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Determination of Radiation Attenuation Coefficients in Concretes Containing Different Wastes

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Environmental wastes can be cleaned in a very long time by ecosystem. However, the cleaning power of the ecosystem is not enough. For this reason, the evaluation of the different areas of waste processing is important. In this study attenuation coefficient of gamma rays has been investigated for concretes containing different amounts of glass, bulb and plastic wastes.

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1. Introduction

With the increase of population, increases the amount of accumulated waste. For this reason, the evaluation of the different areas of waste recycling is important. The properties of the materials used in the concrete, affect the radiation absorption coefficient. In this study, attenuation coefficient of gamma rays has been investigated for concretes containing different amounts of glass, bulb and plastic.

Radiation is the energy emitted in the form of particles or gamma photons [1]. Radiation produces somatic or genetic modifications on organs and tissues. In avoiding the effects of radiation, three main factors are the time, distance and shielding. Shielding is the most important in these methods [2]. The development of shielding materials is required to improve the protection against radiation.

In this study application of wastes as additives to shielding materials was investigated. In studied concrete samples the amount of cement was kept constant and various amounts of such materials as bulb glass or plastic were added to the concrete mixture. We have investigated radiation absorption coefficient μ (cm^{-1}) of four different materials produced using waste.

Absorption coefficient per unit path length is defined as the probability of interaction of radiation with the material [3–6].

2. Methodology of research

We have carried out experimental investigation of radiation shielding properties of concretes doped with different waste materials. In the study, four different concretes were manufactured using plastic, glass and light bulb pieces. Cement is a durable material that has a high binding ability [7]. In this study the amount of cement in concrete samples was kept constant and certain amounts of waste materials like bulb glass or plastic were added to concrete mixture.

When preparing concrete, the components of the mixture were precisely weighted, the content of each mixture is presented in Table I. The prepared concrete samples are shown in Fig 1.

TABLE I

Components of the concrete mixture.

Glass	0.1 kg cement 0.05 kg Broken glass 0.005 kg Bepermo (chemical) 0.0505 kg water	Bulb 1	0.1 kg cement 0.0288 kg Broken bulb 0.005 kg Bepermo (chemical) 0.06342 kg water
Bulb 2	0.1 kg cement 0.033 kg Broken bulb 0.05 kg Fine aggregate 0.025 kg Sea stone (broken) 0.0764 kg water	Plastic	0.1 kg cement 0.0203 kg plastic 0.005 kg Bepermo (chemical) 0.04032 kg water

The utilized radiation sources comprised ^{137}Cs and ^{60}Co radioactive elements with photon energies of 662 keV for ^{137}Cs and two energies of 1173 keV and

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1332 keV for ^{60}Co. The measurements have been performed using a gamma spectrometer which contains 3×3 cm^2 NaI(Tl) detector. Analysis of the resulting spectra was performed using MAESTRO Software Version 7.01.

Fig. 1. Concrete samples prepared using waste materials.

Beer-Lambert equation was used for calculation of the absorption coefficient

$$\mu = \frac{1}{x} \ln \frac{I_0}{I}, \tag{1}$$

where x is the thickness of the sample, I_0 peak area in the absence of a sample between the source and the detector, I peak area with a sample placed between the source and the detector.

3. Results

Measured absorption coefficients of the concrete samples at different energies of the gamma photons are shown in Table II and Fig. 2.

TABLE II

Absorption coefficient μ [cm^{-1}] at different energies of the gamma photons for different concrete samples.

Radiation sources	Energy [keV]	Plastic	Glass	Bulb 1	Bulb 2
Cs-137	662	0.11199	0.13292	0.10427	0.12476
Co-60	1173	0.10951	0.10411	0.10428	0.12395
Co-60	1332	0.09333	0.12223	0.08145	0.10438

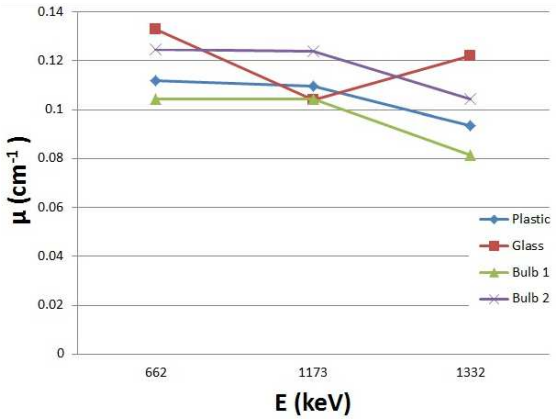

Fig. 2. Results of the linear attenuation coefficient measurements.

4. Conclusions

As it is shown in the graph, a decrease of the observed absorption coefficient μ is observed in concretes marked as "plastic", "bulb 1" and "bulb 2", while μ was constant in the sample with the addition of glass up to 1173 keV. Between 1173 keV and 1332 keV, value of absorption coefficient for glass-doped sample was increasing.

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