Radon Monitoring: Pathway to Environmental Sustainability

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Abstract. One important dimension of environmental sustainability is the need to maintain ecosystem services critical to the human population. These services include providing food, shelter, and construction materials. It has been discovered that construction materials contain certain amount of radon. So humans are most susceptible to radon related problems because we spend at least one third of the day indoor. Maintaining environmental sustainability is crucial to attaining the Sustainable Development Goals (SDGs). Radon monitoring is essential in determining the actual level of exposure in buildings. The indoor radon concentration in Covenant University Centre for Research Innovation and Development (CUCRID) has been studied using RAD7 radon detector machine. The result from the study revealed that the average cumulative radon concentration for the building is 16.15 Bqm\(^{-3}\) which is lower than the permissible recommended level. Hence, it can be concluded that the radon level in CUCRID building does not pose any risk level to the occupants therefore the environment is safe for workers.

Keywords: Radon concentration, indoor, environmental sustainability, Covenant University

1. Introduction

Radon is a radioactive gas present in virtually everywhere man is located though at a varying concentration. It found in all soil and therefore exist at varying concentration in different house types; hence, man is exposed to radon in all indoor environments [1-4]. It is known that half of human radiation dose in a lifetime comes from exposure to radon; being the largest source of natural radiation exposure to man [5-6]. Indoor radon database has been established in several countries of the world [1, 5, 7]. Also, building regulations regarding accumulation of indoor radon has been formulated and enforced, with the aim of promoting environmental sustainability and enhancement of safety. However, several individuals still lack adequate knowledge on the subject and as such do not observe safety rules.

Radon monitoring is essential in determining the actual level of exposure in buildings. It took five decades after the discovery of radon before it was correlated with lung cancer [8]. Thereafter regulations on radon concentrations were formulated [9]. Based on the recommendation, some countries adopted radon reference levels without knowing the concentration variability of this gas in their environment [9]. Further research on the subject showed wide and inconsistency variation in the concentration levels of radon in homes. Indoor radon concentration can build up as high as 50,000 Bqm\(^{-3}\) without knowing the concentration variability of this gas in their environment [9]. Further research on the subject showed wide and inconsistency variation in the concentration levels of radon in homes. Indoor radon concentration can build up as high as 50,000 Bqm\(^{-3}\) without knowing the concentration variability of this gas in their environment [9]. Further research on the subject showed wide and inconsistency variation in the concentration levels of radon in homes. Indoor radon concentration can build up as high as 50,000 Bqm\(^{-3}\) without knowing the concentration variability of this gas in their environment [9]. Further research on the subject showed wide and inconsistency variation in the concentration levels of radon in homes. Indoor radon concentration can build up as high as 50,000 Bqm\(^{-3}\) without knowing the concentration variability of this gas in their environment [9]. Further research on the subject showed wide and inconsistency variation in the concentration levels of radon in homes. Indoor radon concentration can build up as high as 50,000 Bqm\(^{-3}\) without knowing the concentration variability of this gas in their environment [9]. Further research on the subject showed wide and inconsistency variation in the concentration levels of radon in homes. Indoor radon concentration can build up as high as 50,000 Bqm\(^{-3}\) without knowing the concentration variability of this gas in their environment [9]. Further research on the subject showed wide and inconsistency variation in the concentration levels of radon in homes. Indoor radon concentration can build up as high as 50,000 Bqm\(^{-3}\) without knowing the concentration variability of this gas in their environment [9].

The level of radon exposure in homes can be critically reduced and there are several methods to achieving this such as sealing of entry points, increased ventilation, covering of sump pit, installation of active soil depressurization (ASD) system, lifestyle among other [6]. A study conducted in Canada observed that installation of ASD was the most effective method [6]. However, combination of all the safety rules will be a better alternative. More so, acquiring ASD might be expensive for some individuals and might be scarce or not available like in most developing countries. Therefore, applying all the available safety measures within their capability and vicinity will be the way out. Application of preventive measures has led to considerable reduction in indoor radon concentration as witnessed in Norway. Mean radon concentrations for detached houses decreased from 76 Bqm\(^{-3}\) to 40 Bqm\(^{-3}\) and areas within 100 Bqm\(^{-3}\) concentration levels reduced from 23.6% to 6.4% while areas within 200 Bqm\(^{-3}\) levels decreased from 7.6% to 2.5% [1].
There is an urgent need to create awareness on radon exposure and its health implications in homes especially in developing countries. Literature on mitigation of radon in developed nations revealed that substantial number of people undermine the health hazards associated with radon exposure in homes [6, 12-13]. Lung cancer death traceable to indoor radon is about 16% per annum in Canada [10]. In Norway about 12 % lung cancers are associated to radon [1]. Radon gas is classified as group I carcinogen and it is the second leading cause of lung cancer [1, 14]. Radon studies in 66 countries attributed 3% of lung cancer mortality to radon exposure [15]. The authors noted that most lung cancer death globally is associated with radon. Stomach and brain cancer mortality has also been linked to indoor radon in Galicia Spain [16]. A similar study in United States of America has noted a strong correlation between chronic lymphocytic leukemia and indoor radon [17-18]. It is evident that radon is a serious public health concern. Thus recommendation has been made that concentration of indoor radon should be minimized to as low as reasonably achievable (ALARA) [1]. Hence, this study is undertaking in order to determine the level of radon exposure in the study environment thereby enhancing the safety of the dwellers and promote future sustainability.

2. Materials and Method

The study was carried out from October to December 2018 at the Covenant University Center for Research and Innovation (CUCRID) in Covenant University, Ado-Odo, Ota, Ogun state, Nigeria (latitude 6E37’ N, longitude 3E42’ E and altitude 41 m). The choice of selecting this location for the study is because of the construction materials used in constructing the building mainly glasses. In this research, an indoor radon accumulation of the first five floors in the building were measured. The detector used for this research is a calibrated Durridge portable continuous radon monitor called RAD7. The design of the RAD7 device is in such a way to detect only alpha particles as described in study by [3]. We observed all sampling procedures by making sure the radon detector is set on sniff mode so that radon progeny products were prevented from entering the ionization chamber through the glass filter but only the gaseous 222Rn. Only the radon gas is measured in the measurement chamber and it is then recorded. Hourly radon measurement was taken in each study location of the building for a period of 48 hours.

3. Results and Discussion

The indoor radon concentration in Covenant University Centre for Research Innovation and Development (CUCRID) was studied; the average radon concentration values are presented in Table 1. Other measured indoor parameters include room temperature and relative humidity. CUCRID is a five (5) story building constructed predominantly for research. Other administrative purposes also take place in some section of the building. The knowledge of radon concentration level in the building is paramount to assure the safe stay of workers as related to their health and wellbeing. Maintaining safe level of radon concentration in the building is one of the sustainability plans for safe physical work environment for the institution staff and faculty members. The average radon concentration, temperature and humidity of the locations are presented in Table 1. The average radon concentrations from ground floor to the fifth floor with location ID; GF, F1, F2, F3, F4 and F5 are 11.97813, 17.46063, 11.02958, 21.81958, 18.72625 and 15.58875 Bqm$^{-3}$ respectively with cumulative mean concentration of 16.15 Bqm$^{-3}$. Location F3 recorded the highest average value of 21.82 Bqm$^{-3}$. This is due to fluctuation pattern of temperature in the study location over a long period of time. The air condition in F3 study location was not working for most hours of the day as compared to other locations. At the point where the temperature is 30°C and above, the radon concentration was high and when the temperature is below 30°C, the radon concentration measured is equally low as depicted in Figure 2. It was also observed that temperature and humidity shows a regular influence pattern of one on the other in location GF, F1 and F2. The observed pattern displayed in the plots shows that the higher the temperature, the lower the relative humidity indoor. The fluctuations in temperature and relative humidity gave the fluctuating pattern of indoor radon concentrations in these locations. The result obtained in this study is in agreement with study by [3] that temperature and humidity influenced radon concentration. The obtained average radon concentration is well below the world recommended limit of 40 Bqm$^{-3}$. All recorded radon average results in all the locations are below the recommended world limit.
Table 1: Average radon concentration for locations

| Location ID | Radon Con. (Bq m⁻³) | Temp. (°C) | RH (%) |
|-------------|----------------------|------------|--------|
| GF          | 11.97813             | 30.4125    | 69.750 |
| F1          | 17.46063             | 29.1313    | 71.8542|
| F2          | 11.02958             | 27.6333    | 73.3750|
| F3          | 21.81958             | 28.4542    | 73.2708|
| F4          | 18.72625             | 30.4083    | 70.1875|
| F5          | 15.58875             | 29.9438    | 72.0625|

Figure 1: Indoor radon concentration

Figure 2: Variation of radon concentration with temperature at F3
4. Conclusion

The indoor concentration level in CUCRID building at Ota, Nigeria has been studied. Hourly radon measurement result was taken in each study location of the building for 48 hours and the average radon concentration reported in this work. The average radon concentrations from ground floor to the fifth floor with location ID; GF, F1, F2, F3, F4 and F5 are 11.97813, 17.46063, 11.02958, 21.81958, 18.72625 and 15.58875 Bqm\(^{-3}\) respectively. Location F3 recorded the highest average value of 21.82 Bqm\(^{-3}\). All the study locations recorded average indoor concentration values below the recommended limit. Hence, it can be said that the radon level in CUCRID building is not at any risk level, therefore the environment is safe for workers. The sustainability of safe radon concentration level in the entire building requires that temperature should be kept at level below 30°C and relative humidity level be maintained at 70% rate. This can be attain through central cooling system. Implementation of sustainability operational structures to maintain safe level of radon for continued safety of worker through high radon level risk education should be adopted. The study hereby recommends that radon sustainability in CUCRID building requires the maintenance of uniform and steady indoor radon level, hence, constant supply of central air condition system is recommended for proper conditioning of radon meteorological influencers such as temperatures and relative humidity. Also, periodic radon level monitoring is recommended.

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