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STUDY OF GAMMA ABSORPTION PROPERTIES OF SOME WATER SOLUBLE BECOSULE CAPSULE BY VARYING CONCENTRATION AT 0.36 MEV.

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ABSTRACT

Mass and linear attenuation coefficients are two quantities used in the study of gamma rays. Their methods of measurement have been developed by many people for solid and aqueous solutions. But the method developed for aqueous solutions is not complete so we have tried to develop an equation for direct measurement of linear attenuation coefficient of becosule capsule in aqueous solutions. This method is useful in measuring the absorption coefficient of capsules (Vitamins) without obtaining them in pallet form. Also it verifies the composition specified by the manufacturer, which defines originality of capsule.

1. INTRODUCTION

Mass and linear attenuation coefficients are two quantities used in the study of gamma rays. Teli et al.[1] measured the linear and mass attenuation coefficient of water soluble salts $MgCl_2$, $6H_2O$, Sulphate carbonate series compounds For 0.123 MeV to 1.33 MeV gamma radiation by varying concentration of salt solution. The mixture rule[2] for solutions by taking in to consideration the shrinkage of volume when salt is added to water as suggested by Gerward[3] using the revised technique, [4]Dongarge, S. M.; Mitkar, S.R.(2012) Measurement of linear and mass attenuation coefficient of alcohol soluable compound for Î³-rays at energy 0.36 MeV.

Hubbel[6] has calculated mass attenuation coefficient for 92 elements for hydrogen (z=1) to Uranium (z=92) and some compounds from photon energies 1 kev to 20 mev. He also tabulated the mass attenuation coefficient of mixture compounds and 92 elements.

In view of importance of the study of gamma attenuation properties of materials and its various applicability in technology and human health, we wish to study here the absorption properties of materials (capsules) in liquid form or those that are soluble in a solvent such as water for checking originality of Becosules.

Further we give measurement of linear and mass attenuation coefficient of Becosules capsules by developing mixture rule.

2. EXPERIMENTAL ARRANGEMENT -

The experimental arrangement is as shown in Fig.1 at 0.36 MeV. The gamma rays of 0.36 MeV. (The source is with strength 10 mCi) are narrowed by passing through lead holes as in Fig. The sodium iodide (Thalium) 1.3/4.2 inches crystal is used as the detector connected to 4k multichannel analyzer and the whole system is enclosed in a lead as shown in Fig. 1

A cylindrical prefix container of internal diameter 2.38 cm was placed below the source at a distance of 1.2 cm by using efficient geometrical arrangement.

3. METHODS AND OBSERVATIONS

The Becosules capsule is weighted by manufacturer and one complete capsule taken in the cylindrical prefix container of internal diameter 2.38 cm. twenty milliliter of distilled water was added to it to dissolve the Becosule. The height of the solution was measured by travelling microscope. Further for varying concentrations distilled water of measured volume was added. Volume of the capsule Vc (Fixed), Vw volume of water, m_w is the mass water and m_c mass of Becosule (Capsule) were measured accurately. Every time the height of solution (h) was measured by using a travelling microscope.

4. RESULTS AND ANALYSIS

The graph of ln(Ao/A) versus height of the liquid column (h) as shown in Fig. 2. The observed points are seen to be closely distributed around lines having positive slopes. These lines are obtained by fitting the experimental data by the least square method. Their slope gives the linear coefficient (cm^{-1}) and thus the linearity of the curves with positive slopes suggests the relation.

$$\frac{A_O}{A} = e^{-\mu h} \qquad \text{......................1}$$

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

$$A = A_0 e^{-\mu h} \qquad \text{……… ....2}$$

We have Hubbel's mixture rule. 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 sections presented by all the atoms in the mixture because the bends are only of the order of few electron volts, there have no significant effects on the Compten photo or pair interaction.

Mass attenuation coefficient for solution is given by.

$$\frac{\mu}{\rho} = \Sigma_i W_i \left(\frac{\mu}{\rho}\right)_i \qquad \text{............3}$$

Where ρ is the density and which is made up on solutions 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 aqueous solution of salts, namely,

$$\left(\frac{\mu}{\rho}\right)_S = \left[\frac{\mu}{\rho}\right]_w W_w + \left[\frac{\mu}{\rho}\right]_{Ca} W_{Ca} \qquad \text{........4}$$

If we use this formula for the proposed work by the following way

$$\left(\frac{\mu}{\rho}\right)_S = \left(\frac{\mu_W}{\rho_W}\right) \times w_W + \times W_{B3} + \left(\frac{\mu_{FA}}{\rho_{FA}}\right) \times W_{FA} + \left(\frac{\mu_{B1}}{\rho_{B1}}\right) \times W_{B1} + \left(\frac{\mu_B}{\rho_B}\right) \times W_B + \left(\frac{\mu_{B12}}{\rho_{B12}}\right) \times W_{B12} \qquad \text{.......5}$$

For water

$$\left(\frac{\mu_W}{\rho_W}\right) w_W = 2\left(\frac{\mu_H}{\rho_H}\right) W_H + \left(\frac{\mu_O}{\rho_O}\right) W_O$$

For vitamin C

$$\left(\frac{\mu_C}{\rho_C}\right) W_C = 6\left(\frac{\mu_C}{\rho_C}\right) W_C + 8\left(\frac{\mu_H}{\rho_H}\right) W_H + 6\left(\frac{\mu_O}{\rho_O}\right) W_O$$

For Vitamin B_6

$$\left(\frac{\mu_{B6}}{\rho_{B6}}\right) W_{B6} = 8\left(\frac{\mu_C}{\rho_C}\right) W_C + 11\left(\frac{\mu_H}{\rho_H}\right) W_H + \left(\frac{\mu_N}{\rho_N}\right) W_N + 3\left(\frac{\mu_O}{\rho_O}\right)$$

For vitamin B_2

$$\left(\frac{\mu_{B2}}{\rho_{B2}}\right) W_{B2} = 17\left(\frac{\mu_C}{\rho_C}\right) W_C + 20\left(\frac{\mu_H}{\rho_H}\right) W_H + 4\left(\frac{\mu_N}{\rho_N}\right) W_N + 6\left(\frac{\mu_O}{\rho_O}\right) W_O$$

For vitamin B_3

$$\left(\frac{\mu_{B3}}{\rho_{B3}}\right) W_{B3} = 6\left(\frac{\mu_C}{\rho_C}\right) W_C + 5\left(\frac{\mu_H}{\rho_H}\right) W_H + \left(\frac{\mu_N}{\rho_N}\right) W_N + 2\left(\frac{\mu_O}{\rho_O}\right) W_O$$

For folic Acid

$$\left(\frac{\mu_{FA}}{\rho_{FA}}\right) W_{FA} = 19\left(\frac{\mu_C}{\rho_C}\right) W_C + 19\left(\frac{\mu_H}{\rho_H}\right) W_H + 7\left(\frac{\mu_N}{\rho_N}\right) W_N + 6\left(\frac{\mu_O}{\rho_O}\right) W_O$$

For vitamin B_1

$$\left(\frac{\mu_{B1}}{\rho_{B1}}\right) W_{B1} = 12\left(\frac{\mu_C}{\rho_C}\right) W_C + 17\left(\frac{\mu_H}{\rho_H}\right) W_H + \left(\frac{\mu_N}{\rho_N}\right) W_O + 4\left(\frac{\mu_N}{\rho_N}\right) W_N + \left(\frac{\mu_S}{\rho_S}\right) W_S$$

For Biotin

$$\left(\frac{\mu_B}{\rho_B}\right) W_B = 10\left(\frac{\mu_C}{\rho_C}\right) W_C + 16\left(\frac{\mu_H}{\rho_H}\right) W_H + 3\left(\frac{\mu_O}{\rho_O}\right) W_O + 2\left(\frac{\mu_N}{\rho_N}\right) W_N + \left(\frac{\mu_S}{\rho_S}\right) W_S$$

For vitamin B_{12}

$$\left(\frac{\mu_{B12}}{\rho_{B12}}\right)W_{B12} = 63\left(\frac{\mu_C}{\rho_C}\right)W_C + 88\left(\frac{\mu_H}{\rho_H}\right)W_H + \left(\frac{\mu_{CO}}{\rho_{CO}}\right)W_{CO} + 14\left(\frac{\mu_N}{\rho_N}\right)W_N + 19\left(\frac{\mu_O}{\rho_O}\right)W_O + \left(\frac{\mu_P}{\rho_P}\right)W_P$$

For solution of Becosule and water we have,

$$\left(\frac{\mu}{\rho}\right)_S = \left(\frac{\mu_W}{\rho_W}\right)W_W + \left(\frac{\mu_{Ca}}{\rho_{Ca}}\right)W_{Ca} \quad ....6$$

$$\left(\frac{\mu_{Ca}}{\rho_{Ca}}\right) = \left(\frac{\mu_C}{\rho_C} + \frac{\mu_{B1}}{\rho_{B1}} + ...\right)$$

Where $\left(\frac{\mu}{\rho}\right)_s$

is mass automation coefficient of becasule

and $W_{ca} = [W_C + W_{B1} + ...]$

But for homogeneous solution the density is same.

$$\therefore \left(\frac{1}{\rho}\right)_S = \left(\frac{1}{\rho_W}\right)W_W + \left(\frac{1}{\rho_{Ca}}\right)W_{Ca}$$

They can be neglected from above equation so equation 6 becomes.

They can be neglected from eq^n 6 eq^n 1 becomes.

$$\mu_S = \mu_W \times W_W + \mu_C \times W_C$$

Table 1 gives the values μ of for from equation 7 for various concentration C and theoretical values of (μ / ρ) are calculated by Hubbel mixture rule which is given by

$$\left(\frac{\mu}{\rho}\right) = \Sigma_i W_i \left(\frac{\mu}{\rho}\right)_i$$

Fig. 2 - shows the graph of against concentration for experimental observations and theoretical values obtained from equation 7. The data are fitted on a straight line by the least square method.

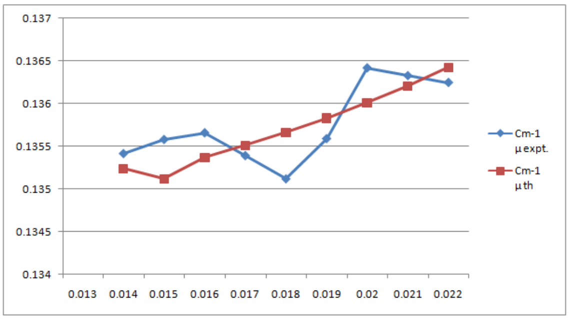

Fig. 2 - Graph of con. (C) V_s $\mu_{exp.}$ & $\mu_{theo.}$ For 0.36 MeV Gamma rays energy

The validity of eq^n 7 gives us with a new and alternative method for a solution.

Table:1 Experimental and theoretical values of linear attenuation coefficient of solution Becosules soluble in water at Gamma ray energy 0.36 MeV.

Ao=15.8811(sec-1)

Sr no	C=Vw /V'	h cm	A(Sec-1)	Ln Ao/A	Cm-1 µ expt.	Cm-1 µ the	% Error
1	0.022483	4.7	8.371	0.640356	0.136246	0.136424	0.130261
2	0.021435	4.75	8.311	0.64755	0.136326	0.136207	-0.08724
3	0.020481	4.8	8.251	0.654795	0.136416	0.13601	-0.29799
4	0.019608	4.92	8.15	0.667112	0.135592	0.13583	0.175461
5	0.018806	5	8.081	0.675614	0.135123	0.135665	0.399391
6	0.018068	5.12	7.94	0.693216	0.135394	0.135512	0.087306
7	0.017385	5.26	7.78	0.713573	0.13566	0.135371	-0.21361
8	0.016752	5.39	7.654	0.729901	0.135418	0.13524	-0.13104
9	0.016752	5.5	7.534	0.745704	0.135582	0.135119	-0.34306
10	0.015614	5.62	7.412	0.762029	0.135592	0.135006	-0.43462

CONCLUSION:

To study linear and mass attenuation of Becosules at 0.36 MeV. Soluble in water explores the validity of the exponential absorption law for gamma radiation in solution also as in solids and provide a direct and new method for the determination of the linear μ_S and mass $\left(\frac{\mu_s}{\rho_s}\right)$ attenuation coefficients for soluble substance.

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