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Short Communication

Investigation of Gamma Radiation Shielding Materials

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Abstract

Shielding materials for nuclear gamma radiations are important in applied nuclear radiation fields such as nuclear radiation therapy, radiation health physics, nuclear reactors shielding, storage of radioactive materials etc. In addition, study of interactions of gamma radiations with different materials are also prime important in basic physics. In view of this, mass adsorption coefficients of gamma radiations for Aluminum, Lead, Teflon for Cs-137 gamma radiations are measured and results are reported in present work. Gamma mass absorption coefficients are calculated using NaI(Tl) scintillation detector and 8K Multichannel Analyzer gamma ray spectrometer system. The values of gamma ray mass absorption coefficients for Aluminum, Lead and Teflon are found to be 17.12 cm^2/gm , 0.43 cm^2/gm , 16.80 cm^2/gm . The results are in good agreement with the literature values.

Keywords: Gamma radiation, Mass absorption coefficient, Gamma ray spectrometer, 8K M.C.A. analyzer.

Introduction

The study of gamma radiations are important in applied nuclear radiation fields such as nuclear radiation therapy, radiation health physics, nuclear reactors shielding, storage of radioactive materials etc. In addition, study of interactions of gamma radiations with different materials are also prime important in basic physics. The shielding properties of different materials for gamma radiations are expressed in terms of linear and mass absorption coefficients. In view of this, mass adsorption coefficients of gamma radiations for Aluminum, Lead and Teflon for Cs-137 gamma radiations are measured and results are reported in present work.

Experimental Work: The mass adsorption coefficients of gamma radiations for Aluminum, Lead and Teflon for Cs-137 gamma radiations are measured. Gamma mass absorption coefficients are calculated using NaI(Tl) scintillation detector and computer software.

Materials and Methods

Ten samples of pure Aluminum, Lead and Teflon were prepared for each material with increasing thickness ranging from 0.05mm to 0.45mm, 1mm to 2mm and 0.25mm to 1mm respectively, each having circular size 3cm. The average thickness of each circular sample was measured by taking ten observations with micrometer screw gauge.

Procedure: The standard gamma ray Cs-137 source of activity strength 0.45 μCi made by BARC, Mumbai was used in the present work. Cs-137 gamma source has half life of 30 years and gamma energy of 662 KeV. This source of gamma radiation was selected to study the low gamma ray interaction such as photoelectric and Compton scattering interaction with aluminum, lead and Teflon. In the present work 2"× 2" NaI(Tl) gamma ray detector was used for measuring gamma radiations transmitted intensity through the absorber samples. The gamma ray spectrum was analyzed with help of 8K M.C.A. coupled to the NaI(Tl) gamma ray detector and computer . A sample of each material under study was placed between gamma ray detector and Cs- 137 sources. Gamma ray intensity for each sample was counted for fixed time period of 180 seconds.

Analysis of Data: The linear absorption coefficient (μ) of each sample under study was estimated using the relation[1-4].

$$I = I_0 e^{-\mu x}$$

I_0 is the incident gamma ray intensity with zero thickness of sample, I is the transmitted intensity through the sample after, X is sample thickness in cm, μ is total linear absorption coefficient

The transmitted gamma ray intensity I of Cs-137 source for each sample is measured using the scintillation detector. Linear absorption coefficient of gamma radiations for each sample was estimated using the above relation. Mass absorption coefficient for each element was also calculated by using the standard density values of each material under study using the relation[5].

$$I = I_0 e^{\frac{-\mu x}{\rho}}$$

ρ is density of absorber material in g/cm^3, x is thickness of sample in cm^2

Results and Discussion

The results of gamma radiation mass absorption coefficients for aluminum, lead and Teflon samples are given in Table-1.

Table-1
Gamma ray mass absorption coefficient

Name of materials	Density gm/cm^3	Linear mass absorption coefficient (μ) cm^{-1}	Mass absorption coefficient (μ_m) cm^2/g
Aluminum	2.7000	46.2100	17.1200
Lead	11.3400	4.8400	0.4300
Teflon	2.2000	36.9710	16.8000

Conclusion

The results are in good agreement with expected values for gamma absorption coefficient[5]. The gamma ray absorption is maximum for lead compared with aluminum and Teflon which means that lead has good capacity to absorb gamma radiations incident on it as compared with aluminum and Teflon that's why lead is used for shielding of gamma radiations. This can be used in reactor shielding material along with the concrete bricks. Gamma ray mass absorption coefficient for Teflon has competitive value with aluminum.

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