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Investigating the indoor Concentration of Radon-222 and its possible health Implications on the staff of a Pharmaceutical Company in Ota, Ogun State, Nigeria

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Abstract. The present study investigated the concentration of radon in some offices of a pharmaceutical company in Ota, Ogun State. A Durridge RAD 7 equipment was engaged for the indoor radon measurement. The measurement of radon concentration was carried out for 8 days in 4 different offices in the main administrative building of the company (one office on the ground floor and three on the first floor). The results obtained for the four locations ranged between 19 and 160 Bqm^{-3} which is still below the world set limit of 200 Bqm^{-3} as recommended by International Commission on Radiological Protection. However, the office on the ground floor reported the highest concentration of radon-222, which is 160 Bqm^{-3}. Therefore, it can be concluded that, since, the highest concentration of radon-222 observed in this study is below the international set limit, then, the occupants of the offices considered for this study are safe.

Keywords: Radiological protection, RAD 7, radon-222, Gamma Spectrometer

1. Introduction

Natural Occurring Radioactive Material (NORM) has become an international concern due to its impact on human health [1]. These radioactive substances; mainly ^{238}U, ^{232}Th and ^{40}K originate from the earth subsurface which forms a major part of man's existence [2]. They are found in geological formations like soils, water, plants and so on, since man depends on these materials for living, exposure to radiation can hardly be avoided. Among the radioactive materials, ^{238}U is known to disintegrate to ^{226}Ra, which in turn gives birth to ^{222}Rn, popularly known as Radon [3]. Radon has the symbol Rn and atomic number 86, and it is a chemical element. It is a noble gas that is radioactive, uncolored, does not have a smell and tasteless [4]. Radon is the product of radium's immediate decay. Its most stable isotope, ^{222}Rn, is only about 3.8 days old and has made radon one of the rarest elements, as it declines very fast [5]. Under normal conditions, radon is gaseous and easily inhaled. Radon gas is regarded as a risk to health. It often contributes the largest radiation dose to a person's background, but the radon gasses level differs from location to location due to local geological differences [6,7]. In spite of its short lifespan, natural radon gas, for example uranium mineral, could build on low areas like basements and crawl areas, especially due to its high density. In ground water radiation can also occur–in some spring and hot waters for example [8]. There has been a connection between high radon breathing level and the incidence of lung cancer in epidemiology studies. Radon is an indoor air quality contaminant worldwide. Radon is the second most common cause of lung cancer following cigarette smoking, resulting in 21,000 lung cancer death each year [9][4][10]. While radon is the second most common cause of lung cancer, according to USEPA estimates, it is the number one non-smoker cause. As the radon decay itself, it produces decay products called radon daughters (also known as radon descent), which are other radioactive elements [11]. In contrast to gas-based radon itself, radon daughters are solid and adhere to surfaces, such as airborne dust particles. These particles may also cause lung cancer if contaminated dust is inhaled. Radon was the fifth radioactive element to be found after uranium, thorium, radium and polonium [7] that radium compounds were emanating from a radioactive gas called Radium. [12] researched the improvement on indoor radon accumulation rate in CST laboratories at Covenant University Ogun state, Ota, Nigeria. In this study, the level of radon measured ranged from 0 to 57.3 Bqm^{-3} for all study locations which is well below the world set limit of 200 Bqm^{-3}. Their study further discovered that the indoor relative humidity has high influence on indoor radon. Studies have revealed that uranium-238 contributes to the concentration of radon-222 [2-4]. Since uranium-238 occurs naturally, there is need to measure its contribution to the indoor gas so as to mitigate its health effect on the people that are always in such buildings. It is on this basis that the contribution of uranium-238 to the concentration of radon-222 in the premises of a pharmaceutical company was measured in order to investigate its health implications on the staff.

2. Geology And Geographical Location Of The Study Area

The study site is situated at Sango Ota, Ogun State in southwest Nigeria. It lies within the latitude 6° 38□N to 6° 41□N and longitude 03° 8□E and 3° 12□E. It is accessible through Agbara –Atan road, off Badagry–Seme express road it is also accessible via Iyana Ipaja to if road. The study area for this project is within the eastern Dahomey basin which is in the sub-humid tropical region of southwest Nigeria. It extends along the mainland edge of the inlet of Guinea. It has a distinct wet and dry period, the dry season is from November-March while the wet portion of the year runs between April and October. There has been extensive discussion on the geology of this study area by various authors such as [13, 14]. They discussed the types of rocks in this area from the formation of early tertiary to late cretaceous in age. The basin stratigraphy has also been put in six lithostratigraphic formations which are Benin Formation, Ilaro, Oshosun Akinbo, Ewekoro and Abeokuta from the youngest to the oldest [15] discussed the formation of Abeokuta to consist of the Araromi, Ise and Afomo Formations. This formation is mainly made out of poorly arranged grit mud stone with shale clay layers and siltstone.

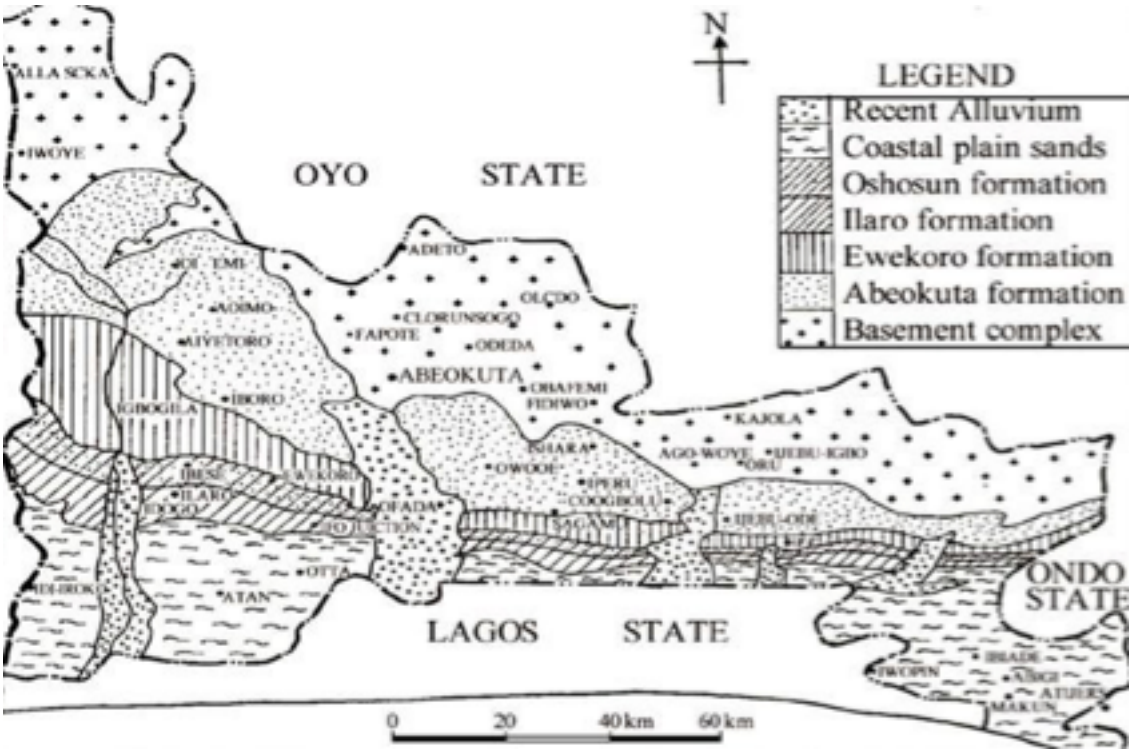

Figure 1: Geological map of the study area [15]

3. METHODOLOGY

The instrument used for this work is Durridge RAD7 electronic radon detector. Indoor radon accumulation levels were measured continuously on hourly basis at the different sampling locations in the pharmaceutical company between 23rd and 31st October 2018. It takes 45 seconds for the RAD7 sniffing process to take place, during this process, air sample passes through the small drying tube and flows into the measurement chamber for radon concentration readout. The equipment is set up in the location of interest for 48 hours, during which it measures the concentration of radon at the investigated location. At the expiration of the 48 hours, a print-out comes from the printer of the RAD 7 that captures information such as time and date of the measurement, serial number of the machine, the average test values, the bar diagram of each reading and the cumulative spectrum of alpha energy.

4. Result And Discussion

As earlier declared, four (4) offices were considered for this study, one on the ground floor and the remaining three are located on the first floor of the main office complex. From the data acquired, the graphs of radon concentration were plotted against time in the four cases as presented in Figures 2 and 3.

Figure 2: Graph of location 1

At location 1, the concentration of radon over the 48 hours period of data acquisition ranged between 20 and 160 Bqm-3. The highest level of radon concentration, 160 Bqm-3, was observed at this location. The measured result is below the world set limit of 200Bqm-3 as recommended by International Commission on Radiological Protection, and [16] so the office is considered safe for the occupants. The activity concentration of uranium-238 in the soil beneath the foundation of these building is suspected to have contributed mainly to the high level of radon concentration detected in the office [11]. Furthermore, indoor air is the major source of radon build-up in soil, concrete and rocks and building material [8]. The change in the concentration of radon indoors reflects the effect of ventilation in each office. The office considered as location 1 does not have any means of ventilation, besides the air conditioning cooling system that is used. Thus, the higher the concentration of radon a man is exposed to, the more the risk of having lung cancer and other related sicknesses increases [9,10].

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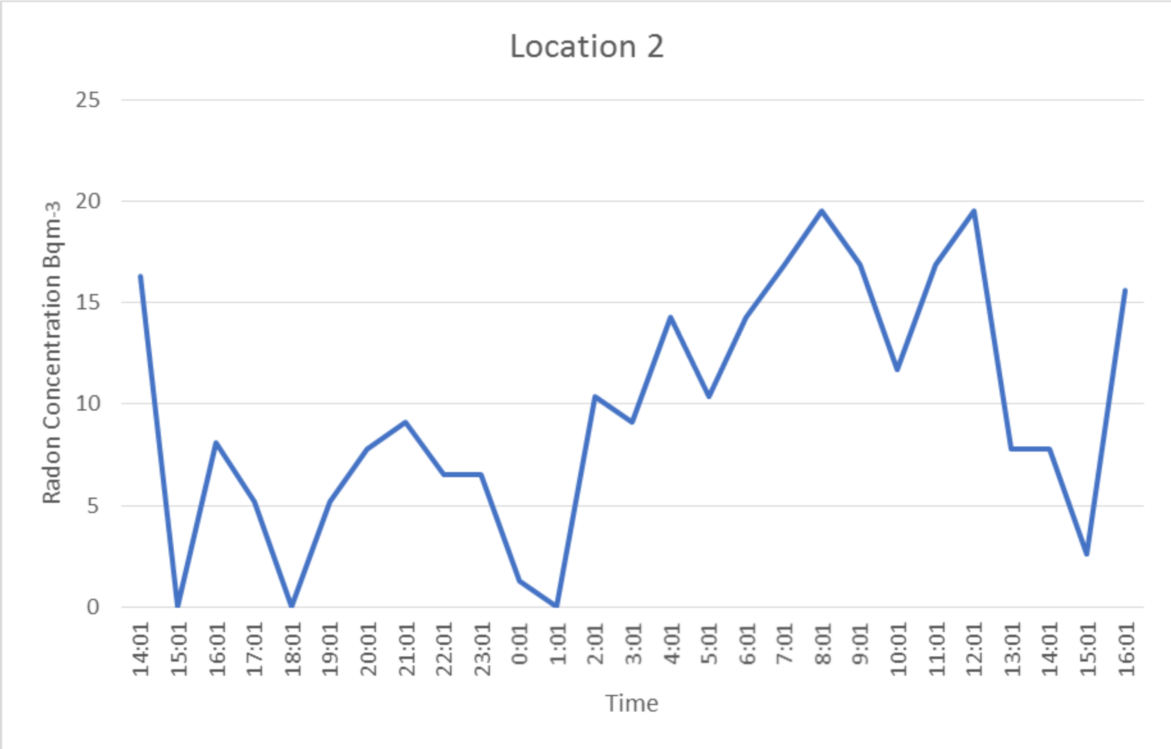

Figure 3: Graph of Location 2

In location 2 (Figure 3) the highest value of radon concentration was found to be 19Bqm^{-3} and the lowest level is below detectable limit (BDL) which makes the office safe for the occupants. As a result, they have lower risk of having lung cancer when compared to the occupants of the office in location 1. The reason for the lower radon concentration measured in this location could be largely, as a result of the fact that the office is located on the first floor of the building, where influence of background radiation from the environment is minimal. Furthermore, the level of ventilation in the office is more than what obtained in the other offices. Therefore, the workers that have their office in location are safe from the radiation poisoning that could lead to other serious diseases.

Figure 4: Graph of location 3

In locations 2, 3 and 4, the results obtained for radon concentration ranged between below detectable limit (BDL) and 19 Bqm-3, BDL and 27 Bqm^{-3}, and BDL and 25 Bqm^{-3} respectively. A lower level of radon concentration was noted in locations 2, 3 and 4, when compared to location 1. This could be because locations 2, 3 and 4 are on the first floor of the office complex, thus reducing the influence of background radiation that emanates from the environment on the radon concentration [3]. Another reason for the low level of radon concentrations in these offices could be because of the level of a more reasonable level of ventilation provided in the offices. Unlike location 1 that has no room for ventilation, locations 2, 3 and 4 are more ventilated. Therefore, the workers that have their offices in locations 2, 3 and 4 are safer from the risk of radon exposure than those in location 1. Thus, they are less likely to have cancer of the lungs by reason of their stay in the offices except if they have exposure to radiation and radon gas from other sources besides the office.

5. Conclusion

The indoor radon concentration level were investigated at the offices of a pharmaceutical company in Ota, Ogun State, Nigeria. Radon concentration was measured on hourly basis using the RAD 7 equipment. The result obtained revealed a variation in radon concentration within the office complex. The values obtained ranged between 19 and 160 Bqm^{-3}. The highest value of 160 Bqm^{-3} of radon concentration was reported at the office on the ground floor, this could be due largely to the contribution of uranium-238 from the background radiation or the poor ventilation of the office. On the other hand, the result obtained from the offices on the first floor took a different turn because the values reported were 19, 27 and 25 Bqm^{-3}. The difference observed in this result could be attributed to the degree of ventilation available in the offices and the lower level of influence by background radiation. Finally, the results obtained in all the locations are far lower than the international safe limit of 200 Bqm^{-3}. Thus, there may be no health implication by reason of exposure to radon gas of these concentrations.

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