Ain shams university
Faculty of education
Department of physics

Determination of Radon Concentration in Artificial Fertilizers Using Nuclear Track Detector and Gamma-Rays Spectrometer

THESIS

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By

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DEDICATION

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Abstract

In this work, the specific activities of natural radionuclides in synthetic fertilizers and some soil samples were studied using gamma spectroscopy and sealing technique. Also, radon concentrations in 42 fertilizers and soil samples were measured by passive technique detector (CR-39). Radon exhalation rates in terms of mass and area were also calculated using "sealed can technique" using CR-39 SSNTDs.

The average areal exhalation rates of radon are found to be (9.6±0.40, 11.40 ±0.90, 0.30±0.05 and 0.38±0.02) Bq $m^{-2}h^{-1}$ for waste product, phosphate fertilizers, chemical fertilizers and soil samples, respectively. Whereas, the mean average mass exhalation rates are estimated to be 0.30±0.02, 0.40±0.02, 0.01±0.001 and 0.01±0.001 Bq kg^{-1} h^{-1} for waste product, phosphate fertilizers, chemical fertilizers and soil samples, respectively.

The average specific activity concentrations of ^{238}U, ^{226}Ra, ^{232}Th and ^{40}K in waste product samples were found to be 246.13±20, 474.47±30, 9.19±0.70 and 91.25±8.50 Bq kg^{-1}, respectively. In phosphate fertilizer samples were found to be 295.29±20, 630±40, 7.31±0.50 and 39.63±2.50 Bq kg^{-1}, respectively. For soil samples, the specific activity concentrations for ^{238}U, ^{226}Ra, ^{232}Th and ^{40}K, have average values of 14±1.50, 21±40, 12.8±1.20 and 218.9±20 Bq kg^{-1}. Radiological hazard indices such as radium equivalent activity (Ra_{eq}), absorbed gamma dose rates (D_R) at 1m above ground, annual external effective dose rate, annual effective dose equivalent (AEDE), internal hazard index (H_{in}), external hazard index (H_{ex}) and annual gonadal dose equivalent (AGDE) were evaluated.

The value of radium concentration in all soil samples except for

samples near the Abu-Zaabal factory is less than the permitted value of 370 Bq kg^{-1} authorized by organization for Economic corporation and development. The specific activity values of ^{238}U,^{232}Th and ^{40}K in soil samples from Al-Ghabat village and in chemical fertilizers are lower than the recommended value of 50, 50 and 500 Bq kg^{-1}, respectively, so no radiation hazard is considered with them. While phosphate fertilizers and soils surrounding Abu Zaabal factory are higher than the recommended value. Also, radiation hazard indices for phosphate fertilizers are high, so it is considered a risk to health.

The dealers and farmers dealing with phosphate fertilizers should take care as it contains high concentration of radionuclides. The Abu-Zaabal factory waste product must be removed safely as it contains the highest concentration of ^{238}U. Finally, the results obtained from the two used techniques (SSNTDs and gamma spectrometer) are well correlated with each other and with other previous studies performed in Egypt.

Summary

The aim of this study is to estimate the concentration of radon, the specific activity of the element of radium, the rate of mass and surface emission of radon from samples of phosphate fertilizers and soil samples fertilized with these fertilizers using the CR-39 nuclear track detector, in addition to determine the level of radioactivity and radiation risk factors of the investigated samples using High-purity germanium detector. The samples were collected from Abu-Zaabal factory products for phosphate fertilizers, factory waste and samples of agricultural soil fertilized with these products and from the agricultural soil of the Al-Ghabat village of El Balyana district of Sohag governorate, located in the southern west of the governorate. In order to fulfill our target, the thesis consists of four chapters.

First chapter

It consists of an introduction, radon isotopes, radioactive series , radon sources, the units used in measure radon concentration, sources of radiation, gamma-ray interactions with matter , theoretical aspects, and radon measurement techniques (active-passive method), semiconductor detector and Na I (Ti) detector.

Second chapter:

Literature review, in this chapter some of the pervious published paper in the field of radon concentration measurements and natural radioactivity levels have been summarized.

Third chapter

It contains some information on how samples are collected, samples preparation and the two techniques used in the present investigation. The specific activity of ^{238}U, ^{232}Th, and ^{40}K are also measured using active

techniques. Finally, radon, radium and radon exhalation rates are also evaluated using CR-39 nuclear track detector.

Fourth chapter

In this chapter, the results obtained throughout the present study have been listed and discussed, which are, radon concentration, radium activity, radon areal exhalation rate and mass exhalation rate of ^{222}Rn using track detectors. In addition, the specific activity of natural radionuclides of ^{238}U, ^{232}Th and ^{40}K using high purity germanium spectrometer and the calculation of radiological hazard. Finally, our result are compared with the average published results from similar studies from other countries.