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Research Article

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Transmission Rate of Fabric to Test Radiation Shielding Properties

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Abstract:

In parallel with the developments in technology, the use of radiation in many areas such as medicine, industry, agriculture and obtaining electrical energy through nuclear power plants has not only facilitated social life but also brought about many health problems due to exposure. It has become inevitable to be protected from the harmful effects of radiation because it poses a risk to human health. There are three basic rules in radiation protection: time, distance and shielding. The most effective method is armoring. Protective clothing is especially important for those working in radiation areas. In this study, thericoton fabric, which is widely used in daily life, was coated with different amounts of barite (0%, 40%, 50%, 60%) and its radiation absorption properties were examined. For this purpose, the transmission rate, which is an important parameter in terms of shielding properties, was investigated by using 511, 835 and 1275 keV gamma energies emitted from ^{22}Na and ^{54}Mn radioactive sources.

1. Introduction

Radiation has become a factor that significantly affects human health in daily life with the increase in its usage areas both from natural sources and with technological developments. The importance of protection from radiation increases because it poses a risk to human health in industry, agriculture, obtaining electrical energy through nuclear power plants, and especially in units such as radiology, where radiation is widely used in medical applications. Therefore, the three basic rules for protection from the harmful effects of radiation are time, distance and shielding. Shielding, the most effective method, is based on placing material between the radiation source and the system to be protected. Lead and heavy concrete are generally used to protect against radiation [1-3]. For this purpose, some of the studies on radiation protection are on ultraviolet (UV) protection of fabrics, while some are on fabrics produced for protection from electromagnetic radiation [4-7]. Protective clothing should be used especially by people working in radiation areas [8-9]. In this respect, since lead, which is commonly used as radiation shielding material, is harmful to human health, it is very important to investigate the availability of new alternative materials that can absorb radiation. In this study carried out for this purpose, the use of barite mineral as shielding material against radiation was investigated by penetrating the fabric with different rates by coating method.

2. Material and Methods

The reason why tericoton fabric was preferred in this study is that it is widely used especially as aprons and shirts [10]. Barite was used as the coating material. In the study, the feature desired to be given to the fabric is the ability to absorb gamma rays by penetrating the barite mineral into the fabric [11]. For this purpose, the effect of barite addition at different rates by coating method, which is the most suitable method, on gamma ray retention was investigated. Measurements were carried out using the gamma spectroscopy system containing the

"3x3" sized NaI(Tl) detector located in the Suleyman Demirel University Gamma Spectroscopy Laboratory (Figure 1).

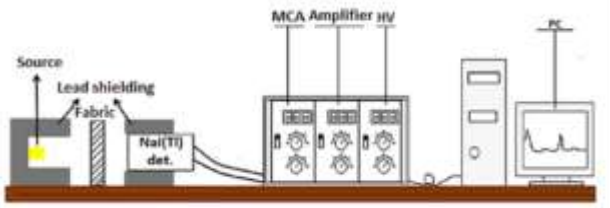

Figure 1. *Schematic view of the gamma spectroscopy system (Akkurt et al., 2015)*

Radiation measurements were made with ^{22}Na (511 and 1275 keV) and ^{54}Mn (835 keV) radioactive sources. An important parameter used in testing the radiation shielding property of a material is the transmission rate [12-13]. Transmission rate may also be used to for shielding properties and it is defined as equation 1.

$$Transmission = Ln\left(\frac{N}{No}\right) x \frac{1}{\mu_o} \qquad (1)$$

In the study, the transmission rate of fabric samples obtained by adding 0%, 40%, 50%, 60% barite to tericoton fabric was investigated at 511, 835 and 1275 keV gamma energies, depending on the change in barite ratio and energy.

3. Results and Discussions

As the transmission rate is the min length to stop gamma rays for specified rate, it is important to know. This is obtained and displayed in Figure 2, Figure 3, Figure 4 for 511,835 and 1275 keV gamma rays. It can be seen in this figure that small thickness of fabric is required for TCF60, TCF50, TCF40, TCF0 type fabric respectively for all energies. This is also another indication of the importance of barite coating on fabric to improve radiation shielding properties. According to Figure 1, Figure 2 and Figure 3, it is seen that the gamma rays can be stopped at shorter distances with the increase in the transmission rate with the increase in the barite ratio in the barite fabrics coded as TCF0, TCF40, TCF50, TCF60 obtained by using 0%, 40%, 50%, 60% barite.

4. Conclusions

In this study, in which the effect of barite mineral used on gamma ray trapping was investigated, it was

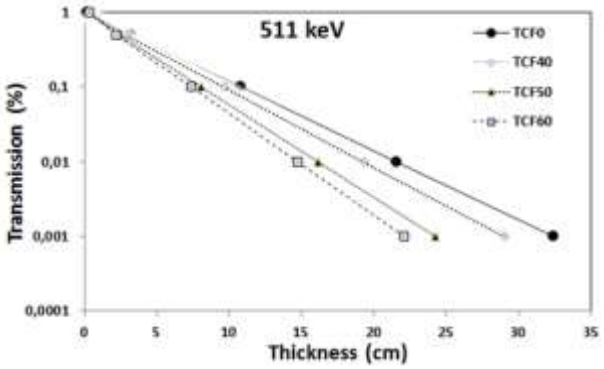

Figure 2. *The transmission rate as a function of thickness for all types of fabric for 511 keV.*

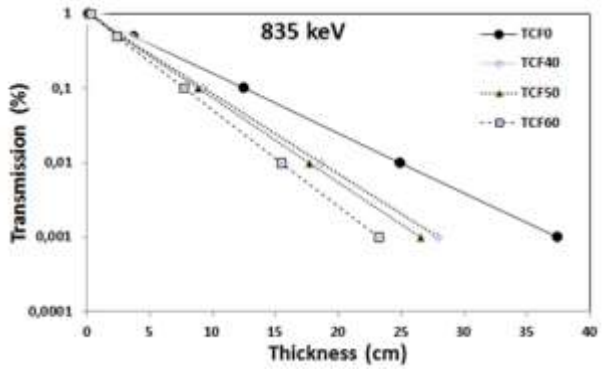

Figure 3. *The transmission rate as a function of thickness for all types of fabric for 835 keV.*

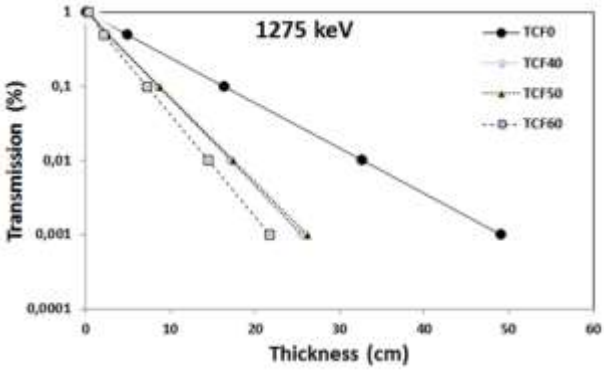

Figure 4. *The transmission rate as a function of thickness for all types of fabric for 1275 keV.*

seen that the gamma ray absorption feature of the fabric coated with different ratios of barite increased, in other words, gamma rays could be stopped at shorter distances depending on the increase in barite ratio. Therefore, fabrics containing barite provide an important area of use as radiation shielding material.

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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- **Data availability statement:** The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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