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Research Article

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To study the linear and mass attenuation coefficient of alcohol soluble compound for gamma rays at energy 662 KeV

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ABSTRACT

Linear and mass attenuation of 662 KeV gamma radiations from alcohol ethanol by dilute solution of para-nitro aniline ($C_6H_6O_2N_2$) 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 radiation in solution and also provides an alternative method for direct determination of linear and mass attenuation coefficients of soluble compound in alcohol.

Keywords: Mass and linear attenuation coefficients, Gamma-rays, HP (Ge) photon detector, Para-nitro aniline and ethanol.

INTRODUCTION

Linear and mass attenuation coefficient for gamma rays for different materials and solutions plays an important role in RSID units. There are different measurement techniques to measure them. As the technology developed day by day, the gamma rays are used in many fields, like medicine, food preservation and with their measurement techniques are developed but we find these measurements can be made with still simpler method. Recently Teli et al has developed the mixture rule and we have modified the rule with simpler approach and are considered for our research work.

This method is developed from single element mass attenuation coefficient of gamma rays to mixtures (solute and solvent). Dongarge S.M. (2010) extended for the mixture of liquid and solid materials also. There are various reports on the measurement of these quantities (1-6). Hubbell (3) has developed the rule for calculation of gamma absorption coefficient for mixtures and gave tables of theoretical values for various elements and their mixtures. Teli et al (1994) have measured the attenuation coefficient of 123 Kev gamma radiations by dilute solution of sodium chloride. Dongarge et al (2010) reported the linear attenuation coefficient for measurement of linear attenuation coefficient of gamma rays for ammonium sulfate salt by aqueous solution method 1.28 MeV gamma energy.

So for the study of both types of absorption coefficient for gamma rays has been done for materials in solid and crystal forms by using various techniques as reported above and the observations are compared with the theoretical values as calculated from Hubbell's mixture rule and his table

We give here measurements of the attenuation of 662 KeV gamma radiations in ethanol soluble compound Para-nitro aniline of different concentrations.

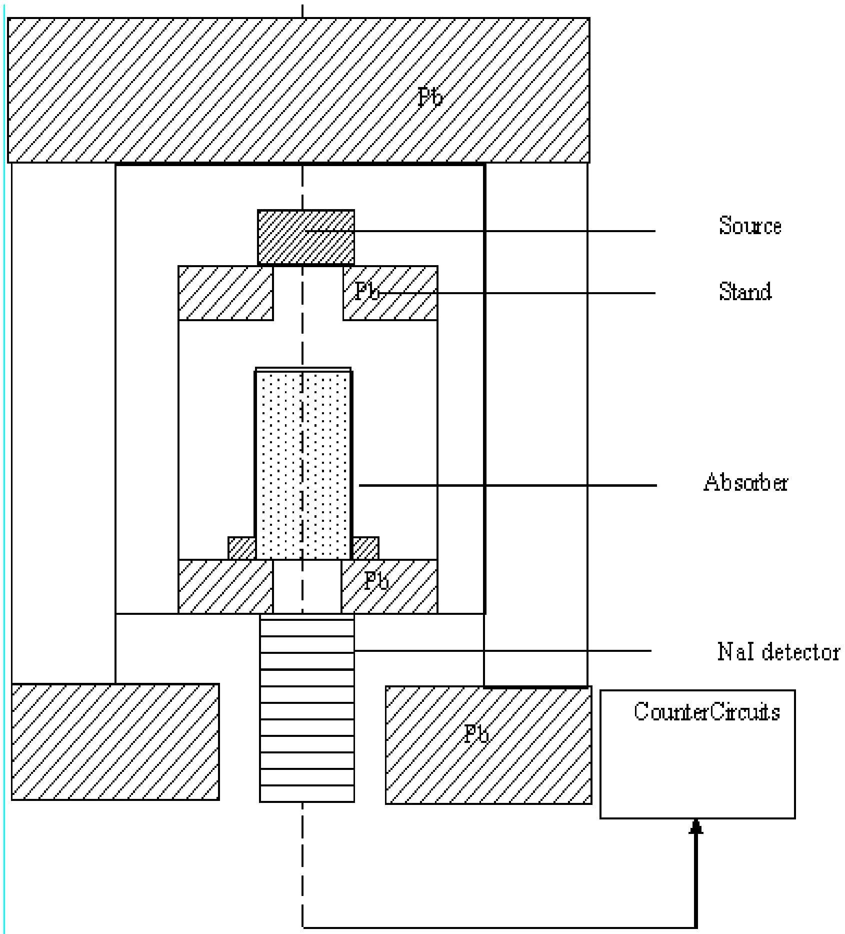


Fig. 1 - Experimental Arrangement

EXPERIMENTAL SECTION

The experimental arrangement is as shown in fig.(1) cylindrical prefix container of internal diameter 2.46 cm was placed below the source at a distance 1.2 cm and above the detector at 2.2 cm by using efficient geometrical arrangement. The NaI (T1) crystal is used as the detector connected to multichannel analyzer. The stand is made up of prefix sheet with suitable size the source and absorber are placed along the axis of the stand the whole system is enclosed in a lead castal.

Method of observations

First the gamma rays are passed through empty container reaching the detector. The spectrum is obtained for 1800 sec. using MCA which gives plot of channel number Vs counts. We select the interested peak which is smoothed for avoiding the random nature and obtain the peak gross area Ao (The sum of the spread counts which are coming under the peak) this is obtained because in MCA the counts get spread over some energy range around the photo peak. This increases the accuracy of measured solution kept in the container and gamma rays are passed through it. The concentration varied by p-nitro-aniline compound adding to it. The gamma rays are passed through such solutions and interested peak gross area measured as A_1, A_2, …………… A_{10} the other quantities measured in the experiment are the volume of p-nitro aniline (V_a) and ethanol V_e added together to give total volume (V).

The actual volume V of the solution is calculated by measuring its height in the container and by multiplying it by the cross-sectional inner area of the container (πr^2). This procedure is repeated for all the concentrations we prepared for gamma energy 662 KeV.

Theoretical development for the experiment

The graph of In (A_0/A) versus height of liquid column (h) is measured. The observed points are seen to be closely distributed around line having positive slopes. These lines are obtained by fitting the experimental data by the least square method. Their slope gives the linear coefficient and thus the linearity of the curves with positive slopes suggests the relation.

$\left\{\frac{A_0}{A}\right\}=e^{-\mu h}$ ------------ (1)

This indicates the validity of the standard exponential absorption law of gamma rays when they pass through liquid substances.

$A=A_0e^{-\mu h}$ ------------- (2)

We know Hubbell's mixture rule (1982). The mass attenuation coefficient of gamma rays in chemical or any other mixtures of compound is assumed to depend upon the sum of the cross section presented by all the atoms in the mixture because the bonds are only of the order of few electron volts; there have no significant effects on the Compton, photo or pair interaction.

Mass attenuation coefficient for solution is given by:

$\frac{\mu}{\rho}=\sum_i W_i \left\{\frac{\mu}{\rho}\right\}_i$ ------------ (3)

Where ρ is the density and which is made up on solution of elements. W_i is the fraction by weight.

The effect of shrinkage on the linear attenuation coefficient of a solution is given by Bragg mixture rule which we assume without approximation for alcohol namely,

$$\left(\frac{\mu}{\rho}\right)_{sol}=\left(\frac{\mu}{\rho}\right)_a W_a+\left(\frac{\mu}{\rho}\right)_c W_c \quad \text{---------} \quad (4)$$

When the Para nitro aniline is dissolved in alcohol then the homogeneous solution is forms. If the solution is homogeneous then one can neglect the density from both sides. If we use this formula for the proposed work in the following way then it will be

$\mu_{the}= \mu_{alco}w_{alco} + \mu_{aniline}w_{aniline}$ ---------- (5)

table 1 gives the values using equation (5) for various concentration and theoretical values of (μ_{alco}) and (μ_{comp})are calculated by multiplying their densities to (μ/ρ) which is calculated by Hubble mixture rule.

$\frac{\mu}{\rho}=\sum_i W_i \left\{\frac{\mu}{\rho}\right\}$ -------------- (6)

Is used to calculate theoretical $\mu_{(the)}$ given in the table-1

Solution technique for calculation of linear attenuation coefficient of pure Para-nitro aniline.
Using the data the experimental linear attenuation coefficient of the p-nitro aniline solution ($\square_{exp.}$) is obtained from,

$\{\mu_{exp}\}=\frac{1}{h}In\left\{\frac{A_0}{A}\right\}$_______________ (7)

Where h is the height of the solution.
The theoretical (μ_{the}) and experimental (μ_{exp}) is obtained by equation (5) and equation (7) respectively, the values are given in the table 1 (μ_{exp})values in fifth column and(μ_{the}) values are given in sixth column and The percent error is obtained by the following eq^n (8) and is given in seventh column of table 1.

$\% \text{ error } = \frac{\{\mu\}\text{the.}-\{\mu\}\text{exp}}{\{\mu\}\text{the}}\times 100$ ______________ (8)

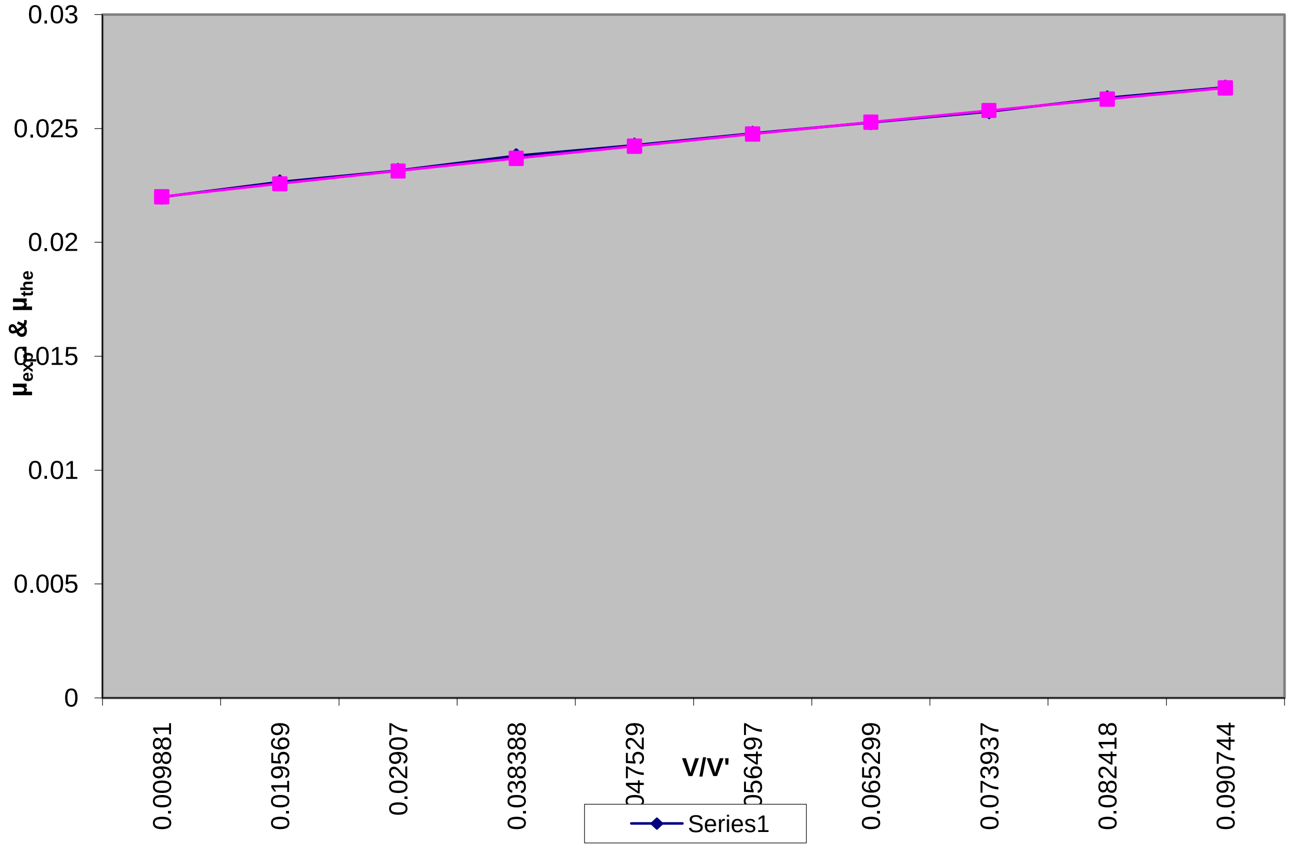
$\frac{\mu}{\rho}$ for alcohol and par nitro aniline is obtained from Hubbell Table by multiplying its density we get theoretical $\mu_{(the)}$ for alcohol and par nitro aniline, then by using eq.(5) μ_{the} is obtained, the results calculated are tabulated in table 1 for nitro aniline solution. Eq^n (5) is the eq^n of straight line between $\mu_{(exp)}$ and concentration in which alcohol volume is fixed. The intercept is the attenuation coefficient for the alcohol and its slop the attenuation coefficient for the Para nitro aniline. From graph the slope and intercept are obtained which is the linear attenuation coefficient for Para nitro aniline and alcohol if we multiply them by fraction by weight. We observe from these tables that, the experiments $\mu_{(exp)}$ are within the acceptable limit showing very good agreement. The graph of μ_{exp} (cm^{-1}) versus concentration Va/V at 662KeV gamma ray energy for p-nitro-aniline are shown in graph 1. The experimental points in the figs are nearly lying on theoretical line.

Table 1 Linear attenuation coefficient for Para nitro aniline solution in ethanol for energy 662keV

A0 =17.75

v/v'	h	A	ln(A0/A)	μ_{exp}	μ_{the}	%error
0.009881	4.24	16.17	0.093227842	0.021987699	0.022005125	0.079193063
0.019569	4.28	16.11	0.096945319	0.022650775	0.022577841	-0.323035319
0.02907	4.32	16.06	0.100053807	0.023160604	0.023139502	-0.091192306
0.038388	4.36	16	0.103796794	0.023806604	0.023690345	-0.490744425
0.047529	4.38	15.96	0.106299924	0.024269389	0.024230724	-0.15956871
0.056497	4.44	15.9	0.110066407	0.024789731	0.024760877	-0.116532973
0.065299	4.48	15.85	0.113216016	0.025271432	0.025281216	0.03869921
0.073937	4.52	15.8	0.116375576	0.025746809	0.02579186	0.174670875
0.082418	4.56	15.74	0.120180273	0.026355323	0.026293222	-0.236184528
0.090744	4.6	15.69	0.123361949	0.026817815	0.026785422	-0.120934193

Graph 1 Linear attenuation coefficient for para nitro aniline solution in ethanol for energy 662keV



Measurement of mass absorption coefficient of p-nitro-aniline at 662KeV gamma ray energy.

The mass (m_a) of the p-nitro-aniline is already weighted using four digit digital balance. Mass of ethanol (m_e) is obtained (at room temp.) by multiplying density of ethanol to volume of ethanol.

The cross sectional area of the container is measured, and then the experimental mass-attenuation coefficient for p-nitro-aniline solution is calculated by the formula as

$$\frac{\mu}{\rho} = \frac{A}{m}\ \mathrm{In}\left\{\frac{A_0}{A}\right\} \quad \text{------------ (9)}$$

Where -
m = $m_a + m_e$ mass of solution
A = gross area obtained for the different concentrations of the solution after passing gamma rays through them.
A_o = is the initial gross area of the interested peak of the observed spectrum when gamma rays are passed through the empty container.

The Brags mixture rule for mass attenuation coefficient is given by

$$\mathrm{m}\left\{\frac{\mu}{\rho}\right\} = \mathrm{m_a}\left\{\frac{\mu}{\rho}\right\} + m_e\left\{\frac{\mu}{\rho}\right\}$$

The graph of m $\left\{\frac{\mu}{\rho}\right\}$ = AIn $\left\{\frac{A_0}{A}\right\}$against mass of ethanol gives a straight line whose intercept gives $\mathrm{m_a}\left\{\frac{\mu}{\rho}\right\}_a$ and slope gives $\left\{\frac{\mu}{\rho}\right\}_e$. The $\left\{\frac{\mu}{\rho}\right\}_a$and $\left\{\frac{\mu}{\rho}\right\}_e$ values are calculated for p-nitro-aniline and ethanol at 662 KeV gamma ray energies. The measured values are found to be agree well with the theoretical values.

The percentage error with respect to theoretical values of mass absorption coefficient of p-nitro-aniline the formula as follows.

$$\%\ \text{error} = \frac{\left\{\frac{\mu}{\rho}\right\}\text{the.} - \left\{\frac{\mu}{\rho}\right\}\text{exp}}{\left\{\frac{\mu}{\rho}\right\}\text{the}} \times 100 \quad \text{-----------} \quad (10)$$

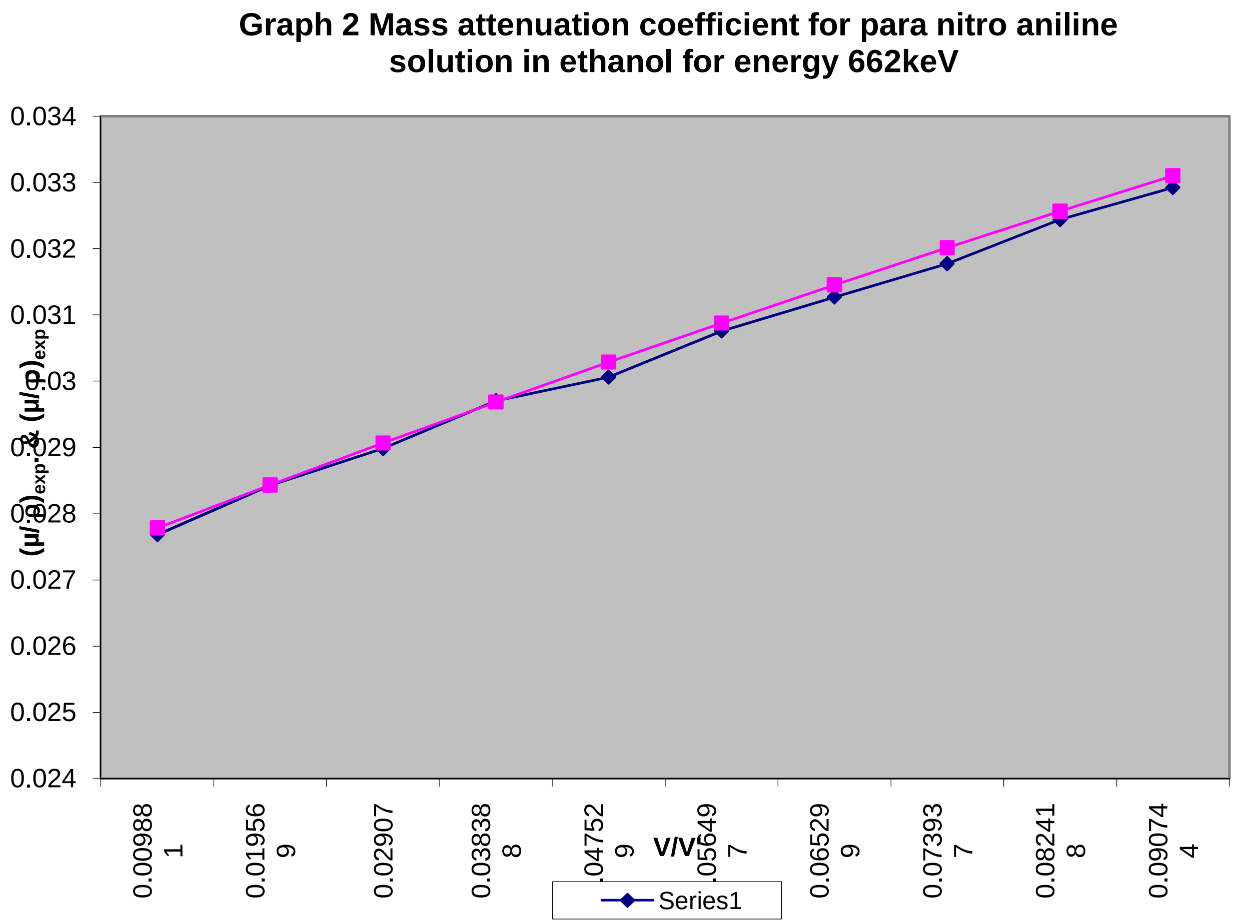


Table 2 Mass attenuation coefficient for Para nitro aniline solution in ethanol for energy 662keV

A_0 = 17.75

v/v'	h	A/m	A	ln(A0/A)	$(\mu/\rho)_{exp}$	$(\mu/\rho)_{the}$	%error
0.009881	4.24	0.29691	16.17	0.093227842	0.027679929	0.02778095	0.363633848
0.019569	4.28	0.29324	16.11	0.096945319	0.028428317	0.028430272	0.006874815
0.02907	4.32	0.28966	16.06	0.100053807	0.02898205	0.029063756	0.281128774
0.038388	4.36	0.28617	16	0.103796794	0.029704016	0.029681976	-0.074254707
0.047529	4.38	0.28277	15.96	0.106299924	0.030058202	0.030285476	0.750440553
0.056497	4.44	0.27944	15.9	0.110066407	0.030757086	0.030874776	0.381185897
0.065299	4.48	0.27619	15.85	0.113216016	0.031269342	0.031450372	0.575605624
0.073937	4.52	0.27302	15.8	0.116375576	0.031772539	0.032012736	0.750316817
0.082418	4.56	0.26991	15.74	0.120180273	0.032438431	0.032562318	0.380461632
0.090744	4.6	0.26688	15.69	0.123361949	0.032923086	0.033099551	0.533131316

CONCLUSION

Our experimental measurement of linear and mass attenuation coefficient of alcohol soluble Para nitro aniline for different concentrations and estimated from them the attenuation coefficient for pure compound by using the mixture rule developed by Teli (1998) established the validity and utility of the solution technique. This method is simple and avoids the need of preparation of pure crystalline compound for experiment thereby saving time and expenditure. The use of multichannel analyzer has also improved the results as we could replace the counts at the photo peak by the area under it. Further the variation of concentration of solution is made easy by adding alcohol to solution without changing the compound amount in it. This saves the compound quantity and thus further economizes the experiment.

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REFERENCES

[1] Dongarge S M et al**,** *Intl J of Phys&ApplISSN Volume 2, Number 1* **(2010),** *pp. 1--8*
[2] GerwardL :*Rad Phys And Chem***(1996)** *48,679*
[3] Hubbell J H *Int J ApplRadiatIsot***(1982)** *33, 1269*
[4] J H Hubbell; S M Seltzer *Tables of X-Ray Mass Attenuation coefficients and Mass EnergyAbsorption Coefficients 1keV to 20MeV for Elements z=1 to 92 and 48 Additional Substances of Dosimetric Interest* (**1995)**
[5] Teli M T ,Chauehari L M and Malode S S: *AppliRadiatIsot* **(1994 a)** *45,987*
[6] Teli M T:*AppliRadiatIsot***(1997)**
[7] S M Midgley *Phys. Med. Biol. 49*, **2004**, *307–25.*
[8] S M Midgley *Phys. Med. Biol. 50*, **2005**, *4139–57.*
[9] Pravina P. Pawar *et al J. Chem. Pharm. Res., **2011**, 3(5):41-50*
[10] Pravina P. Pawar *et al J. Chem. Pharm. Res.,* **2011**, *3(6):693-706*
[11] Mitkar S.R. and S. M. Dongarge *J. Chem. Pharm. Res.,* **2012**, *4(6):3116-3120*