The study of Shielding Effectiveness of Rice Husk Powder Filled with polyurethane composite

Hamed A. Hamde, Riyadh. Ch .Abul-Hail

Abstract— **The aim of this study is to create a new polymer based composite for a radiation shield where we used polyurethane as a matrix material incorporated with different materials (ordinary Portland cement , aluminum filings ,epoxy ,salt and rice husk) as fillers. The new compound is less expensive than other shielding materials due to the substantial reduction in part weight, ease of fabrication, wide area etc .Both *rice husks and oyster shells are common wastes thatare used as fillers to the fabricated composite . the* linear attenuation coefficient, mass attenuation coefficient, half value layer and mean free path *have been calculated .The study also investigated the effect of the curing method where three types (moisture, water and dry)have been used due to the use of ordinary Portland cement .The results obtained show that the three curing methods have the same effect on the efficiency* of gamma radiation shielding. *Also they reveal that the obtained results show* the increase of the removed photons from gamma rays with the increase of the absorber material thickness which is similar to the effect of the aging factor. Finally the results obtained show that the oyster shell particles have increased the shielding efficiency of the fabricated composite more than the same composite filled with rice husk particles.**

Keywords: **polyurethane, aluminum filings, epoxy, salt and rice husk**

I. INTRODUCTION

Materials made of high density compositions, such as lead bricks, high density concrete, and metal or metal alloys are often used for radiation shielding purposes. However, these materials are heavy and bulky as well as lacking in the service flexibility and hence cannot be used under all conditions especially when flexibility shields are required. Different types of electromagnetic isolation materials are developed by the industrial companies and/or research laboratories. These are commonly based on copper, nickel, ferrite, etc. or their composites that are resistive up to 200 "C. However they are not optimum for public use due to their costs, installation conditions, and advantages in daily life [1-3]. Multifunctional polymer composites incorporating inorganic additives could potentially provide a structural, radiation shielding, and even flame retardancy properties [4-5]. Polyethylene as an example has been found effective in shielding against galactic cosmic rays and solar energetic particles [6].

However, only a few investigators are successful in preparing the composites with lead oxides as a filler in polyethylene, co-polymers of ethylene with vinyl alkalyte, alkyl methacrylate, polyethylene glycol, styrene butadiene rubber, natural rubber, and polystyrene[7-12].

Conducting composites of PANI and PPy could be used as antistatic boards, heating elements operating at temperatures slightly above ambient or shielding materials for various regions of frequencies of electromagnetic radiation [13-15]. The enhancement in the microwave shielding and absorption properties of the polyaniline nano composite have been achieved by the incorporation of the dielectric filler (TiO_2) along with the magnetic filler (barium ferrite) in the polyaniline matrix since the unique properties of the nano structured ferrite offer excellent prospects for designing a new kind of shielding materials [16,17] .

II. EXPERIMENTAL PROCEDURE

The Four types of materials have been used as fillers due to their ability to absorb gamma ray and they are ordinary Portland cement, aluminum filing, salt and rice husks (or oyster shells).The rice husk particles are used as fillers incorporated in to the fabricated composite where both rice husk and oyster shell materials are considered as waste .The fabrication of modified polyurethane was made by using diizocyanate and polyol with a mixing ratio of 1:1 using a cuboid container and good mixing by hands for 2 minutes, the filler has been incorporated through the mixing process. After mixing we put the total in to that cuboid container and cover it with a heavy plate for 20-30 minutes .After that we have the final product in the form of a plate ready to be tested as a gamma ray shielding material. The source used in this experiment is Co-60 which emits gamma rays with energies of 1.173 Mev and 1.332 Mev. Co-60 radioactive source is sited in front of a small detector (Geiger Muller tube) in an appropriate distance and plates of Pb (or other absorbers) are inserted among them. The counting rate as a function of the thickness of the irradiated material is measured as mentioned in reference (18).After that we determine the half-value thickness X1/2 (the thickness at which the initial counting rate is reduced to half) and the absorption coefficient μ of some materials to calculate the mass attenuation coefficient from the measured values. The attenuation of the gamma rays when they pass through an absorber of thickness x is expressed by the exponential law:

$$N(x) = N(o)e^{-\mu\chi} \quad (1)$$

(where No: initial radiation intensity, x: the thickness of the material and μ: the linear absorption coefficient). The exponential law is valid under certain conditions, i.e.,a mono energetic point source under narrow beam conditions and the absence of background radiation.

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HamedA.Hamde, Basrah University ,Polymer research Center, Materials science Department/ Basrah, Iraq

Riyadh. Ch .Abul-hail, Physics department, Basrah University/ Education College for pure sciences/ Basrah, Iraq.

III. Results and Discussion

Figure 1 shows the variation of intensity logarithm with thickness where the fraction of photons removed from gamma rays per unit material thickness is called linear attenuation coefficient (μ), typically expressed in cm^{-1} which can be obtained from the slope of the above figure where this slope is depending on the incident gamma-ray energy, type of the material and its density [19] .The linearity of the above figure indicates the increase of the removed photons from gamma rays by the increase of the absorber material thickness. The linear attenuation factor is proportional to the density of the material where the probability of Interaction depends on the number of atoms that the gamma rays encountered per unit distance where this dependency can be overcome by normalizing the linear attenuation coefficient for material density [20].

Mass attenuation coefficient= linear attenuation coefficient /density

Where mass attenuation coefficient is independent of density but the mass absorption coefficient is dependent on the energy of the incident gamma radiation and the elemental composition of the shielding material [21].

Average distance traveled before interaction can be calculated from the linear attenuation coefficient or the HVL of the beam which is mathematically related to Mean free path (MFP) of photon beam by the formula

$$MEP = \frac{1}{\mu}\frac{1}{0.693/HVL} = 1.44HVL \qquad (2)$$

Table1. Shows the variation of the linear attenuation coefficient, mass attenuation coefficient, half value layer and mean free path as a function of curing method (water, moisture and dry) at different aging times.

Curing method	Aging months	μ linear cm^{-1}	μ m cm^2/gm	HVL cm	MFP cm
Water	1	0.052	0.0841	13.32	19.19
Dry	1	0.049	0.0792	14.14	20.36
moisture	1	0.055	0.0889	12.6	18.14
Dry	3	0.073	0.118	9.493	13.67
Dry	6	0.087	0.14	7.965	11.47

The three curing methods (water, moisture and dry) are used in this study due to the existence of ordinary Portland cement. It is well known that the compressive strength of such cement is totally dependent on the curing method and age. Table 1 indicates that the curing method has no noticeable effect on the shielding efficiency contrary to the aging factor which has a noticeable effect.

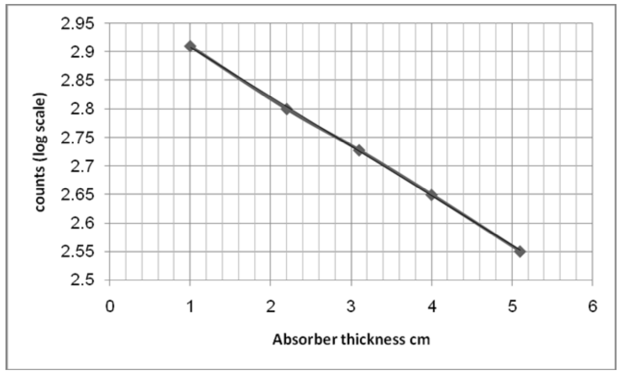

Fig.1. the variation of intensity with the sample thickness 3 months old.

The effect of the particle filler type is also investigated in this search where we used oyster shell particles instead off rice husk particles applying the same procedure of manufacturing mentioned above .The results obtained are shown in table 2 at the age of one month. This result proves that the oyster shell powder is more effective in the shielding of nuclear radiation than rice husk.

Tabel 2. The variation of shielding parameters at one-month age.

μ linear cm^{-1}	μ m cm^2/gm	HVL cm	MFP cm
0.118	0.191	5.872	8.456

Conclusion

We In radiation shielding, even though the polymer materials are inferior to metals, they have merits in usage flexibility, workability, chemical stability, low cost, volume reduction after use, ease of fabrication and handle, wide area and volume and light weight. Composite materials may offer benefits in nuclear shielding where the degree to which gamma radiation is attenuated depends upon the thickness of the shielding composite also the curing method of that composite due to the existence of ordinary Portland cement in its compositionregardless of the curing method type. The aging factor has a noticeable effect on the shielding efficiency due to the increase of the compressive strength of the cement used. Finally oyster shell particles are more suitable in fabricating such composites due to their chemical composition.

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