INTERNATIONAL JOURNAL OF SCIENCE AND NATURE
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MEASURING OF RADON CONCENTRATION IN INDOOR AIR IN ADIGUDEM, TIGRAY, ETHIOPIA

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ABSTRACT
Radon measurements were carried out in 12 dwellings of Adigudem, Ethiopia using LR-115 type II Cellulose Nitrate films. After exposure time of 4 months, the detectors were etched in a NaOH solution at 65°C. Obtained values show that concentrations of indoor radon vary from 53 Bq/m^3 to 125Bq/m^3 with mean value of 92.17Bq/m^3. In general, the level of radon concentration found to be within recommended limits.

KEY WORDS: Indoor radon concentration, LR-115, exposure time.

INTRODUCTION

Radon (^{222}Rn) is a noble gas that is formed as natural deposits of uranium throughout the earth's crust decay.). Uranium occurs naturally in soils and rocks. The half life of radon is 3.8 days, and tends to concentrate in enclosed spaces like houses. As the decay products of radon inhaled, they can mutate the cells in the lungs. Densely ionizing alpha particles emitted by deposited short-lived decay products of radon (^{218}Po and ^{214}Po) can interact with biological tissue in the lungs leading to DNA damage. The alterations can greatly increase the pool of cells available for the development of cancer [1]. Radon gas is considered to be the second leading cause of lung cancer after smoking. Factors that contribute the indoor radon are building ground, interior or exterior building material, soil properties, water supply, ambient air, temperature, pressure, wind and age of buildings [2] an important phenomena by which radon enters into indoor condition from building materials are by a means of diffusion and advection[3].

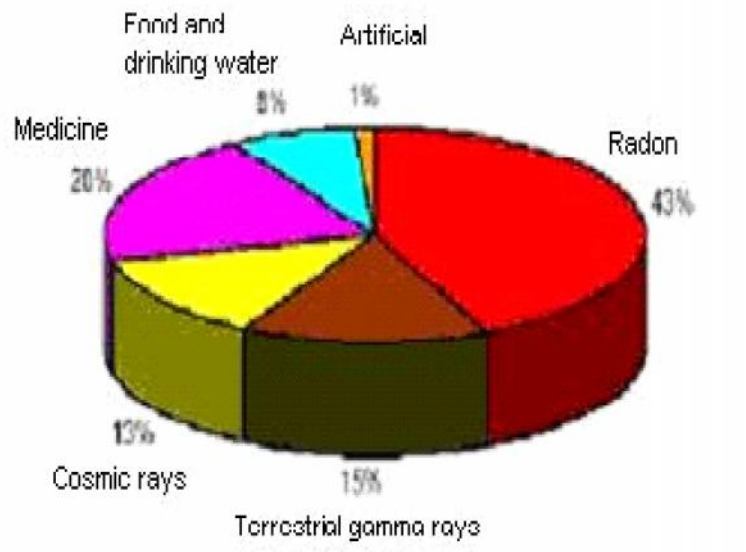

FIGURE 1. Estimation of total annual dose received by people (Adapted from [4])

Study Area

Adi Gudem is a town in Tigray, Ethiopia and located in the Southeastern Zone of the Tigray Region. It is 746 km far from Addis Ababa, the capital city of Ethiopia. This town has a latitude and longitude of 13°15′N 39°31′E with an elevation of 2100 meters above sea level.

FIGURE 1: Map of Adigudem Town

MATERIALS AND METHODS

Solid state nuclear track detector (SSNTD) made of cellulose nitrate film (LR-115, Type II) was used for detection of radon gas. The detector is hung over on selected houses at a height of 2 m from floor and at least 15 cm away from any surface. After an exposure time of 4 months, the detector is retrieved and chemically etched using 2.5 N NaOH solution at constant temperature of 65°C for 90 minutes. The track formed due to the alpha particles on the SSNTD films are then counted by using an optical microscope at a magnification power of 400x. The potential alpha energy concentration Cp (mWL) was obtained using the formula,

$$C_p\,(\text{mWL}) = \frac{\rho}{KT}$$

mWL is mili working level which is the unit of Cp , ρ is track density(number of tracks per Area of the film), K is the average value of the calibration factor of ^{222}Rn in (tracks.cm^{-2})/ (days.Bq.m^{3}) and T is the exposure time (day)[5][6].

The concentration of radon and the potential alpha energy concentration were also calculated using the relation;

$$C_{Rn}\,(\text{Bq.m-}^{3}) = \frac{3.7C_p}{F}$$

Where F=0.4 is equilibrium factor.

The inhalation dose D_{in} (in mSv.y^{-1}) was calculated using the equation;

D_{in} (in mSv.y^{-1}) = 0.009C_{Rn}

RESULTS AND DISCUSSION

TABLE: Observed values of track density (tracks.cm^{-2}), potential alpha energy concentration, radon gas concentrations and inhalation dose rates.

Detectors code	Track density ρ (tracks.cm^{-2})	Nature of ventilation	C_p(MwL)	C_{Rn}(Bq.m^{-3})	D_{in}(mSv/y)
AD-1	32.33	Unvent.	13.5	125	1.13
AD-2	27.67	Unvent.	11.5	106	0.95
AD- 3	23.67	Partially vent.	9.9	92	0.83
AD- 4	30	Unvent.	12.5	116	1.04
AD- 5	25.8	Unvent.	10.8	100	0.9
AD- 6	17.67	Vent.	7.4	68	0.61
AD- 7	29	Vent.	12.1	112	1.0
AD- 8	16.67	Unvent.	7	65	0.58
AD- 9	13.67	Vent.	5.7	53	0.48
AD- 10	17.33	Vent.	7.2	67	0.60
AD- 11	31.67	Unvent.	13.2	122	1.10
AD- 12	20.67	Partially vent.	8.6	80	0.72
		Mean	9.95	92.17	0.83
		Standard deviation	2.58	23.8	0.21

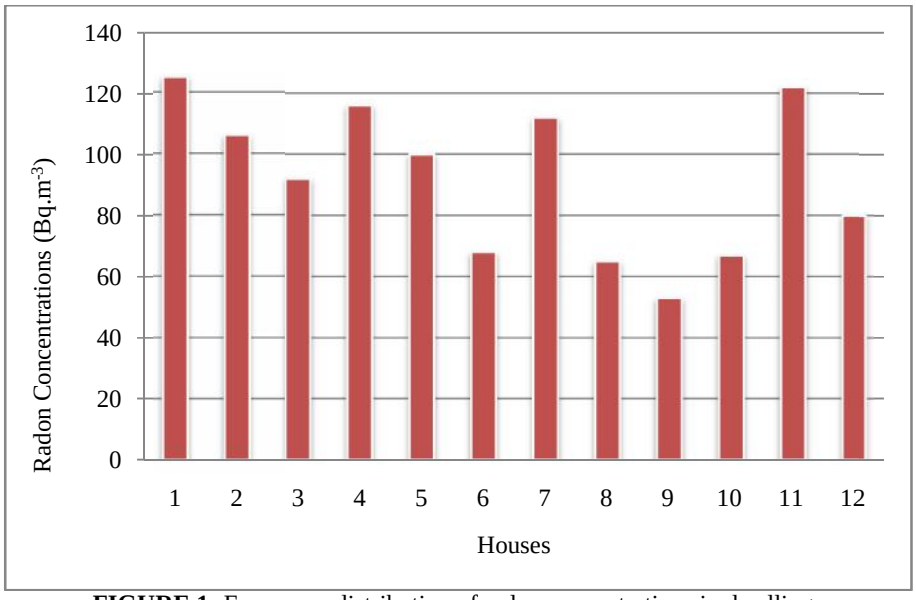

FIGURE 1: Frequency distribution of radon concentrations in dwellings

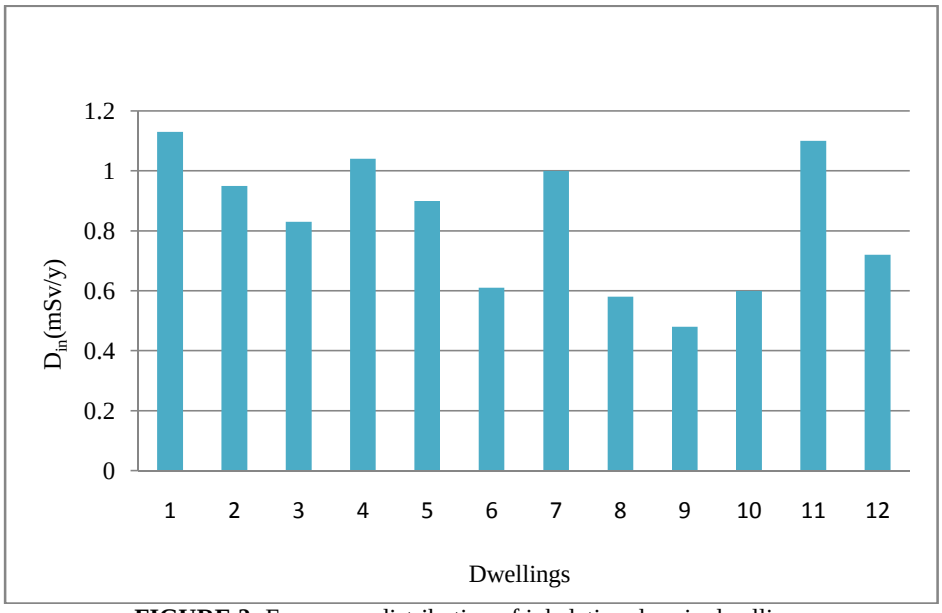

FIGURE 2: Frequency distribution of inhalation dose in dwellings

The result for radon concentrations are presented in Table 1, and Figs.1 and 2. From the above two figures it is clear that the poor ventilation system, the factor which is most responsible for the increased radon concentration in dwellings, has contributed much to the effect. The obtained value of concentration of radon ranges from 53Bq/m^3 to 125Bq/m^3 with mean value of 92.17Bq/m^3 and standard deviation of 23.8 Bq.m^{-3} and the inhalation dose rate varies from a minimum of 0.48 mSv.y^{-1} to a maximum of 1.13 mSv.y^{-1} with an average of 0.83 mSv.y^{-1} and standard deviation of 0.21 mSv.$y^{-1.}$ The maximum acceptable value of indoor radon concentration must be less than 200 Bq.m^{-3} and annual effective dose of 3-10 mSv/y as prescribed by International Commission on Radiological Protection (ICRP).[7]. Thus results reveal that the area is safe as far the health hazard effects are concerned.

CONCLUSION

In this work, radon concentration levels in randomly selected dwellings in Adigudem, are reported. The overall average of radon concentration level inside dwelling of Adigudem was 92.17Bq/m^3 which is less than the average value recommended by ICRP. Therefore, the area is safe as far the health hazard effects are concerned and we strongly recommend that better ventilation rate to these houses must be considered to keep low radon concentration level.

ACKNOWLEDGMENT

The Authors are thankful to Mekelle University, Department of Physics, Department of Chemistry and School of Earth Sciences for providing all necessary facility for carried out this work.

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