
Comparison of the radiation shielding effect of travertine and gasconcrete

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Abstract: With the increasing use of technology, radiation protection has become a significant issue today. The development of searches for various materials for radiation protection has also accelerated. However, it has become important to investigate the radiation attenuation properties of building materials in order to find the answer to the question of how much indoor areas where we spend 80% of our time protect us. This study investigated the use of gasconcrete and travertine as shielding materials against gamma radiation. A gamma ray spectrometer equipped with a 3"x3" NaI(Tl) scintillation detector was used in the measurements to measure gamma rays with energy of 662, 1173, and 1332 keV in the Radioactive Research Laboratory of Amasya University Sciences & Arts Faculty.

Keywords: NaI(Tl) scintillation detector, gamma shielding, gasconcrete, travertine

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1. Introduction

With the advancement of technology and the increase in the use of technological devices, radiation protection has become more important. To reduce the radiation dose that increases in parallel with developing technology, it is possible to minimize the effects of radiation on living beings by developing appropriate protective materials [1]. The most effective way to protect against radiation is to place a protective material between the radiation source and the human being. This method is called "shielding." Since the importance of shielding in radiation protection is known, studies aimed at developing different shielding materials are important in almost every field working with radiation. Researchers are investigating the radiation shielding properties of many materials in the literature, including concrete, steel, and metal. As is known, concrete and lead are used as standard radiation shielding materials. Concrete is commonly used for gamma ray protection and is an inexpensive material. While easily available, concrete has disadvantages such as high sensitivity to moisture, lack of transparency, crack formation upon radiation exposure, impermeability to visible light, and immobility [2]. Since lead is a material that is not feasible in every platform due to both cost and technical considerations, identifying new shielding materials is crucial. Furthermore, considering that we spend 80% of our lives in enclosed spaces [3], it is important to know and select the radiation permeability of the materials used in the construction of barriers that can protect every individual. The radiation absorption properties of materials are directly proportional to their density. For this reason, lead, which has a high density, is the most commonly used material in shielding technology. However, by identifying and using alternative materials to lead, different shielding materials can be produced. In this way, while

precautions are taken against the various known harmful effects of lead, the application area of the material will also be increased, and the national economy will benefit greatly. Therefore, in this study, the radiation shielding properties of gasconcrete and travertine were investigated using a 3"x3" NaI(Tl) detector gamma spectrometer.

2. Material and Methods

To investigate the radiation shielding properties of travertine and aerated concrete samples, gamma peaks at energies of 662, 1173, and 1332 keV obtained from ¹³⁷Cs and ⁶⁰Co radioactive sources were used, and the radiation attenuation properties of the samples were compared using the linear attenuation coefficient μ (cm⁻¹) values calculated from the obtained measurements. The linear attenuation coefficient results obtained from the measurements of the samples are shown in Figure 1. Furthermore, the correlation between linear absorption coefficients is shown in Figure 2.

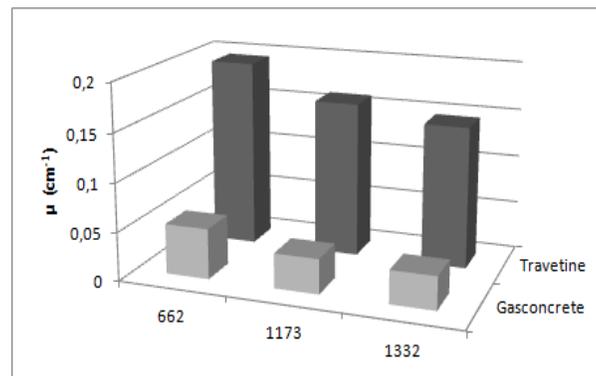


Figure 1. Linear attenuation coefficients for energies of 662-1332 keV.

From Figure 1, which shows the difference in absorption between travertine (1) and gas concrete (2), it can be seen that travertine is a better absorber than gas concrete.

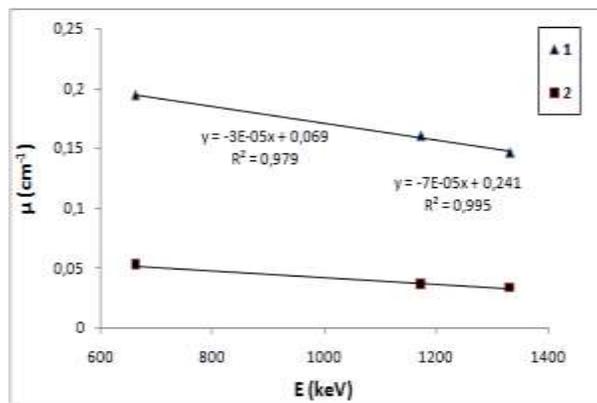


Figure 2. Variation of μ values for travertine and gas concrete in the energy range of 662-1332 keV.

The graphs show a linear relationship between the gamma energy and the linear attenuation coefficients of the samples in the range of 662 keV, 1173 keV, and 1332 keV. When selecting shielding materials, the linear attenuation coefficient alone is not sufficient to determine the effectiveness of materials exposed to gamma radiation; parameters such as HVL and TVL must also be calculated. Figure 3-5 shows the HVL and TVL

calculation values and their change with thickness. As can be understood from these figures, a greater thickness is required to stop higher energy gamma radiation.

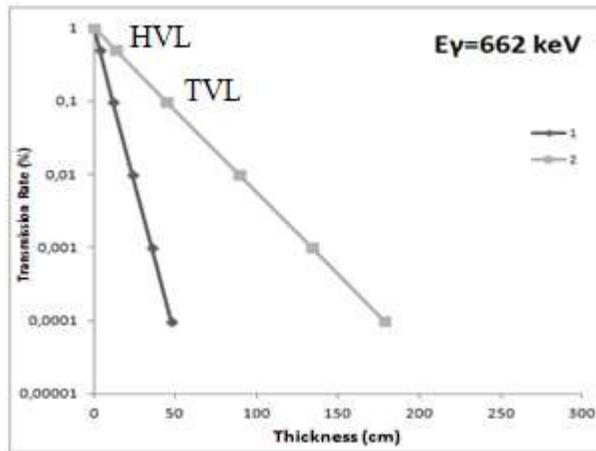


Figure 3. HVL and TVL values at 662 keV energy

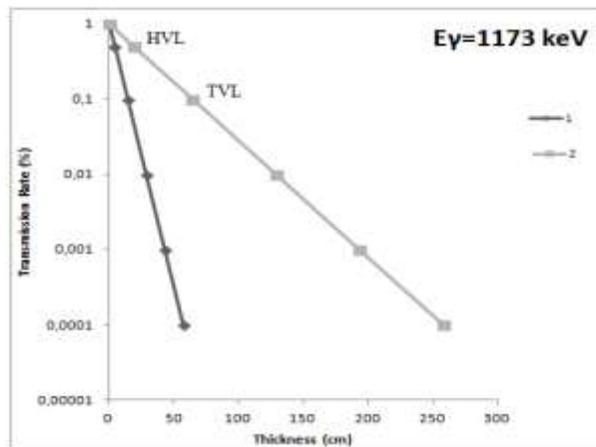


Figure 4. HVL and TVL values at 1173 keV energy

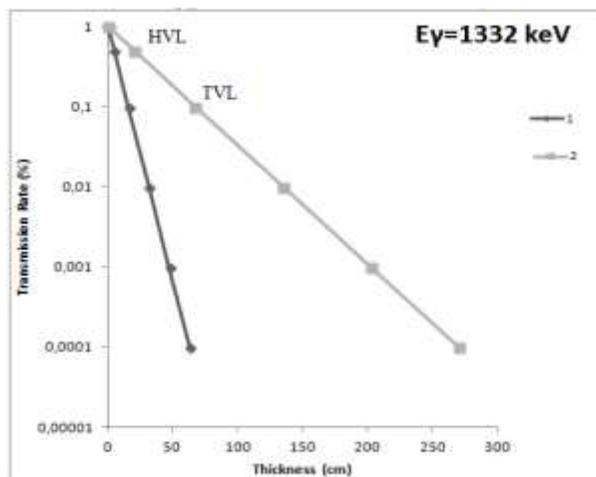


Figure 5. HVL and TVL values at 1332 keV energy

4. Conclusions

As can be seen from the graphs, travertine is a better absorber than gas concrete. Furthermore, much thicker aerated concrete would be needed to stop gamma radiation of the same energy. Radiation related works have been well studied and reported in the literature [4-12].

Author Statements:

- **Ethical approval:** The conducted research is not related to either human or animal use.
- **Conflict of interest:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper
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