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THE SHIELDING OF γ-RAYS BY CONCRETES PRODUCED WITH BARITE

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ABSTRACT

The concretes produced with barite ($BaSO_4$) were studied as shielding materials for γ-radiation. The concretes were prepared with different volumes of barite, and thus each concrete has different density and aggregate. The mass attenuation coefficients have been calculated at photon energies of 1 keV to 100 GeV using XCOM and the obtained results were compared with the measurements at 0.66 and 1.25 MeV. The barite concrete results were also compared with ordinary concretes.

Keywords: γ-rays, photon attenuation, XCOM

1. INTRODUCTION

Buildings are constructed mostly using concretes containing water, cement and aggregates. In a building construction, two main points have to be considered. They are resistance against earthquake expressed as strength of the building, and resistance against radiation expressed as radiation attenuation. Using barite ($BaSO_4$) in building construction surely would be ideal to protect against radiation, but this is not feasible as there is not enough barite reserve in the world. Moreover, the barite itself can not be used as a construction material in building. Thus, barite-loaded heavy concrete is one of the most widely used materials in building construction done especially to protect against γ-rays, as in many buildings for applications such as nuclear power plants, accelerators, hospitals, etc. As a γ-ray is uncharged and has no mass, it can easily penetrate into matter, and thus the shielding of photons is very difficult. The interaction of γ-rays depends on the incoming photon energy. The linear attenuation coefficients (μ), which is defined as the probability of a radiation interacting with a material per unit path length, is the most important quantity characterizing the penetration and diffusion of gamma radiation in a medium. The magnitude of linear attenuation coefficients depends on the incident photon energy, the atomic number and the density (ρ) of the shielding materials (Wood, 1982). Several works have been performed to obtain μ theoretically and experimentally for different elements, compounds and mixtures (Hubbell, 1982), (Akkurt et al., 2004), (Bashter, 1997), (Singh et al., 2003), (Teli et al., 1995). In this paper, the linear attenuation coefficients (μ) were extracted from mass attenuation coefficients (μ/ρ) calculated using the computer code XCOM, to investigate the contribution of barite in concretes for photon attenuation. The relations between physical parameters such as the water (w) to cement (c) ratio (w/c), density and compressive strength (CS) of concretes, and the μ have been investigated. This is done using two groups of concrete, ordinary and barite-loaded concretes, and results were compared with the experimental data obtained with 0.66 and 1.25 MeV photons.

2. MATERIALS AND METHODS

Two groups of concrete were prepared to test the contribution of barite in the concrete to protect against γ-rays. Each concrete was prepared with different amounts of water (w), cement (c) and aggregates. These are tabulated in Table 1 and will be detailed elsewhere (Kilincarslan et al.). Ordinary