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Research Article

Experimental Investigation of Radiation Shielding Effect in Different Doped Slag Concrete[#]

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Abstract: Shielding is the greatest way to protection radiation. Therefore, the development of different shielding materials is important for radiation protection. In this study, radiation shielding properties of different doped slag concrete samples investigated which were prepared with keeping constant the amount of cement. Concrete samples were supplemented with coke slag, calcit slag, aluminum slag at different rate. The measurements have been performed using a gamma spectrometer which contains 3"x3" NaI(Tl) detector.

1. Introduction

With the growing technology, the use of radiation in the areas of modern societies is increasing. Radiation is commonly used in military purposes, scientific research, medicine, industry and agriculture. Increasing the use of the radiation to creates a biological risk for all creatures.

Radiation is the energy emitted by the energy package called wave, particle, or photon [1]. One's dose in the vicinity of an external radiation source can be reduced by increasing the distance from the source, by minimizing the time of exposure, and by the use of shielding. In principle, shielding alone can be used to reduce dose rates to desired levels. [2]. For this reason, shielding should be convenient for protection from radiation.

The literature is rich in works dealing with linear attenuation coefficients of construction materials. These studies are based on experimental and theorically. For example, Akkurt et al. have measured and calculated attenuation coefficients of pumice and barite [3, 4]. Awadallah and Imran have measured gamma-ray attenuation coefficients for limestone, bricks and concrete in Jordan [5]. Mavi have measured gamma-ray attenuation coefficients for granite [6]. Türkmen et al. have calculated attenuation coefficients in Portland cements mixed with silica fume, blast furnace slag and zeolite [7]. Salinas et al. have calculated the effective density and mass attenuation coefficients for several building materials normally used in Brazil [8]. Charanjeet et al. have calculated mass attenuation coefficients for glass, concrete, marble, fly ash, cement and lime in India [9]. Turhan et al. have measured the raw materials and end products in the Turkish ceramics [10].

The armor material for the development of the linear attenuation coefficient μ, it is important to be known. Linear attenuation coefficient μ (cm^{-1}), by definition, per unit path length is defined as the probability of interaction of radiation with the material [11]. The thickness of the armor and the armor placed in front of source type of material is very important in reducing the severity of the radiation. The thickness of the armor increases the armor of the last rays of the intensity decreases in an exponential manner [12].

2. Materials and Methods

In this study, the linear attenuation coefficients (μ) for different slag cement doped concrete samples were measured at the photon energies of 662 and 1173, 1332 keV obtained from ^{137}Cs and ^{60}Co γ-ray sources respectively. Four different types of concrete have been used for measurements and the details of concrete samples are given in table 1.

This study was carried out in the Nuclear Physics Laboratory at the Amasya University. The detection of γ-rays has been performed using a gamma spectrometer, contains a Ortec type 3”x3” NaI(Tl) detector which is connected to the 16384 channels Multi Channel Analyser (MCA). The communication of the system was performed using MAESTRO32 software.

The prepared samples and amounts shown in Table 1. The linear attenuation coefficients can be extracted by Lambert law:

$$\mu = \frac{1}{x} In(\frac{N_0}{N})$$

where μ is the linear attenuation coefficient; x is the thickness of the sample (cm), N_0 is the number of counts recorded in the detector before attenuation; N is the number of counts recorded in the detector attenuation.

***Table 1**. Mixture into concrete components*

Aluminum	0,1 kg cement 0.00401 kg Aluminum slag 0.05 kg Fine Aggregate 0.05412 kg water
Coke	0,1 kg cement 0.005 kg Bepermo (chemical) 0.05 kg Coke slag, 0.06849 kg water
Calcit1	0,1 kg cement 0.05 kg Calcit slag, 0.0746 kg water
Calcit2	0,1 kg cement 0.005 kg Bepermo (chemical) 0.05 kg Calcit slag, 0.0746 kg water

3. Results and Discussion

The measurement have been performed for four different sample at 3 different energies. The measured linear attenuation coefficients are displayed as a function of gamma ray energies in Figure 1. It can be seen from this figure that, the linear attenuation coefficients for all sample were decreased with the increasing gamma ray energies. It is also clear from this figure that the material of Calcit 2 has highest gamma ray absorption capability then others. This could be the results of its components.

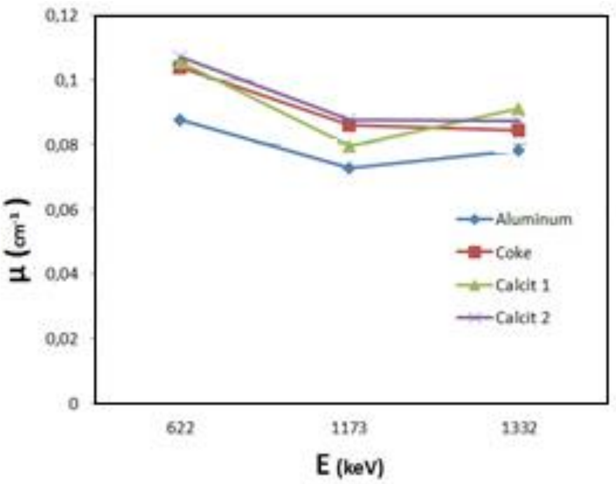

***Figure 1.** The measured μ for the different concrete samples energies at 662, 1173,1332 keV.*

It can be concluded from this work that the linear attenuation coefficients can decreases with the photon energy and calcit is an important materials in terms of radiation shielding.

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