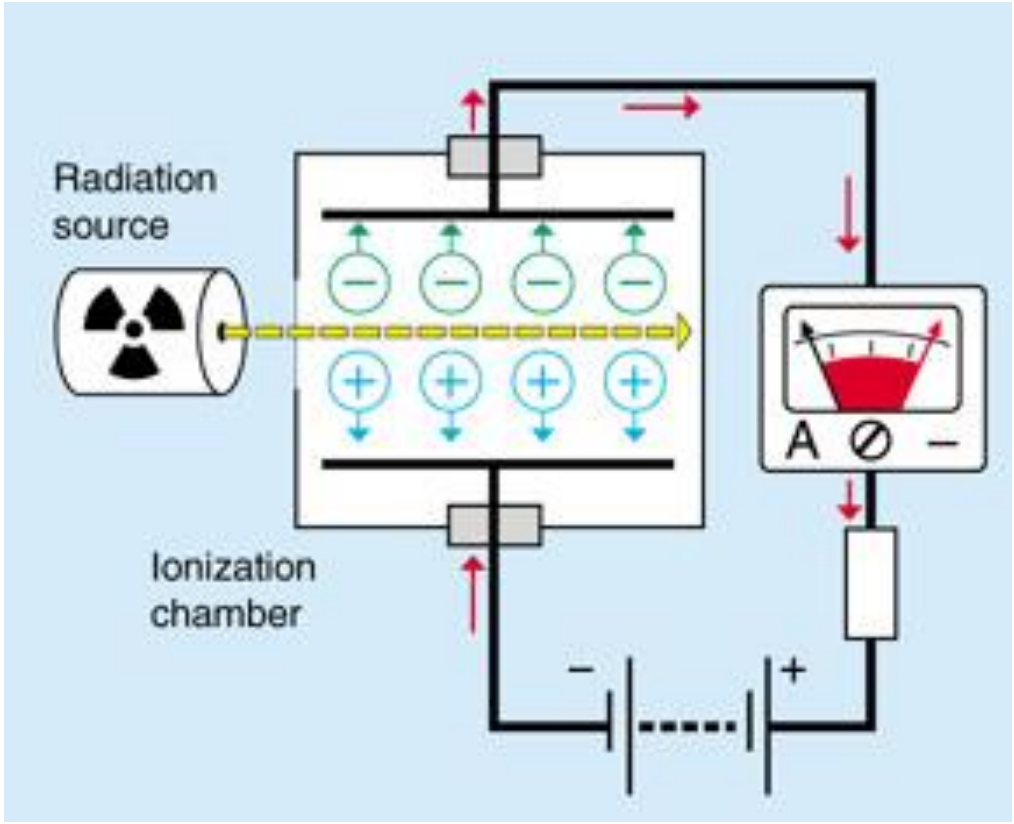
- When gas between the electrodes is ionized by incident ionizing radiation, ion-pairs are created and the resultant positive ions and dissociated electrons move to the electrodes of the opposite polarity under the influence of the electric field.

- This generates an ionization current which is measured by an electrometer circuit.

- The electrometer must be capable of measuring the very small output current which is in the region of femtoamperes to picoamperes, depending on the chamber design, radiation dose and applied voltage.

- Each ion pair created deposits or removes a small electric charge to or from an electrode, such that the accumulated charge is proportional to the number of ion pairs created, and hence the radiation dose.

- This continual generation of charge produces an ionization current, which is a measure of the *total* ionizing dose entering the chamber. However, the chamber cannot discriminate between radiation types (beta or gamma) and cannot produce an energy spectrum of radiation.


Radiation
source
Ionization
chamber
A
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