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Studies on total attenuation cross sections of several elements at 662 and 1170 KeV.

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ABSTRACT

The photon attenuation cross sections of several elements of thin uniform multiple foil were determined in the energy at 662 and 1170 KeV photons by using formula $\sigma_{tot}= \mu/\rho\ (A/N)\ x\ 10^{24}$, the values are compared with the values calculated from the data of Hubbell for the individual elements.The radioactive sources used in the experiments were Cs^{137} and Co^{60}. Total attenuation cross sections for several elements have been measured for gamma rays from 662 and 1170 keV photons using the well type scintillation spectrometer. Measurements have been made to determine total photon cross sections very accurately by using a narrow collimated beam method which effectively excluded correction due to small angle and multiple scattering of photons. The values of Total attenuation cross sections are found to be in good agreement with the theory.

Keywords: Attenuation coefficient, Total attenuation cross sections, Scintillation spectrometer.

INTRODUCTION

The high intensity radiation sources and other radiation generating equipment, a variety of shielding materials are used to minimize exposure to individual. Among the several elements are best known for radiation shielding for gamma radiation due to their high density and atomic number. Better compressive strength, smoother surface finish and high abrasion resistance, offers adequate shielding to gamma radiation in comparison with element. Although photon attenuation data are available in literature [1], it is necessary to test these commercially available materials experimentally for their radiation shielding efficiency before putting them in to regular use.

Radio isotopes are being increasingly used in radiation therapy and oncology. Therefore a through knowledge of the photon interaction cross sections of the above energy sources for lead and silver desirable these sources are used in medical field, industry and radiation sterilization because of high energy with its optimal long life. Data on the total attenuation cross of elements Cs^{137} and $Co^{60}$are quite useful [2-14]. With this end in view we have calculated the photon cross sections of several elements using Cs^{137} and Co^{60}sources. The values are compared with the values calculated from XCOM programe of Hubbell J.H.for the individual elements and found to be in agreement with it.

MATERIALS AND METHODS

EXPERIMENTAL SECTION:
Photons did not change appreciable due to scatter or fluorescent radiation contribution from the collimators. A provision was made midway between the collimator to introduce absorbers which were in the form of thin foils. The entire system was arranged vertically over the scintillation detector, ensuring that the central axis of the collimator coincided with the central axis of the detector. The source was positioned over the collimator so as to allow, a narrow well collimated photon beam from the collimator incident normally on the absorbers. The source and the detector were well aligned with the collimators. The incident energy of photon radiation from each radioactive source was known accurately from the photon spectrum taken with a calibrated gamma spectrometer. The absorbers used include thin and uniform foils of high purity of Magnesium, Nickel, Zinc, Silver and Gold.

The absorbers were weighted accurately on a sensitive balance, and from their measured area the thickness proportional to the aerial density in g/cm-2 were determined. The absorbers having varying thicknesses of a few mg.cm2 and higher thicknesses were obtained by stacking them together. All absorbers were of high specified purity. Each absorber of specified thickness was interposed in the beam such that the primary photon beam was incident normally on its surface. The transmitted photon spectrum of the source used had energy resolution characteristics of the full energy absorption peak, identical with that of primary photon beam. The thickness of the absorber was increased in steps. The counts under the full energy absorption peak of the recorded photon spectrum were determined. The photon spectra were recorded several times for each additional thickness and an average of counts under the full energy absorption peak was obtained. From the transmitted (I) and the incident photon intensity (I_0), for a thickness `x' of the absorber, the photon attenuation coefficient µm is given by the following expression:

$$\mu_m = \ln (lo /l)/X$$

In the present work the total cross-section values for 662 and 1170 keV photons are determined in six elemental solids of atomic numbers ranging from 12 to 82 through photon transmission measurements. The monoenergetic photon radiation required for these measurements was derived from Cs137 and Co60 radionuclide .The source was procured as a sealed source from BARC, Trombay, Mumbai. The photon transmission measurements were done under a narrow beam counting geometry employing high resolution NaI(Tl) solid state detector. The NaI (Tl) detector utilized in the present work is of 30.3 cc active volume and was obtained from Nucleonix systems Hyderabad India.. Schematic construction of a Scintillation detector as shown in figure1.shows Block diagram of photon counting system. With the present experimental system, it was established from the photon spectrum that the energy of transmitted photons did not change appreciably due to scatter or fluorescent radiation from the collimators. A provision was made midway between the collimators to introduce absorbers which were in the form of thin foils. The entire system was arranged vertically over the NaI(Tl) detector, ensuring that the central axis of the collimators coincided with the central axis of the detector. Radioactive source of CS^{137} and Co^{60} had thin beryllium windows for the exit of photon radiations. The source was kept in a lead container which was provided with an aperture for the exit of photons. The source container assembly was then kept over the collimator so as to allow a narrow, well collimated photon beam from the collimator incident normally on the absorbers. The source and the detector were well aligned with the collimators. The incident energy of photon radiations from the source was known accurately from the photon spectrum. The chosen absorbers include thin and uniform foils of high purity of Magnesium,Nickel, Zinc, Silver and Gold.

These foils were weighed accurately using a digital balance, and from their measured area the thickness proportional to the areal density in g cm-2 was determined. The absorbers had varying thicknesses of a few mg cm-2and higher thicknesses were obtained by stacking the foils together. The presently used absorbers are uniform sheets of Mg,Ni,Zn,Ag,Au,Pb. These sheets/foils were weight accurately and from their measured area, the thickness (t) in gm/cm2 was determined in each case. The absorbers had varying thicknesses of a few mg/cm2. The higher values of thickness were obtained by stacking required number of foils together. The absorbers used were of nuclear grade of specified purity of the order of 99.95%. No further attempts were made to ascertain the purity of these absorbers.

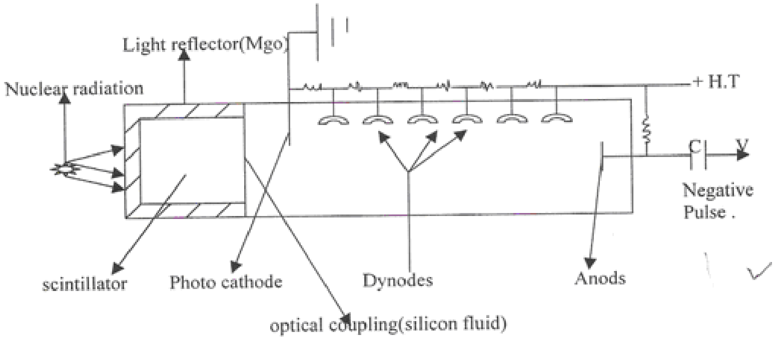

Figure1. Schematic construction of a Scintillation detector

The experimental setup used and the procedure followed were the same as described earlier [15].Transmission ratio I_0/I for various thicknesses (gm/cm2) of several elements at 0.360 and 0.511MeV, as shown in Table1. Where I_0 is the number of particles of radiation counted without absorber, and I is the number of particles of radiation counted with absorber.

Observation Tables:

Table1. Total Attenuation Cross Sections (In Barn/Molecule) of Several Elements at 360 and 511 KeV.

Sr.No.	Elements	Atomic Number	Energy (keV)	
			662	1170
1	Mg	12	1.57	0.99
2	Ni	28	3.49	2.78
			3.48	2.77
3	Zn	30	3.73	2.58
			3.74	2.59
4	Ag	47	6.24	4.13
			6.25	4.12
5	Au	79	18.36	14.42
			18.37	14.43

First Line: Experimental values of total attenuation cross sections
Second Line: Theoretical values of total attenuation cross sections from J.H.Hubbell

RESULTS AND DISCUSSION

The results reported here in Table-1, are the experimental values of photon attenuation coefficients (σ_{tot}) determined in this work. The data of Table-I, represents actual values of photon attenuation coefficients (σ_{tot}) determined experimentally at 363keV, 661keV, 1171keV and 1332keV photon energy for Barite, Lead and Lead Glass and have not been reported experimentally earlier. Theoretical values (2) obtained for the specified absorbers and photon energies have not been shown in this table. However, the values agree well with theory within range of experimental errors. The overall uncertainty of the measured values was estimated to be around5% and had the following components: the counting statistics for I and Io exposure measurements and thickness uniformity of the absorbers. Thus the derived values of attenuation coefficients of these materials can be utilised in compilation of shielding thicknesses for photons in a radiation facilities where these materials are to be used.

From Table 1 it is observed that total attenuation cross sections of several elements at 360 and 511 keV goes on increasing with increasing atomic number. It is also observed that with increasing photon energy the values of total attenuation cross sections goes on decreasing.

CONCLUSION

The theoretical values of total attenuation cross sections for elements are available from [16] and the author carried out the work of their experimental measurement with excellent accuracy. The agreement of the author so measured values with theory confirms the theoretical considerations of the contribution of various processes such as photoelectric effect, the Compton scattering and the pair production. The measured total attenuation cross sections of element are useful for dosimetry and radiation shielding purpose. From the results of the present study, it is observed that the errors quoted are due to mainly counting statistics, since the sample impurity corrections are negligible. The agreement seems to be good within experimental error. The results are in good agreement [17-18].

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REFERENCES

[1]. Davisson C.M. and Evans R.D.(**1952**), *Rev. Mod. Phys*.24, 79
[2] E C McCullough Med.Phys.1975,2 307; Z.H.Cho, C.M.Tsai and G.wilson *Phys.Med.Biol*.20 879 **(1975)**
[3] K Parthasaradhi and H H Hansen *Phys Rev.* A, 10 563 **(1974)**
[4] S A Colgate *Phys.Rev*.87 592-01 **(1952)**
[5] Wyard S.J. *Phys.Rev*.87 165L **(1952)**
[6] P R Howland and W E Kreger *Phys.Rev*.95 407-10 **(1954)**
[7] S Shimizu, T Hanai and S Okamoto *Phys.Rev*.85 290-94 **(1952)**
[8] V Lakshminarayana and Jnanananda *J.Sci.Ind.Res*.B,20 1 **(1961)**
[9] R Quivy *J. Phys*. (Paris), 27 94-96 **(1966)**
[10] R C Murty *Proc.R.Soc.Lond*.84 1032-34. **(1964)**
[11] R P Knerr and H Z Vonach *Angew Phys*,22 507 **(1967)**
[12] M Wiedenbeck *Phys.Rev*. 126 1009 **(1962)**
[13] E H McCrary, Plassmann, J M Puckett,A L Conner and Zimmermann *Phys.Rev*.153 307-12**(1967).**
[14] J L Perkin .and A C Douglas. *Proc.Phys.Soc.Lond*.92 618 **(1967)**
[15] P P Pawar and G K Bichile *J.Chem.Pharm. Res*.3 (6) 693-706 **(2011).**
[16] J H Hubbell and S M Seltzer Tables of X-Ray Mass Attenuation coefficients and Mass Energy-Absorption Coefficients **(1995)**
[17] P P Pawar *J. Chem. Pharm. Res*, 3(4) 899-903 **(2011).**
[18] P P Pawar and G K Bichile *J.Chem.Pharm.Res.* 3(5) 267-273 (**2011**)