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Mass Attenuation Coefficient of Ethanol Soluble organic Compound for Gamma Ray Energy 0.84 MeV

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ABSTRACT

Mass attenuation of 0.84 MeV gamma radiations from ethanol soluble organic compound naphthalene studied for different concentrations, Mixture rule for theoretical calculation of attenuation coefficient is developed for the solution; our study explores the validity of the expected exponential absorption law for gamma ray radiations in solution and also provides an alternative method for direct determination of liner and mass attenuation coefficient of ethanol soluble organic compound naphthalene.

Keyword: Mass Attenuation Coefficient, Naphthalene, Gamma Energies.

Introduction:-

The photon attenuation coefficient is an important parameter for characterizing the penetration of x-rays or gamma ray in multi elemental materials [1,2]. In the shielding calculations of structure of nuclear power plants and dosimetry, parameters like attenuation coefficients of constructive material become very useful for the calculations of gamma ray shielding design. Mudahar and Satota (1991) studied total and partial mass attenuation coefficient of soil as a function of chemical composition [3]. The measurement technique of linear and mass attenuation coefficients for organic materials and their solutions for different gamma ray energies play an important role in radiation physics. Now a day the gamma rays are used in many fields like medicine, food preservation, for growing the seeds etc. [4, 5]. The half thickness values of materials are useful in radiation shielding. Many scientists have tried to develop the measurement technique and measured these values. This method is developed from single element linear attenuation coefficient of gamma rays to mixtures (solid and solid). Now a day it is extended for the mixtures of liquid and solid materials also we used those organic compounds which are insoluble in water but soluble in ethanol. In view of importance of study of gamma attenuation properties of organic materials and its various applications in science and technology [6, 7], we wish to study here the linear and mass attenuation coefficient of organic compounds which are insoluble in water but soluble in ethanol by developing mixture rule [8, 9].

Experimental arrangement:

In the experimental arrangement a cylindrical prefix container of internal diameter 2.462 cm was placed blow the source at a distance of 1.2 cm and above the detector at 2.2 cm by using efficient geometrical arrangement. The NaI (Tl) crystal is used as a detector connected to multichannel analyzer. A suitable size stand is made by for the source & absorbers (container) are kept along the axis of the detector in the stand. The whole system is enclosed in the lead (Pb) castle as shown in fig.1.

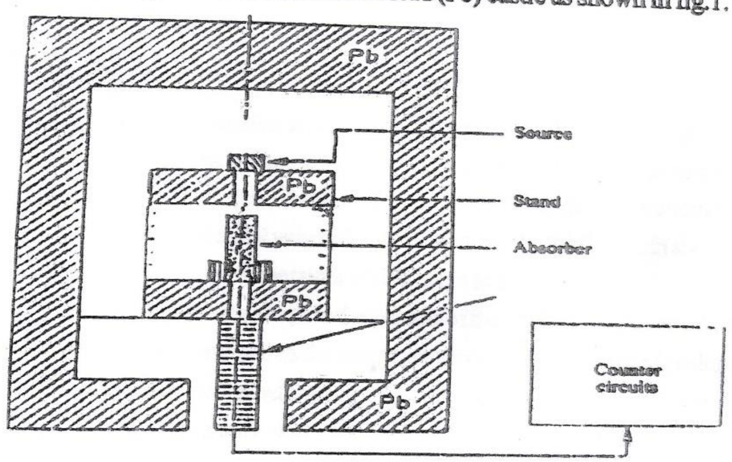

Fig. 1 Experimental set up for measurement of gamma absorption coefficient for solutions.

Material:-

The densities of organic compounds are obtained from Mark Index Volume 11 and molecular weights are calculated including the impurities. These are needed for calculating theoretical linear and mass attenuation coefficients by mixture rule using Hubbell's table. These organic compounds are of AR grade and their minimum essay is 99.5%.Ethyl alcohol is the alcohol of wine, beer, whiskey, and similar beverages. It is often referred to al simply 'alcohol'. Ethyl alcohol is also known as Grain Alcohol, since it can be prepared from starchy grains. Naphthalene and ethanol used for the measurement of linear attenuation coefficients are obtained from Analytical Rasayan S.D. Fine Chem. LTD, Boiser (A.R. Grade).

Preparation and Measurements:--

Pipette 20ml of ethanol & add to the prefix container. Then take Naphthalene and weigh it to four digital balances for 0.2, 0.4, 0.6, and 0.8 in such a manner and add to the different container in which 20 ml ethanol is already exist. Then shake well and note down the concentration by using formula,

$$V' = V_{Nap.} + V_{eth.}$$

Than, for concentration C.

$$C = \frac{V_{Nap.}}{V'}$$

Results and Analysis:-

The quantities measured in the experiment are the volumes of Naphthalene (VNP) and Ethanol (Veth) added together to give total volume V' = VNP + Veth, height (h) of the solution for calculating its volume V. the measured quantities along with the counts are shown in the various tables below. The second column shows the ratio of the volume of the Naphthalene (VNP) to the total volume V' of the solution. The third column shows the height (h) of the solution in the container which helps to calculate the volume of the solution V as to calculate the shrinkage in the volume of the naphthalene when added in the ethanol. The fourth column shows the counts per second of the interested peaks, A1, A2. The fifth column shows the natural log of the A0 and fourth column. The sixth & seventh column is the linear attenuation coefficient $\mu_{exp.}$ and μ_{tho}.The last column is the % error.

Here we have given the linear attenuation coefficient of solutions and ethanol soluble Naphthalene selected for our study the table1 show the liner attenuation coefficient for solutions by varying concentrations for gamma ray energies from 0.84MeV. In this table the first column shows the VNP./V' which is the concentration of the solution in terms of the ratio of volumes. The sixth column shows the experimental ?exp. for aqueous solution which is obtained by using formula

$$\mu_{exp.} = \frac{1}{h} \ln \frac{A_o}{A}$$

The seventh column shows theoretical ?theo. for aqueous solution obtained by using Hubbell table data in the mixture rule. The eighth column shows the % error or deviation of ?exp. from the ?theo. obtained by the formula

$$\% \text{ Error} = \frac{\mu_{theo.} - \mu_{exp.}}{\mu_{theo.}} \times 100$$

We observe from these tables that the ?exp. are within the acceptable limit showing very good agreement

Table: -1. Linear attenuation coefficient of Naphthalene soluble in Ethanol at Gamma ray energy 0.84 MeV

Ao =5.12(Sec-1)

Sr No.	$C=V_N/V'$	h cm	A (Sec^{-1})	Ln Ao/A	μ expt. Cm^{-1}	μ the. Cm^{-1}	% Error
1.	0.008696	4.24	4.71	0.083467	0.019686	0.019666	-0.09674
2.	0.017241	4.28	4.69	0.087722	0.020496	0.020203	-1.45037
3.	0.025641	4.32	4.68	0.089856	0.020800	0.020730	-0.33878
4.	0.033898	4.36	4.67	0.091995	0.021100	0.021248	0.0697292
5.	0.042017	4.38	4.65	0.096287	0.021983	0.021757	-1.0383
6.	0.050000	4.44	4.64	0.098440	0.022171	0.022258	0.39201
7.	0.057851	4.48	4.63	0.100598	0.022455	0.022751	1.302422
8.	0.065574	4.52	4.61	0.104927	0.023214	0.023236	0.094234
9.	0.073171	4.56	4.6	0.107098	0.023486	0.023712	0.953251
10.	0.080645	4.6	4.59	0.109274	0.023755	0.024182	1.762532

The table1. report our measurements of V', VNP/ V', h and ln(A0/A). This data can be used to estimate the mass attenuation coefficient as fallows. The mass mNP of the

Naphthalene are already weighed using four digit digital balances. Mass of ethanol (meth.) is obtained at room temperature by multiplying density of ethanol to volume of ethanol. The density of ethanol at room temperature is obtained from hand book of Chemistry and Physics (fourteenth edition). The cross sectional area of the container is measured. Then the experimental mass attenuation coefficient for solutions is calculated by the formula as,

$$\frac{\mu}{\rho} - \frac{a}{m} \times \ln\left(\frac{A_o}{A}\right)$$

Where m = mNP + meth. mass of the solution, AO is the initial gross area of the interested peak of the observed spectrum when gamma rays are passed through the empty container while A is the gross area obtained for the different concentrations of the solution after passing gamma rays through them.

Table: -2. Mass attenuation coefficient of Naphthalene soluble in Ethanol at Gamma ray energy 0.84MeV

Ao =5.12 (Sec-1)

Sr No.	$C=V_N/V'$	a/m	Ln Ao/A	(μ/ρ)expt. Cm^2/gm	$(\mu/\rho)$the. Cm^2/gm	% Error
1.	0.008696	2.643409	0.083467	0.024782	0.024797	0.061359
2.	0.017241	2.629863	0.087722	0.025724	0.025376	-1.37107
3.	0.025641	2.616647	0.089856	0.026028	0.025940	-0.3387
4.	0.033898	2.603749	0.091995	0.026327	0.026491	0.621436
5.	0.042017	2.581955	0.096287	0.027227	0.027029	-0.73123
6.	0.050000	2.578864	0.098440	0.027508	0.027555	0.168114
7.	0.057851	2.566855	0.100598	0.027784	0.028068	1.009532
8.	0.065574	2.555123	0.104927	0.028647	0.028569	-0.27281
9.	0.073171	2.543657	0.107098	0.028907	0.029059	0.520715
10.	0.080645	2.532449	0.109274	0.029163	0.029538	1.266698

The Bragg mixture rule for mass attenuation coefficient is given by,

$$\bar{m}\left(\frac{\mu}{\rho}\right) = m_{Np}\left(\frac{\mu}{\rho}\right)_{NP} + m_{eth}\left(\frac{\mu}{\rho}\right)_{eth}$$

The graph of $m\frac{\mu}{\rho} = a \ln\left(\frac{A_o}{A}\right)$ against mass of ethanol gives a straight line intercept gives $m_{NP}\left(\frac{\mu}{\rho}\right)_{NP}$ and slope gives $\left(\frac{\mu}{\rho}\right)_{eth}$. The $\left(\frac{\mu}{\rho}\right)_{NP}$ and $\left(\frac{\mu}{\rho}\right)_{eth}$

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are calculated for naphthalene and ethanol at various gamma ray energies. The measured values are found to agree well with the theoretical values given by Hubbell. The experimental and theoretical mass attenuation coefficient values are given in the fifth and sixth column of the tables 2. It is found to agree with the standard value.

The electron cross section for different gamma ray energies is calculated by using the relation

$$\sigma = \frac{M}{N} \times \left(\frac{\mu}{\rho}\right)$$

Where M is the molecular weight of the material and N is Avogadro number. These experimental and theoretical values are tabulated in the fifth and sixth column of the tables 2. the last column of the in the table of % error with respect to theoretical values of mass absorption coefficient of solution. The formula used for % error is as fallows

$$\frac{\left(\frac{\mu}{\rho}\right)_{th.} - \left(\frac{\mu}{\rho}\right)_{exp.}}{\left(\frac{\mu}{\rho}\right)_{th.}} \times 100$$

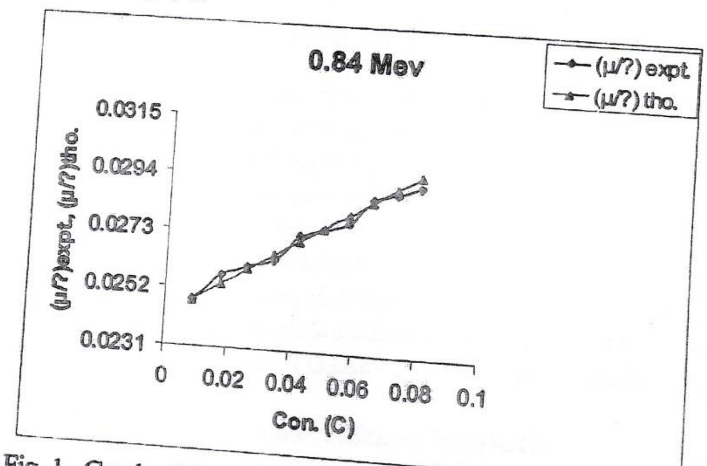

Fig. 1. Graph of Con. (C) Vs $(\mu/\rho)_{exp.}$ and $(\mu/\rho)_{theo.}$ for 0.84 MeV Gamma rays energy

The graph of $(\mu/\rho)_{exp}$ and $(\mu/\rho)_{theo.}$ versus concentration (C) = V_{NP}/V at various gamma ray energy for above said solutions are as shown in the Fig.1 The experimental points in the Fig1. are nearly lying on the theoretical line.

Conclusion:-

We have experimentally applied in details the mixture rule for non aqueous solution of salt developed by us and measured the linear and mass attenuation coefficients of salt solutions with varying concentration for gamma energies from 0.84 MeV. Here we have experimentally applied in details the mixture rule for naphthalene soluble in ethanol with varying concentration gamma rays energies from 0.84 MeV.

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