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Constructasa simple radon chamber for measurement of radon detectors calibration factors

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ABSTRACT

In this work a radon calibration chamber was designed and build in the environmental pollution laboratoryuniversity of Basra. The chamber a volume is 125l and contains a standard radon source (^{226}Ra) and radon distribute fan. The pressure and temperature inside the chamber are kept constant during the experiment. Different types of calibration data wereachieved by using this design.The calibration factor of CR39 used in cylindrical can 25cm x 7 cm was found to be 0.2279±0.022Tr/cm^2.d/Bq/m^3. While, calibration factor for 11 cm x 7 cm was 0.3420±0.0459 Tr/cm^2. d/Bq/m^3 and the indoor calibration factor using cup technique 6 cm x 7 cm was 0.1888±0.0433Tr/cm^2.d/Bq/m^3.

Keywords; radon gas, radon chamber, ^{226}Ra, calibration factor

INTRODUCTION

Fora healthy environment, it is important to carry out a routine measurementof radioactive radon gas concentration in the outdoor and indoor environments. Radon gas is a radioactive gas produced by the decay of ^{226}Ra and ^{228}Ra isotopes, and this gas produced a solid radioactive daughter^{218}Po and ^{214}Po and these are radioactive as welland more hazardous, due to their fast and high energy alpha particles decay (short half-life) [1-2]. Different mode of measurements were produced to estimate the concentration and exhalation rate of this gas; some methods are actives methods using electronics devices and the other are passive method using Solid State Nuclear Track Detectors (SSNTDs);the latteristhe most popular methods, in term of precisions and simplicity [3-8]. However, the estimation of radon concentration and exhalation rate, in the environment using the passive methods (SSNDTs) required a parameterwhichtransfers Track/cm^{2}toBq/m^3. This parameter can be determined using a standard radon source (^{226}Ra) and electronic instrument to measure the activity concentration in the space by, the well-sealed radon chamber.

After the fabrication of the potable electronics radon gas meters, many types of multipurpose radon chamber have been designed [9-13].These chambers have been used to determine the calibration factors of CR39 or LR115 detectors for alpha decays of ^{222}Rn or ^{220}Rn.

The aim of the present work is to determine the calibration factor for CR39 detectors using a hybrid between active and passive methods in a newcalibration factor.

2.Design and fabricate the chamber

This chamber was designed and fabricated by environment pollution laboratory team in Basra University. The chamber made of solid class, 6mm thickness, and dimension 50 cm for each side (Figure 1). The chamber has two circulate holes of radius 6 cm. Each hole is well fitted with thick rubber gloves to remove contents inside the chamber without any contact with the outside. On the top of the chamber there is another hole, 20 cm diameter, to insert equipment. This hole should be well sealed during the experiments. Inside the chamber there are the radioactive ^{226}Ra (5 µCi) source, fan to provide circulation of gases inside the chamber and digital continues radon monitor Radon Scout by SARAD GmbH company (Germany). Five cylindrical containers (25cmx7cm) were inserted inside the chamber for the calibration of CR39 radon dosimeters. The CR39 detectors, 1.5cmx1.5cm, were placed inside a hard glass small container to protect them from the radon effect until the irradiation time starts.

FIG. 1. The calibration chamber

3.The Experimental Mythology

In order to start measuring the radon concentration inside the chamber after inserting the radon source and seal the chamber by cold silicon, we switched on the radon monitor which fabricated to measure radon concentration each one hour and supplied with dry batteries. The battery life time in this instrument is 3 months. The instrument saves the date of the whole experiment and could be transferred to computer for analyzing. The background measurement was done by Radon Scout and the CR39 detector for 27 days.

RESULTS

4.1 Calibration factor for 25cm*x*7cm

The chamber was used to measure the calibration factor for CR39 detector in can mode of dimension25cm x 7cm.Group of emanation containers was leftclosed inside the chamber without the detectors for four weeks to let radon and radium reach the equilibrium states. It follows that the activities of radon and radium are equal. The radon Scout monitor was recorded radon concentration each hour up to equilibrium state where the concentration is stable at its maximum. After attainment of secular equilibrium, each CR39 (1.5cm x 1.5cm) detectors, fixed on the bottom of the top cover of the can, were exposed to radon for a different exposing time (4, 7, 10, 18 and 27 days). At the end of exposure, the CR39 detectors wereimmediately removedfrom the cans and store inside the chamber until the end of the experiment. The detectors were etched with 6.25N NaOH at 70^o C for 7 h. The trackswere counted for many fieldareas using 400X microscope to determine the track density per cm^2. Figure 2 plots of the track density in Tr/cm^2 against radon exposure dose in (Bq/m^3). d. The best straight line was found, and from the slope of this line, the calibration factor of the CR39 polymeric detector using hybrid method is found to be K= 0.22790±0.02211 Tr/cm^2. d/Bq. m^{-3}.

Moreover, Saadet al [3] were measured the calibration factor byhybrid between AlphaGaurd and CR39 and useda 7.35 cm x 14.8 cm can. The factor was K=0.239±0.008 Tr/cm^2. d/ Bq/m^3, which is very closed to our measurement.

4.2. Calibration factor for 11 cm x7 cm

The experiment was repeated using different groups of emanation cans (11 cm x 7 cm). The exposure time at equilibrium were the same and the same etching conditions, Figure 3 shows the relation between track density and exposure dose of radon. The best straight line passing through experimental point was produced, and from this line the calibration factor for CR39 is; K= 0.3232±0.04586 Tr/cm^2.d per Bq/m^3.

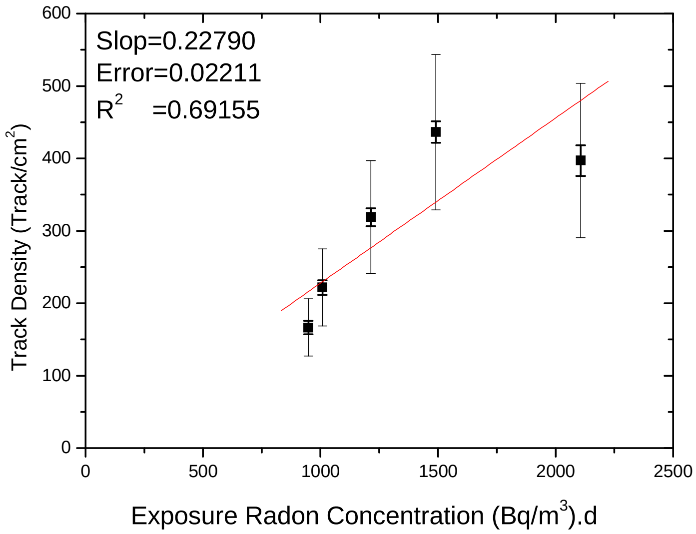

FIG. 2.Plot between track density in Tr/cm^2 and radon exposure rate in (Bq/m^3).day measured by 25cm x 7cm can

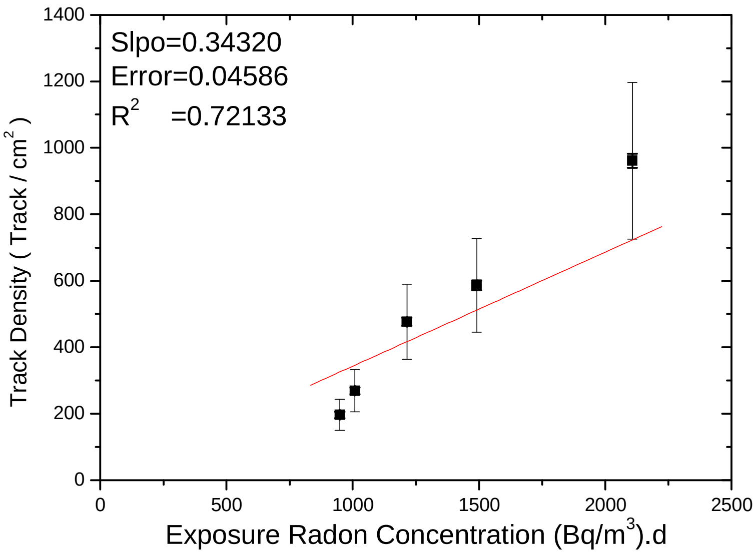

FIG 3. Plot between track density in Tr/cm^2 and radon exposure rate in (Bq/m^3).day measured by 11cm x 7cm can

4.3. Calibration factor for indoor cup

The same experimental procedure has been followed, using 6cm x 7cm group of cups to measure the calibration factor for CR39 used in the indoor measurements [14-16]. The cups contained detectors were hung freely in the radon chamber for 27 days after equilibrium. The average track density found to be4890 Tr/cm^2 for 27 days exposure and radon concentration inside the chamber was 949 Bq/m^3 as measured by radon vision instrument. According to these data, the calibration factor for CR39 detector in the indoor mode is K= 0.188±0.0433Tr/cm^2.d perBq/m^3 and this is close tothe value used by Al-Jarallaand his researchers group.

CONCLUSION

A new multipurpose, calibration chamber has been built to enable the solid state nuclear track detector to be calibrated for radon concentration measurement. By increasing the exposure time; it is found that the track density increases and, radon concentration at the equilibrium was stable at 949Bq/m^3 measured by the Radon vision instrument. According to our results for the calibration factors in different can modes, one canextrapolate that; the dosimeter dimensions have an effect on the value of the factor and specially the height. Increasing traveling distance for radon means reducing the track density, in other word; the calibration factor should be reduced to maintain the same concentration and this is well established in our calibration chamber.

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