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ORIGINAL ARTICLE

# Chemical corrosion on gamma-ray attenuation properties of barite concrete

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**KEYWORDS**

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**Abstract** The variation of photon attenuation coefficient on the chemical media has been investigated. For this purposes the linear attenuations of barite concrete have been measured at 662, 1773 and 1332 keV before leaving the chemical media and following a 6 month period. The linear attenuation coefficients have been measured using gamma spectrometer that contains a NaI(Tl) detector and 16k channel MCA. It was found from this measurement that the chemical media decreased the linear attenuation coefficients of the barite concrete and the barite rate is important for concrete production.



## 1. Introduction

Technical development in every place of life brings some extra hazard for human health especially in the field where radiation is used. The radiation shielding properties of a material are expressed with the term linear attenuation coefficients and they are defined as the probability of radiation interacting with a material per unit path length (Woods, 1982). The magnitude of linear attenuation coefficients can vary with the incident photon energy, the atomic number and the density of the shielding materials (Akkurt et al., 2005a). The γ-ray, having no charge and mass can easily penetrate into matter, is a widely used radiation type and thus its shielding is more crucial. In order to protect public health against radiation, the production of concrete that is a widely used material in building construction becomes more important. Moreover produced concrete should resist against outer effects such as chemical corrosion. Although a large number of experimental and theoretical researches have been performed on the radiation shielding properties of concrete, there has not been any work on the variation of these properties under chemical effect in our knowledge. Akkurt et al. (2005b) have measured photon attenuation coefficients of concrete containing barite and zeolite (Akkurt et al., 2010a,b). Bashter (1997) has calculated to obtain the attenuation coefficient for different types of

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shielding concrete. As investigation of the chemical effect on the radiation shielding properties of concrete is open to questions in the literature, a project has been developed to measure this effect on concrete. This work is part of this project where the behavior of the linear attenuation coefficients of concrete produced with the barite under chemical effects has been obtained.

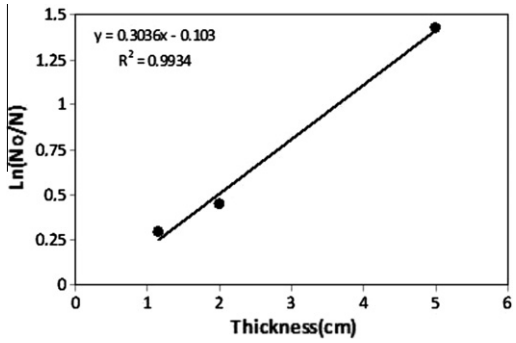


**Figure 1** Plot $\ln(N_o/N)$ versus $x$ to obtain linear attenuation coefficient.

## 2. Materials and methods

The linear attenuation coefficients ($\mu$) of the concrete, where barite has been used as an aggregate, were measured at the photon energies of 662, 1173 and 1332 MeV obtained from $^{137}$Cs and $^{60}$Co γ-ray sources, respectively. As detailed elsewhere (Akkurt et al., 2010b), the measurement has been performed using the gamma spectrometer that contains NaI(Tl) connected to 16k channels Multi-Channel-Analyser (MCA). The communication of the system is done using Genie, 2000 (Genie 2004) software. The linear attenuation coefficients have been evaluated comparing $N$ and $N_o$, which are the measured count rates in detector, respectively, with and without the absorber of thickness $x$ (cm).

$$N = N_o e^{-\mu x}$$

The linear attenuation coefficients can then be obtained from the slope of plot $\ln(N_o/N)$ versus $x$. In Fig. 1 an example for this kind of plot has been displayed.

## 3. Results and discussions

The linear attenuation coefficients of the concrete produced with barite has been measured and the results were compared

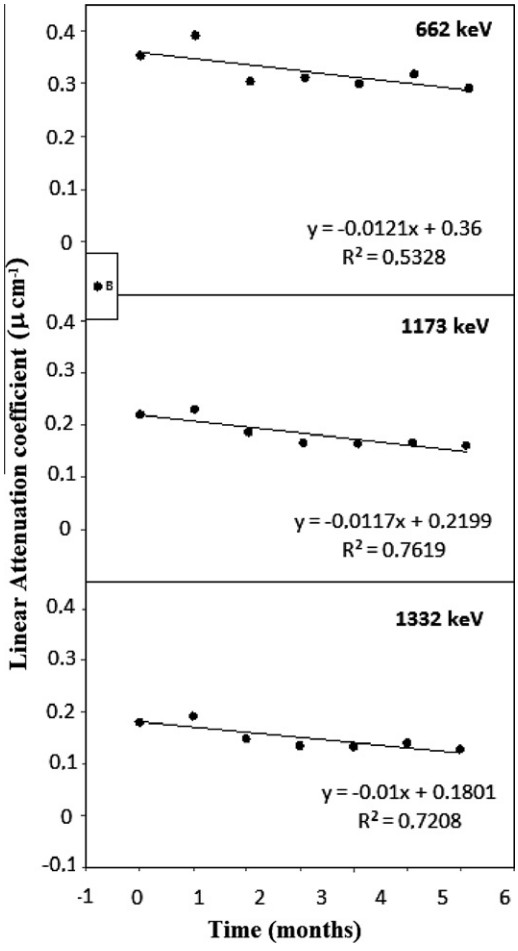


**Figure 2** The variation of the linear attenuation coefficients with the time for 662, 1773 and 1332 keV energy photons in NaOH medium.

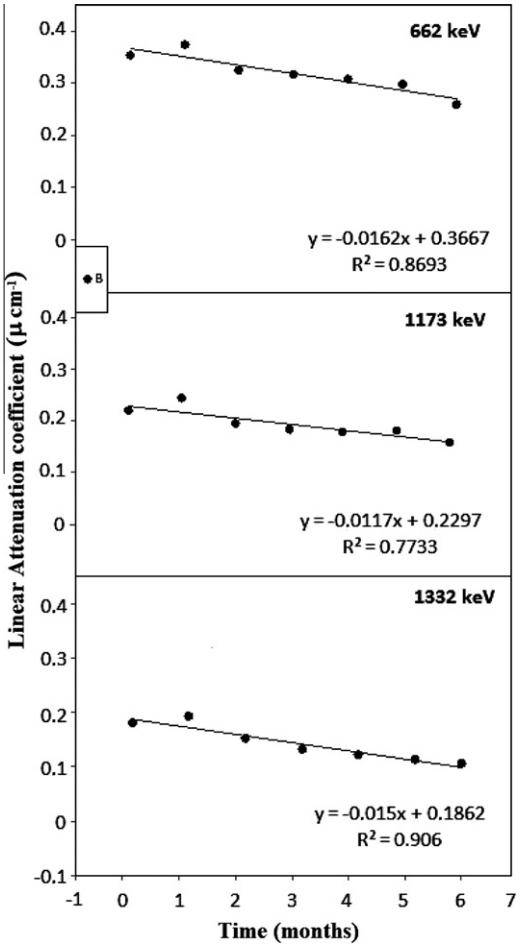


**Figure 3** The variation of the linear attenuation coefficients with the time for 662, 1773 and 1332 keV energy photons in $Na_2SO_4$ medium.

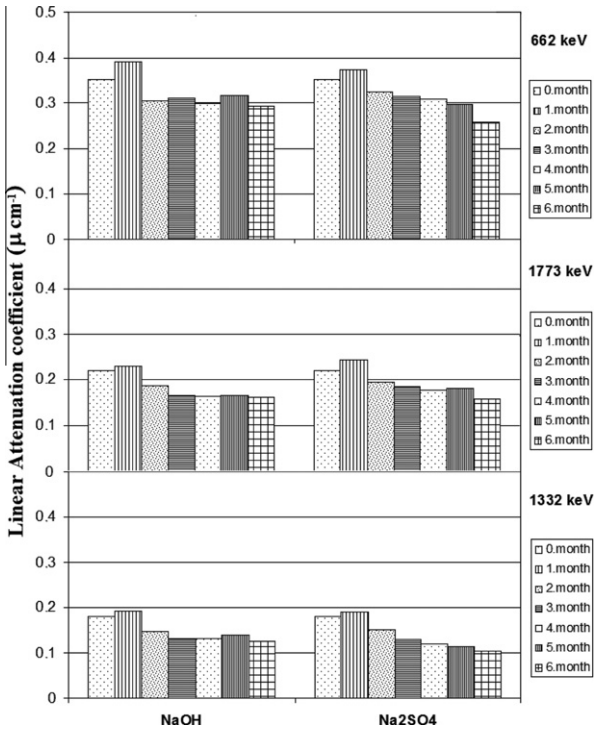


**Figure 4** The variation of the linear attenuation coefficients with the different chemical media obtained at 662, 1773 and 1332 keV energy.

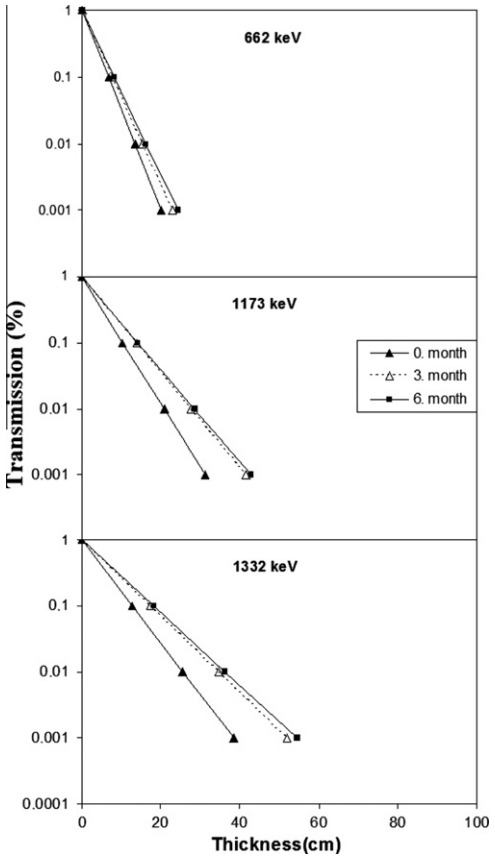


**Figure 5** The transmission rate gamma rays at different energies for various month chemical effect in NaOH medium.

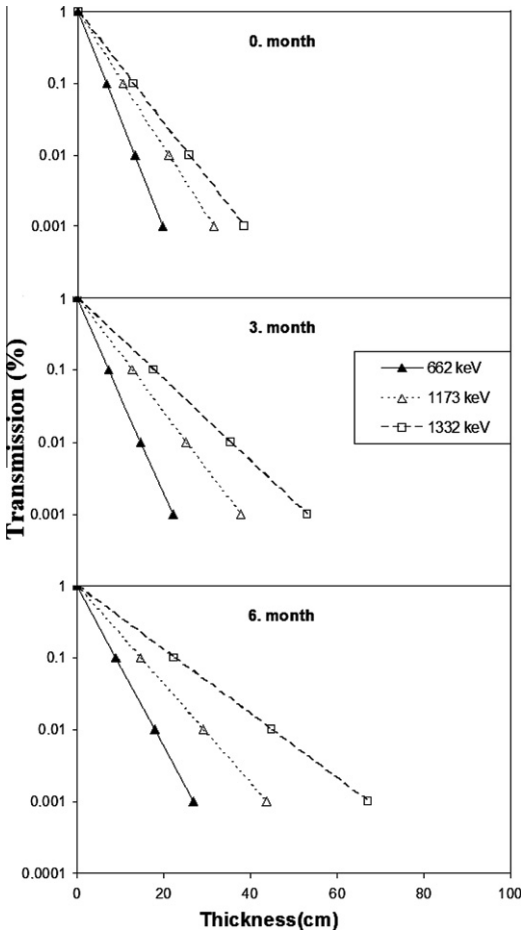


**Figure 6** The transmission rate gamma rays at different energies for 662, 1173 and 1332 keV photon energies in $Na_2SO_4$ medium.

with the measurement performed on chemical media for a 6 month period. The obtained results for NaOH and for $Na_2SO_4$ media have been displayed in Figs. 2 and 3, respectively. It can be seen from those figures that the linear attenuation coefficients have decreased with the increasing exposed time of concrete in the chemical media. This can show that the concrete structure can be destroyed in the chemical media and thus attenuation coefficients decreased. Two different types of chemical media (NaOH and $Na_2SO_4$) have been used to see the variation of linear attenuation coefficients in different types of chemical media. This has been displayed in Fig. 4 where it can be seen that the linear attenuation coefficients have decreased sharply in NaOH medium than in $Na_2SO_4$. The transmission rate for 662, 1173 and 1332 keV as a function of concrete thickness has been placed for NaOH and $Na_2SO_4$ in Figs. 5 and 6, respectively. It can be seen from those figures that the chemical media effect the concrete structure and the stopped thickness of the concrete. For the comparing of 662, 1173 and 1332 keV photon energies (Figs. 5 and 6), it can be clearly seen that the larger concrete is need for higher energy photons.

It is possible to make a conclusion from this work that the radiation shielding properties of concrete have been effected by the chemical media and using barite in concrete is an advantage to protect concrete from this effect.

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