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Study of Attenuation Coefficient Measurements in Buffalo Milk at Gamma Energy 662 keV

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Abstract

Mass attenuation coefficients μ of milk sample have been studied by using gamma radiation at energy 662keV. The results have been presented in a graphical form. The graph of path length (cm) V/s particle intensity shows linearity. The points are fitted with least square method. The slope there graphs gives the value of the liner absorption coefficient. The density of milk sample at different concentrations V/s attenuation coefficients shows that attenuation coefficients decreases exponentially with increasing the density and confirms the interaction of gamma radiations with various concentrations of milk sample The mass attenuation coefficient usually depends upon the density and the concentration of the milk samples. Exponential decay was observed. This validates the gamma absorption law.

Keywords: Attenuation coefficient, gamma ray energy sources, gamma ray spectrometer, NaI (Tl) detector, etc

Introduction

The study of interaction of gamma radiations with the materials of common and industrial use, as well as of biological and commercial importance has become major area of interest in the field of radiation science. For a scientific study of interaction of radiation with matter a proper characterization and assessment of penetration and diffusion of gamma rays in the external medium is necessary. The mass attenuation coefficient usually depends upon the energy of radiations and nature of the material. For characterization the penetration and diffusion of gamma radiation in any medium, the roll of attenuation coefficient is very important.

An extensive data on mass attenuation coefficients of gamma rays in compound and mixtures of dosimetric interest have been studied by[1] in the energy range of 1 kev to 20 Mev. An updated version of attenuation coefficients for elements having atomic number from 1-92 and for 48 additional substances have been compiled by[2]. Other scientists[3-7]. The reports on attenuation coefficients measured by researchers reported[8-24] for different energies for various samples in solid as well as liquid.

In view of the importance of the study of gamma attenuation properties of materials and its various applications in science, technology, agriculture and human health, we have embarked on a study of the absorption properties of buffalo milk sample contains mixture of microelements.

The absorption coefficient of milk is dependent on its content and gamma- ray energy. This work describes a study of content dependence on measurements of attenuation of gamma-radiation at gamma-ray energy 662 keV of milk sample.

The attenuation of gamma rays expressed as:

$$I = I_o \exp(-\mu x) \quad (1)$$

Where I_o is the number of particles of radiation counted during a certain time duration without any absorber, I is the number counted during the same time with a thickness *x* of absorber between the source of radiation and the detector, and μ is the linear absorption coefficient. This equation may be cast into the linear form,

$$\log I = \log I_o - \mu x$$

i.e. $\mu x = \log (I_o / I)$

$$\text{i.e. } \mu = (1/x) \log(I_o/I) \quad (2)$$

The mass absorption coefficient of milk μ_m defined as,

$$\mu_m = \mu/\rho \quad (3)$$

Where, μ_m is the mass attenuation coefficient and ρ is the density of milk sample. The unit of μ is cm^{-1} and that of μ_m is cm^2/gm.

Material and Methods

The experimental arrangement is as shown in figure-1. A cylindrical glass container of internal diameter 2.9 cm placed in between detector and source having nominal activity 3.26 μCi. The collimated beam of gamma source and cylinder kept in a stand. The assembly was placed in lead castle. The distance between detector and source was 18.3 cm. The transmitted and scattered gamma rays were detected using USB-MCA along with external NaI (Tl) detector. First, the cylinder was kept empty keeping acquisition time 600 sec and readings were taken for gamma rays of a particular energy and noted as I_o.

Thereafter, the path length(x) of milk sample varies by path length 1 to 10 cm respectively and readings were taken as I. Same procedure used for each samples with concentrations by adding water in the milk and prepared for 10%, 20%, 30%,……..100%. The NaI (Tl) crystal was used as detector in conjunction with counter circuits. The whole system enclosed in a lead castle.

Results and Discussion

The concentration of milk samples Vs path lengths are shown in tables 1 to 5. Linear attenuation coefficients Vs concentration of milk samples by using gamma source Cs-137 in shown in table 6.

Experimental values of number of particles of radiation without absorber (I_o) per number of particles of radiation counted with absorber (I) were linearly increased with increasing path length in cm as shown in graphs. The slope of the graphs (figures 2-11) gives the value of the linear absorption coefficient.

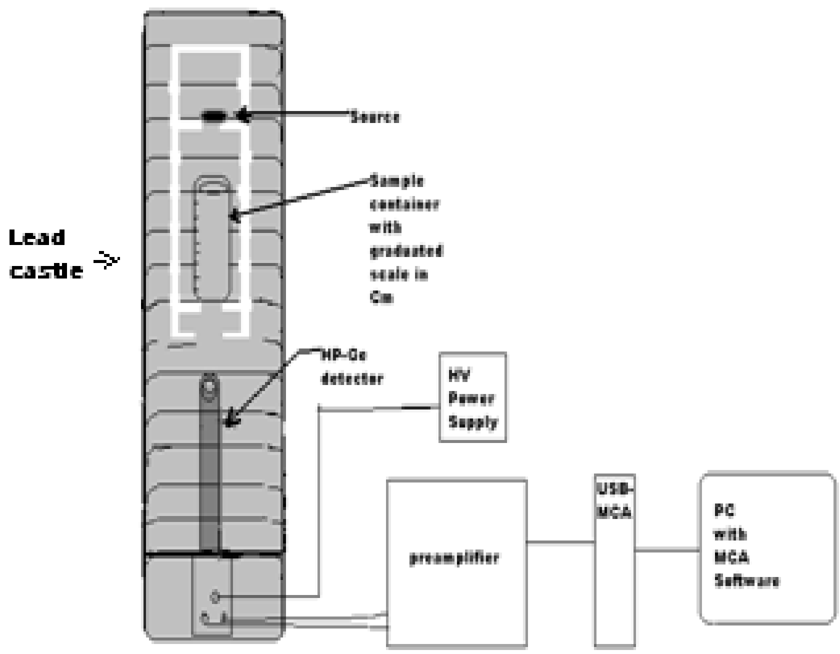


Figure -1

Table-1

Concentration of milk sample 10% and 20%

Milk Concentration : 10 % Initial Counts (I_o) = 161922 /600 sec)				**Milk Concentration : 20 % Initial Counts (I_o) = 160884/ 600 sec)**		
Path length (cm)	**No. of counts I / 600 Sec.**	**I_o /I**	**log (I_o /I)**	**No. of counts I / 600 sec**	**I_o /I**	**log (I_o /I)**
1	154654	1.04699	0.01994	155554	1.034265	0.014632
2	149352	1.08416	0.03509	148376	1.084299	0.035149
3	144403	1.12132	0.04972	143326	1.122504	0.050188
4	138016	1.17321	0.06937	137298	1.171787	0.068849
5	132171	1.22509	0.08816	130426	1.233527	0.091149
6	123862	1.30727	0.11636	121944	1.319327	0.120352
7	114625	1.41262	0.15002	114100	1.410026	0.149227
8	108625	1.49065	0.17337	109539	1.468737	0.166944
9	102807	1.57500	0.19728	98280	1.636996	0.214048
10	92010	1.75983	0.24547	91998	1.748777	0.242734

Table–2
Concentration of milk sample 30% and 40%

Milk Concentration : 30 % Initial Counts (I_o) = 160799 / 600 sec				Milk Concentration : 40 % Initial Counts (I_o) = 160331 / 600 sec		
Path length (cm)	**No. of counts I / 600 Sec.**	**I_o /I**	**log (I_o /I)**	**No. of counts I / 600 sec**	**I_o /I**	**log (I_o /I)**
1	154151	1.04312	0.01833	155423	1.03157	0.01350
2	149573	1.07505	0.03143	149740	1.07072	0.02967
3	143850	1.11782	0.04837	143577	1.11668	0.04793
4	137519	1.16928	0.06792	139233	1.15153	0.06127
5	130183	1.23517	0.09172	128730	1.24548	0.09533
6	123109	1.30615	0.11599	124501	1.287788	0.10984
7	114997	1.39828	0.14559	116685	1.37404	0.13800
8	107712	1.49286	0.17401	106276	1.50862	0.17858
9	98782	1.62781	0.21160	101726	1.57610	0.19758
10	90482	1.77713	0.24972	91872	1.74515	0.2418

Table-3
Concentration of milk sample 50% and 60%

Milk Concentration : 50 % Initial Counts (I_o) =160677 / 600 sec				Milk Concentration : 60 % Initial Counts (I_o) = 159649 / 600 sec		
Path length (cm)	**No. of counts I / 600 Sec.**	**I_o /I**	**log (I_o /I)**	**No. of counts I / 600 sec**	**I_o /I**	**log (I_o /I)**
1	154217	1.04188	0.01782	155048	1.02967	0.01270
2	149221	1.07677	0.03212	149776	1.06591	0.02772
3	144154	1.11462	0.04712	142714	1.11866	0.04869
4	136921	1.17350	0.06948	135868	1.17503	0.07004
5	130437	1.23183	0.09055	128526	1.24215	0.09417
6	123083	1.30543	0.11575	120955	1.31990	0.12054
7	115623	1.38966	0.14290	115082	1.38726	0.14215
8	109188	1.47156	0.16777	108105	1.47679	0.16932
9	97616	1.64601	0.21643	100814	1.58359	0.19964
10	93032	1.72711	0.23732	94840	1.68335	0.22617

Table-4
Concentration of milk sample 70% and 80%

Milk Concentration : 70 % Initial Counts (I_o) =157285 / 600 sec				Milk Concentration :80 % Initial Counts (I_o) = 160885/ 600 sec		
Path length (cm)	**No. of counts I / 600 Sec.**	**I_o /I**	**log (I_o /I)**	**No. of counts I / 600 sec**	**I_o /I**	**log (I_o /I)**
1	154513	1.017940238	0.00772	156566	1.0275	0.01181
2	149714	1.050569753	0.02142	150224	1.07096	0.02977
3	142250	1.1056942	0.04363	146485	1.09830	0.04072
4	136928	1.148669374	0.06019	135908	1.18377	0.07327
5	128759	1.221545678	0.08690	132142	1.21751	0.08547
6	122724	1.281615658	0.10775	124088	1.29653	0.1127
7	116234	1.353175491	0.13135	117054	1.37445	0.13812
8	106132	1.481975276	0.17084	107991	1.48980	0.17312
9	97390	1.61500154	0.20817	99353	1.61932	0.2093
10	91492	1.719112054	0.23530	91445	1.75936	0.24535

Table-5
Concentration of milk sample 90% and 100%

Milk Concentration: 90 % Initial Counts (I_o) = 161246 /600 sec)				Milk Concentration : 100 % Initial Counts (I_o) = 161303/ 600 sec)		
Path length (cm)	**No. of counts I / 600 Sec.**	I_o /I	log (I_o /I)	**No. of counts I / 600 sec**	I_o /I	log (I_o /I)
1	157963	1.02078	0.00893	157410	1.02473	0.01061s
2	151201	1.06643	0.02793	151359	1.06569	0.02763
3	145634	1.10720	0.04422	146192	1.10336	0.04271
4	140437	1.14817	0.06000	139085	1.15974	0.0643
5	131900	1.22248	0.08724	132345	1.21880	0.08593
6	124598	1.29412	0.11197	122994	1.31147	0.11775
7	116443	1.38476	0.14137	118153	1.36520	0.13519
8	105809	1.52393	0.18290	106204	1.51880	0.18150
9	100306	1.60754	0.20616	99392	1.62289	0.21029
10	91269	1.76671	0.24716	70992	2.27212	0.35643

Table-6
Linear attenuation coefficient V/s Concentration at Cs-137

Concentration %	Density, ρ (gm/cc)	Linear absorption Coefficient (cm^{-1})
10	0.9971715	0.02457
20	1.0050593	0.02521
30	1.0082463	0.02563
40	1.0118715	0.02502
50	1.0239756	0.02494
60	1.0258599	0.02406
70	1.0276641	0.02561
80	1.0304305	0.02571
90	1.0323149	0.02639
100	1.034482759	0.0323

The path Length v/s Ln (Io/I) are as shown in the following figures :

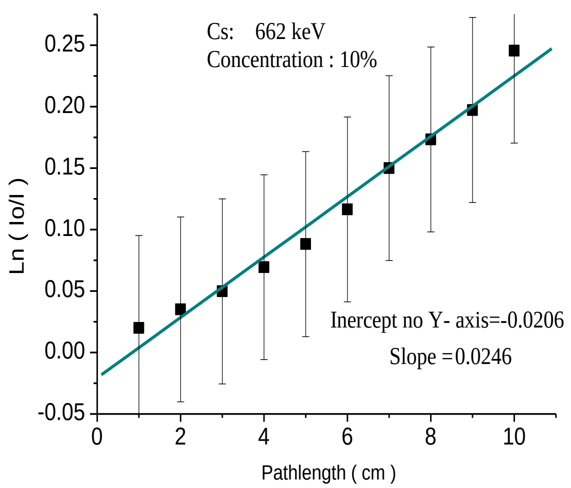


Figure-2
Path Length v/s Ln (Io/I)

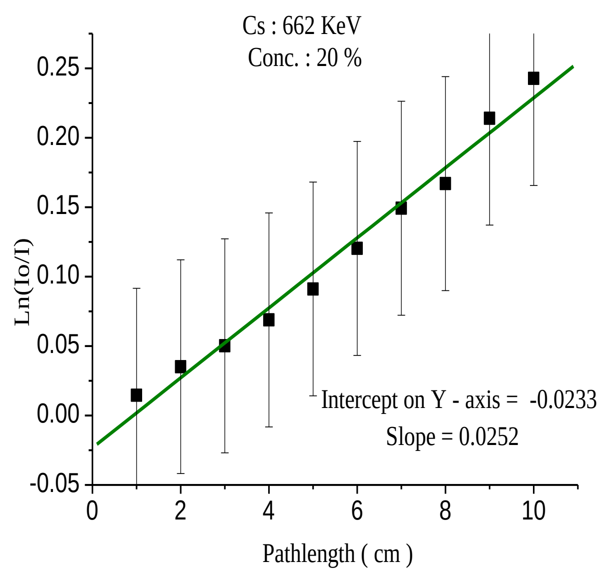
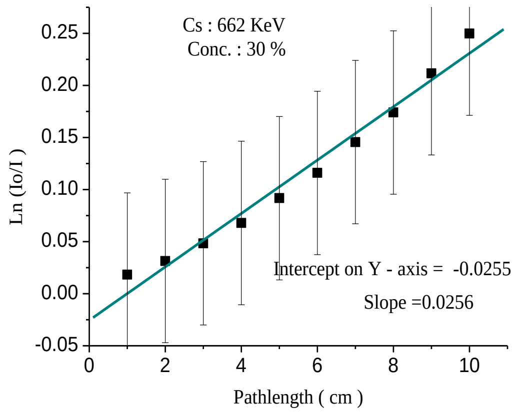
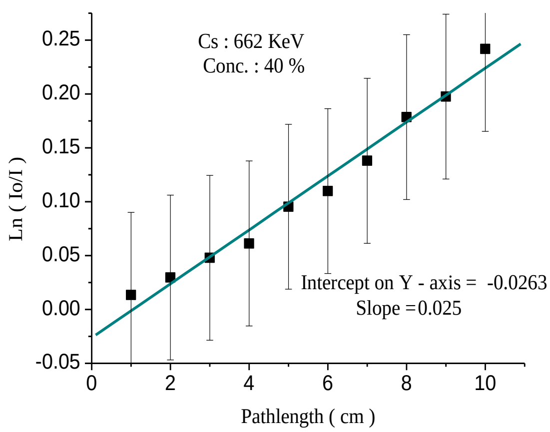


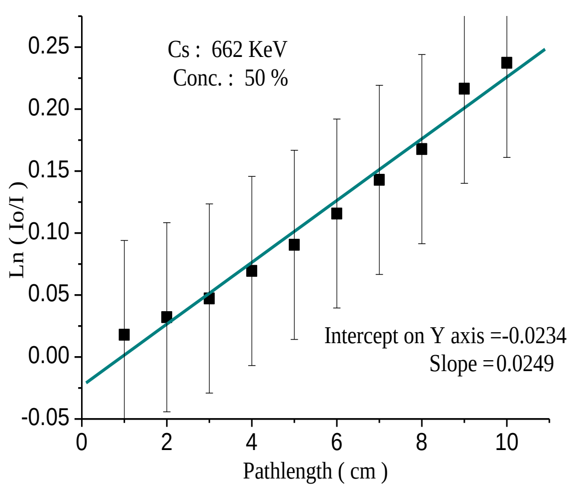
Figure – 3
Path Length v/s Ln (Io/I)



Figure–4
Path Length v/s Ln (Io/I)



Figure–5
Path Length v/s Ln (Io/I)



Figure–6
Path Length v/s Ln (Io/I)

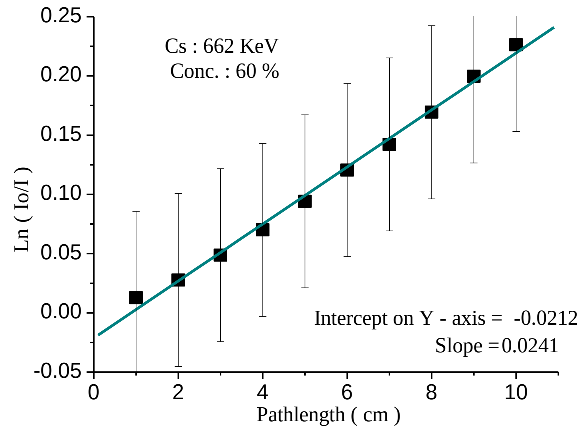
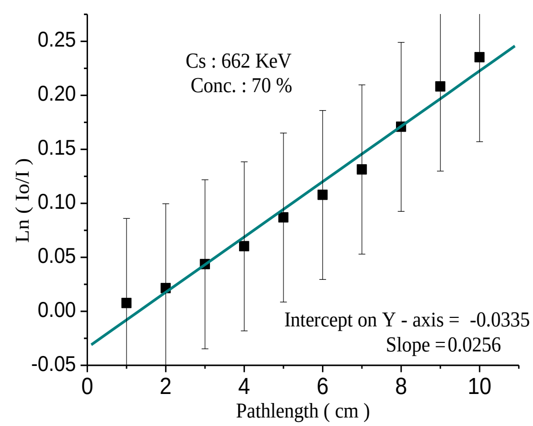
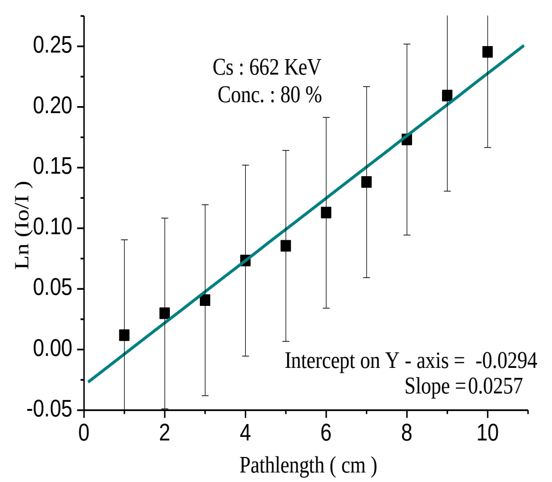


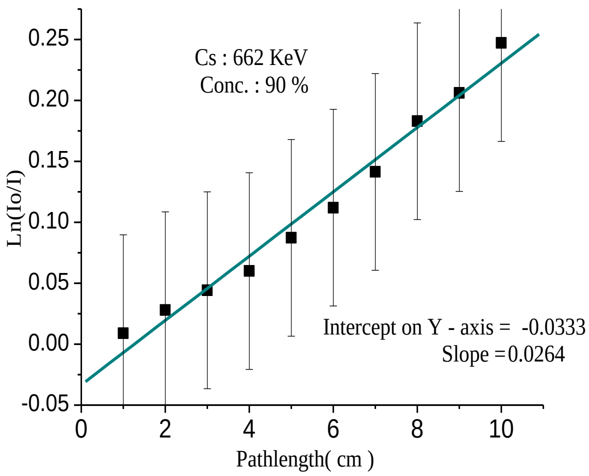
Figure – 7
Path Length v/s Ln (Io/I)



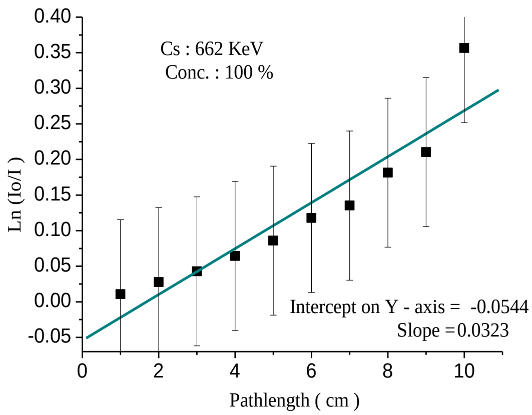
Figure–8
Path Length v/s Ln (Io/I)



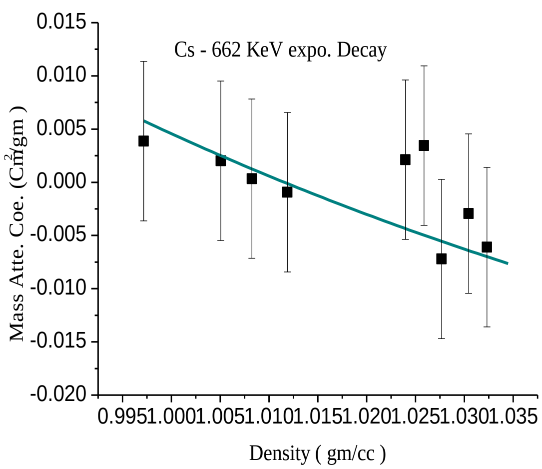
Figure–9
Path Length v/s Ln (Io/I)



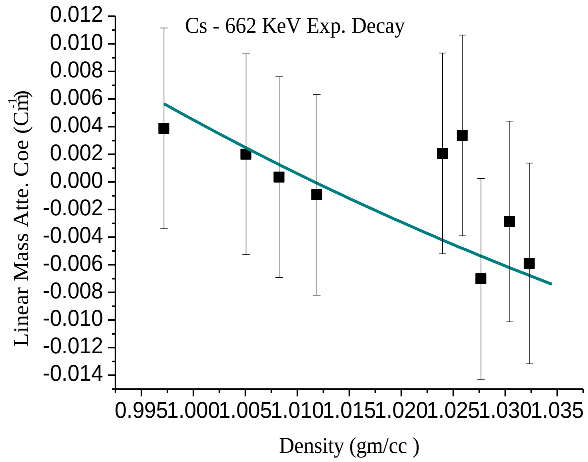
Figure–10
Path Length v/s Ln (Io/I)



Figure–11
Path Length v/s Ln (Io/I)



Figure–12
Path Length v/s Ln (Io/I)



Figure–13
Path Length v/s Ln (Io/I)

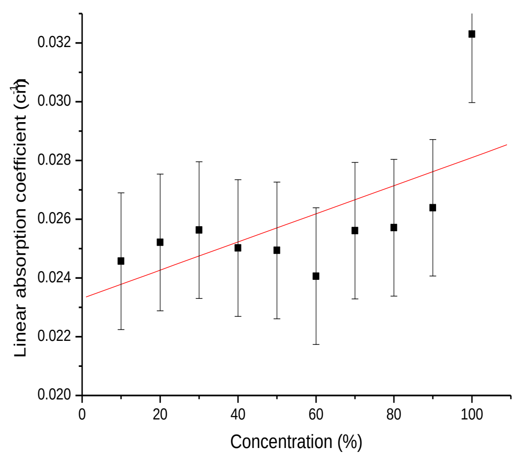


Figure-14
Concentration V/s linear absorption coefficient

Conclusion

We studied the linear and mass attenuation coefficient of buffalo milk sample with different concentrations by adding water in the milk at the gamma ray energy 662 keV of gamma source Cs-137 with narrowed beam. The result shows that as concentration of milk sample increases, mass attenuation coefficient decreases. Gamma dissociation law is valid for the milk sample. The other research work is in progress.

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