Asian Journal of Chemistry Vol. 18, No. 5 (2006), 3314-3316

Mass Attenuation Coefficients Studies in Some Flyash Materials

SUKHPAL SINGH, ASHOK KUMAR, JARNAIL SINGH,
KULWANT SINGH THIND† and GURMEL S. MUDAHAR
Department of Physics, Punjabi University, Patiala-147 002, India

The linear and mass attenuation coefficients have been measured in some flyash materials for 662 keV gamma rays. The values of mass attenuation coefficient are found to be nearly constant for all the materials.

Key Words: Mass attenuation coefficients, Flyash materials.

INTRODUCTION

The behavior of gamma ray interaction depends on the relative dominance of partial interaction processes and the nature of the interacting material. The important gamma ray interaction property is the attenuation coefficient. Attenuation coefficient is a parameter that is related with photon penetration and energy deposition of the incident gamma ray flux. It gives the extent of absorption or scattering. It depends upon the gamma ray incident energy, nature of the target material and also on geometrical conditions, which is very important parameter in gamma ray transport calculations. Before more than decade, there was scarcity of work of gamma ray interaction properties of composite materials. Our research group and other workers have generated the data of attenuation coefficient for different type of composite materials such as Singh *et al.*[1] in HCO materials, Singh *et al.*[2,3] in biological materials and glasses, Akkurt *et al.*[4] in barite, marble and limra, Alam *et al.*[5] in building materials *etc.*

In composite materials, flyash is a material, which is a byproduct of coal fired by thermal power plants, and other coal based industries. A huge amount of flyash, which is being produced every year, poses various serious environmental problems. In the present scenario, flyash is being used in manufacturing of bricks, blocks, cement, high volume concrete, light weight aggregates, landfills and for construction of roads, dames *etc.* In this work, to explore the possibilities of utilization of flyash, an attempt has been made to study the interaction of gamma radiations with the mixture of flyash and cement.

† Department of Physics, Guru Nanak Dev University, Amritsar-143 005, India.

EXPERIMENTAL

In the present studies, gamma ray transmission geometry has been used. The experimental setup and procedure for the measurements of transmitted photon spectra of medium energy gamma rays through composite materials has already been discussed in our previous work[6]. Here, the incident photons of 662 keV were obtained from the decay of ^{137}Cs radioactive isotope obtained from Bhabha Atomic Research Center, Mumbai, India. The source was sealed and was placed in a proper lead container. A gamma ray spectrometer containing an assembly of NaI (Tl) detector (4.5 cm diameter and 5.1 cm thickness), computerized 2K MCA plug-in-card and associated electronics was used to record the pulse height spectra of incident and transmitted gamma rays. NaI(Tl) crystal was properly shielded with lead, lined with aluminium of suitable thickness. The positions of source and detector were fixed. The absorber between 3-4 cm thickness (that is less than one mean free path) was placed at the centre between source and detector in a straight line. The samples were made of the mixture of flyash and cement. In flyash the cement was added from 10 to 40 %. To reduce the statistical error to less than 1%, each spectrum was recorded for the time period of 900 s. Background spectra were recorded for the same time and subtracted from each spectrum. The whole apparatus was placed at a suitable distance from the walls of the room so as to avoid the contribution of scattered photons from the walls.

RESULTS AND DISCUSSION

From the measured intensities of 662 keV gamma rays the linear attenuation coefficients, μ (cm^{-1}) of flyash mixture was calculated using the following simple attenuation equation:

$$I = I_0 e^{-\mu x} \tag{1}$$

where I_o and I are the intensities of the incident and transmitted gamma rays respectively through flyash mixture of thicknesses x.

The mass attenuation coefficient, μ_m (cm^2/g) of the flyash mixture was calculated with a simple relation of:

$$\mu_m = \frac{\mu}{\rho} \tag{2}$$

Where ρ is the density of the flyash mixture in g/cm^3. The obtained value of μ and μ_m are given in the Table-1. From the present results it is seen that the linear attenuation coefficient increases with the increase of cement in flyash material, which is due to the increase in density of flyash with the addition of cement. The mass attenuation coefficient is almost same and is within the experimental errors (< 5%) for all the chosen samples. The constancy of mass attenuation coefficient is because of the reason that in this energy region Compton scattering is the dominance process for all type of materials which is linearly Z dependent. The constancy of μ_m for the chosen samples is in line with the theoretical findings of Singh and Mudahar[7], in which they have reported that in the energy region 150 and 5 MeV the variations in μ_m of low Z (< 20) materials is negligible for a particular energy. The presently chosen energy of 662 keV and the chosen flyash materials are low Z materials.

TABLE-1
THE LINEAR AND MASS ATTENUATION COEFFICIENTS OF FLYASH MATERILS

% wt. Fraction of cement in flyash	Linear attenuation coefficient (cm^{-1})	Mass attenuation coefficient (cm^2/g)
10	0.0913	0.0777
15	0.0949	0.0788
20	0.0951	0.0787
25	0.0959	0.0771
30	0.0980	0.0761
35	0.0991	0.0778
40	0.1026	0.0786

REFERENCES

1. M. Singh, A.K. Sandhu, G.S Brar and G.S. Mudahar, *Appl. Radiat. Isot.*, **4**, 1073 (1993).
2. K. Singh, C. Singh, P.S. Singh and G.S. Mudahar, *Pramana J. Phys.*, **59**, 151 (2002a)
3. K. Singh, H. Singh, V. Sharma, R. Nathuram, A. Khanna, R. Kumar, S.S. Bhatti, and H.S. Sahota, *Nucl. Instrum. Meth.*, **1**, 94 (2002b).
4. Akkurt, S. Kilincarslan and C. Basyigit, *Ann. Nucl. Energ.*, **31**, 577 (2004)
5. M.N. Alam, M.M.H. Miah, M.I. Chowdhury, M. Kamal, S. Ghose and R. Rahman, *Appl. Radiat. Isot.*, **54**, 973 (2001)
6. G.S. Sidhu, K. Singh, P.S. Singh and G.S. Mudahar, *Rad. Phys. Chem.*, **56**, 535 (1999).
7. M. Singh and G.S. Mudahar, *Appl. Radiat. Isot.*, **43**, 907 (1992).