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Estimation of indoor gamma radiation dose rate from concrete blocks constructed from tin mine tailings

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A B S T R A C T

The use of building materials made from geological sources contributes greatly to the indoor radiation exposure of human. As a result, it is critical for public health that building materials be screened for elevated radionuclide concentrations. This research measures the primordial radionuclide content of concrete blocks derived from mine tailings and also estimates the indoor annual effective dose rate (AEDR) and associated parameters. Furthermore, it presents a simple empirical relationship for evaluating dose rate per unit specific activity due to radionuclides from a wall of arbitrary dimensions. Twelve concrete blocks constructed using tin mine tailings as fine aggregates were collected locally and analyzed for ^{235}U, ^{232}Th and ^{40}K content using gamma spectrometry analysis. The concentration of ^{238}U ranged from 86.29 to 197.73 Bq/kg with a mean of 120.93 Bq/kg. Also, the specific activity of ^{232}Th and ^{40}K is within the limits: 99.01–353.67 Bq/kg and 500.71–1021.77 Bq/kg with mean values of 248.31 Bq/kg and 635.10 Bq/kg, respectively. Obtained dose rate per unit specific activity agreed well with data from literature. Using the derived values of dose rate per unit specific activity, the annual effective dose rate (AEDR) obtained from a typical Nigerian room varies significantly from that obtained from equations in referenced documents where a different room configuration was used. The mean AEDR from the realistic Nigerian room ($3.6 \times 3.6 \times 3$ m^3) was higher than the world average value but less than the recommended safety limit of 1 mSvy^{-1}. Some of the blocks with AEDR more than the safety limits were recommended for use in superficial quantities for building construction. The model derived in this study can be applied to calculate dose rates within any room configuration.

1. Introduction

Radiation has always been a human companion ever since man appeared in his environment. The risk associated with human exposure to ionizing radiation can never be eliminated but rather reduced [1]. This is due to the fact that radiation will continue to be present in the human environment. Sources of environmental radiation exposure to man may be categorized into natural and artificial sources [2]. The natural sources of radiation are inevitable as they are present in the human environment as cosmic radiation, whose exposure rate depends on geomagnetic latitude and altitude; terrestrial radiation, which emanates from primordial radionuclides such as isotopes of thorium, uranium, cesium, potassium, etc.; and internal radiation from ^{12}C and ^{40}K within man himself [2]. The terrestrial radiation exposure level often depends on the geology of the local environment, hence, exposure level varies with geography [3,4].

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