**Radiation Hazards,   
Evaluation , Control & Safety for Human Body.**

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**Under the Supervision of**

**DR. Rashmi Shrivastava**

**Professor Department of Chemistry**

**IES UNIVERSITY**

**BY**

**HARDEV**

**(Research Fellow)**

***Email:*** [***hardev.singh555@gmail.com***](mailto:hardev.singh555@gmail.com)

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**OVERVIEW**

* Radiation Quantities & Units
* External radiation hazard
* Source output
* Safety for Human Body.
* Principles of protection

**RADIOACTIVITY**

It is a unstable phenomenon of nucleus attains stability by emission of energy in the form of radiation. (Henry Becquerel, 1896) Spontaneous nuclear transformation that produces new element Radiation can be in the form of particles or e.m. radiation or both

Radiography is non-destructive testing (NDT) method to find out the internal discontinuities present in a component or assembly. It is based on differential absorption of penetrating radiation by the part being inspected.

The basic principle for the detection of anomalies using radiographic testing method is the difference in radiation absorption coefficients properties exhibits by different materials. The images are captured in a recording medium. The recording medium used may be X-ray film, phosphorous imaging plates, diodes etc. Industrial X-ray films are the common recording medium used for these applications.

Radiation is such a powerful and dangerous divine rays that humans cannot see by themselves, coming in contact with it can cause serious illness or death to a person. Dr. HARDEV

Radiography technique is ensuring the integrity of vessels, pipes, welded joints and metal castings.. Radiography produces high energy/penetrative. radiations - person accidentally, exposed to these radiations would result in radiation injury. To avoid unnecessary radiation proper training programmed is organized for maintaining sources and device. If X-ray is less, then gamma is more, if it is beneficial, then if it is used incorrectly, it is more harmful. DR. HARDEV

**ACTIVITY**

Measure the quantity of radioactivity

Rate of decay or no. of disintegrations per second (Bq) is known as activity

Modern unit (SI) - Bequerel : 1 Bq = 1 dps

Traditional unit- Curie (Activity of 1 g of Ra-226)

**EXPOSURE**

Measure of Photon flux and Amount of energy transferred from X-Ray field to a unit mass of air

1 X unit = 1 C/kg air ( SI Unit)

Roentgen ; 1 R = 1 sC/cm3 air

at 0 0C & 760 mm Hg 1 R = 2.58 x 10-4 C/kg

OR

1 X unit = 3881 R

**Absorbed Dose**

Unit Expressed in terms of Energy Absorbed per unit mass; Measure of Energy Deposited by radiation in the irradiated material

1 Gy = 1 J/kg

Earlier Unit : Rad 1 rad = 100 erg/g

1 Gy = 100 rad

**Equivalent Dose**

Measure of Biological Damage Radiation Weighting Factor (WR)

Ratio of Amount of Energy from 200 keV X- Rays required to produce given biological effect to amount of energy from any other radiation to produce same effect (RBE)

**Unit Sievert (Sv)**

Equivalent Dose Sv = Dose in Gy x WR

Earlier Unit is Rem (1 Sv) = 100 rem

WR for X-Rays = 1 For X-Rays & γ-rays

1 Sv = 1 Gy & 1 rem = 1 rad

Radiation Weighting Factors

Effective Dose

Effective Dose (Whole Bode Dose)

: WT x HT

WT :Contribution of tissue T to the total risk due to stochastic effects.

Useful in converting equivalent dose received by one or more tissues to effective dose.

Tissue Weighting Factor

**Literature Review (Old and New) Units**

**Natural Background** - Effective dose is a general term that refers to the amount of energy absorbed by tissue: from ionizing radiation. The effective dose is measured:in sieverts (Sv) and is more: commonly expressed in units of either millisieverts (mSv). Represents a thousandth of a sievert – or microsieverts (μSv) – one millionth of a sievert. The total worldwide average :effective dose from natural radiation is approximately 2.4 mSv per year; in Canada, it is 1.8: mSv. In some parts of the world, it is naturally much: higher – for instance on the Kerala Coast in India, the annual: effective dose is 12.5 mSv. The dose varies with the source of the radiation. E**x.**  in northern Iran, geological characteristics result in a dose that can reach 260 mSv a year.

**Source-:** Radiation is a constant source of ionizing radiation present in the environment and emitted from a variety of sources. According to the: United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), there are four major: sources of natural radiation: cosmic radiation, terrestrial radiation and intakes of naturally occurring radionuclide’s through inhalation and ingestion

**External -:** I have a final project where I should measure maximum solar radiation heat flux during a day on re-radiating surface (i.e mirror) towards a window. My object finally is to find an optimum angle for mirror that should re-radiate the maximum heat flux toward the chosen surface. Comsol 4.3. I succeeded is to simulate a heat flux on given geometry during specific time of a day, where my goal is to simulate heat flux re radiated by given a mirror angle over the whole daytime range.

**Cosmic Rays-** Regions at higher altitudes receive more cosmic radiation. According to a study by Health Canada, the annual effective dose of radiation from cosmic rays in Vancouver, British Columbia, which is at sea level, is about 0.30 mSv. This compares to the top of Mount Lorne, Yukon, where at:2,000 m, a person would receive a dose of about 0.84 mSv annually. Flying in an airplane increases exposure: to cosmic radiation, resulting in a further average dose of 0.01 mSv per Canadian per year

**Terrestrial Sources-** There are also natural sources of radiation in the ground, and some regions receive more terrestrial radiation from soils that contain greater quantities of uranium. The average effective dose from the radiation:emitted from the soil is approximately 0.5 mSv per year. However, this dose varies depending on location and geology, with doses reaching as high as 260 mSv in Northern Iran and 90 mSv in Nigeria. In Canada, the estimated highest annual dose for terrestrial :radiation is approximately 1.4 mSv, as measured in the Northwest Territories

Internal

Potassium- 40

Radon-220,222

And daughters

Uranium, Thorium

Radiation Hazards Evaluation, External Hazard, Internal Hazard. Radiation Hazard Depends.

**Situations leading to a radiological hazard include**

* **loss of control of the radioactive source or exposure device**
* **damage to the source or exposure device**
* **direct contact with the source**.

Potential Hazards of Radiography

The primary hazard of radiographic testing is the radiation, particularly ionized radiation. High radiation exposure can result in the following symptoms:

* Hair loss
* Nausea
* Vomiting
* Hair/skin loss
* Energy of Gamma Radiation-Ir-192: Industrial Radiography
* Se-75 : Industrial Radiography (Selenium)
* Yb-169: Industrial Radiography (Ytterbium)
* Co-60: Density and fill height level switches, industrial Radiography

Radiation Output (Activity )

**Half-life**

TYPICAL RADIONUCLIDES USED IN INDUSTRIAL RADIOGRAPHY Optimum steel

|  |  |  |  |
| --- | --- | --- | --- |
| Radionuclide (MeV) | Gamma energies | Half-life object material | thickness of (mm) |
| Cobalt-60 | High (1.17 and 1.33) | 5.3 years | 50–150 |
| Caesium-137 | High (0.662) | 30 years | 50–100 |
| Iridium-192 | Medium (0.2–1.4) | 74 days | 10–70 |
| Selenium-75 | Medium (0.12–0.97) | 120 days | 4–28 |
| Ytterbium-169 | Low (0.008–0.31) | 32 days | 2.5–15 |

Example

Radiation Output at 1 m from given source is = ERC x activity

1. Radiation Level from 7 Ci Ir-192 source
2. Radiation Level from 200 GBq Co-60 source
3. If Radiation Level is 1.5 R/h from Ir-192

What is activity?

Example- Calculate the dose rate at 1m from a

1 PBq Cobalt - 60 source.

Answers : Dose rate at –

* Safety for Human Body.

Aim-Safety procedure for open field radiography –

Equips:- Radiography camera , survey meter, warning symbols, fencing roper ,radiography accessories ,collimator, civitong, lead pot ,siren red light)

Theory – all type radiation safety procedures should be followed during setting up of radiography unit.

Procedure- wear personnel monitoring (TLD) badge &pocket dosimeter.

Take survey meter which is in proper condition.

Before opening the storage pit monitor radiation levels.

Check the locks & radiation level on the camera.

Carry radiography camera on a trolley to the site.

Cordon off required area with fencing rope & put the red light with fencing rope.

Connect smallest guide tube possible the source assembly (pigtail) should in lock position.

Set up radiography joint with film & pentameter.

Position the collimator in such a way that the radiation bean should be towards unoccupied area .

Spread out maximum length of drive cable &couple it with the source assembly properly.

Put the camera in operate position.

Ensure that no one is in the cordoned pone & switch on siren red light button.

Drive the source in minimum time.

Monitor radiation level at the gear box.

Components of radiation protection

Time - calculation of radiation time and safety.

Distance- radiation time very long distance.

Shielding- radiation time used very heavy lead ,steel, concrete shielding .

TIME

“The amount of radiation dose an individual will receive while being exposed to radiation is directly effect to the time he/she spends around the radioactive materials. Therefore, the less time spent being exposed to radiation the smaller the dose.”

Time

Example - What dose would be received standing 1 m away from a 1 PBq Co-60 source for 1minute ?

Answer : Dose rate at -

Application of distance

For x and gamma radiation, an Inverse Square Law applies :-

DISTANCE

Like A Shotgun Spread Affect

Dose-rate verses Distance

Example

What dose-rate would be measured 5 m

away from a 1 PBq Co-60 source ?

Answer :

Dise rate at =

RADIATION SHIELDING

Important principle for

Protection of personnel

Radiation control

Shielding requirement will vary depending on

Type of radiation –

* x-ray
* gamma ray
* natural radiation

Intensity - Radiation intensity is defined as the power per unit solid angle that is the power incident on that portion of the surface of a sphere which subtends an angle of one radian at the centre of the sphere in both the horizontal and the vertical planes.

Energy of radiation source – Ir-192, Co -60 act.

Shielding

The effectiveness of shielding depends –

* the type of radiation
* the ENERGY of the radiation
* the nature of the absorber
* the thickness of the absorber

**ATTENUATION**

When photons interact with matter three things can occur. The photon may be:

* Transmitted through the material unaffected
* Scattered in a different direction from that traveled by the incident photon
* Absorbed by the material such that no photon emerges

SHIELDING

Exponential Attenuation

Attenuation Coefficients. There are two types of attenuation coefficients:

* Linear Attenuation Coefficient (LAC) provides a measure of the fractional attenuation per unit length of material traversed
* Mass Attenuation Coefficient (MAC) provides a measure of the fractional attenuation per unit mass of material encountered
* Half Value Thickness (HVT)

HVT : Thickness of a specified material required to reduce the dose-rate to one half of its original value.

* Tenth Value Thickness (TVT)

TVT: Thickness of a specified material required to reduce the dose-rate to one tenth of its original value.

Example Shielding

Dose rate at 4 m distance from a 1 PBq cobalt-60 radiation source is 22 Sv h-1.. If a 1 metre thick concrete shield is built there what would be the dose rate after the shield ?

1 metre of concrete represents 4 x TVT for Co-60.

Dose rate after shield will therefore be:

= 22 x 1 x 1 x 1 x 1 Sv h-1 10 10 10 10

= 2.2 mSv h-1

Radiation protection of staff and public

Occupational Dose

Personnel Monitoring Equipment

Public Dose

Surveillance Program

Radiation Safety Program Audit

Occupation dose limits

Workers3

Effective dose

20 mSv/a over 5 years

50 mSv in any single year

Equivalent dose

to the lens of the eye 150 mSv/a

extremities (hands and feet) or the skin   
500 mSv/a

Apprentices and students of 16 - 18 years of age

Effective dose

6 mSv/a in a year

Equivalent dose

to the lens of the eye 50 mSv/a

extremities (hands and feet) or the skin 150 mSv/a

Public Dose Limits

Members of the public

Effective dose

1 mSv/a

in special circumstances 5 mSv in a single year provided that 1 mSv/a over 5 years is not exceeded

Equivalent dose

to the lens of the eye 15 mSv/a

extremities (hands and feet) or the skin 50 mSv/a

Radiation Protection Programmed

Objective

Assignment of responsibilities

Accountability of radiation sources

Classification of areas

Trained persons

Personnel Monitoring

Area monitoring /Workplace monitoring- RSM

Radiation Surveillance& records

Periodic training /Appraisal Programmed

Review and updating of Emergency Plans

**THANK YOU.   
 YOU   
 FOR   
 ATTENTION! !**