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Measurement of Indoor Radon Concentration using LR-115 Plastic Track Detector

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The variation of radon concentration in indoor atmospheres has been studied in the rooms of Guru Nanak Dev University campus using LR-115 plastic track detector. The study has been made on both residential and non-residential rooms and the effects of different parameters have been measured. The results reveal that the indoor radon concentration depends on the ventilation conditions, height from the ground level, wind direction and on materials present inside the room.

Radon is present in trace amounts almost everywhere on the earth, being distributed in the soil, the groundwater and in the lower level of atmosphere. Due to its alpha emitting short-lived daughters, ^{218}Po and ^{214}Po, it has long been known to be a causative agent for lung cancer when present in high concentrations as in uranium mines[1,2]. In recent years, several studies on radon and its decay products in mines and in dwellings have been performed. The concentration of radon and its decay products show large temporal and local fluctuations in the indoor and outdoor atmosphere due to variations of temperature, pressure, building materials, ventilation conditions, wind speed, etc.[3-6] Many techniques have been used for radon measurement inside the houses. The plastic track detector technique is the most reliable technique for integrated and long time measurement of radon activity inside houses[7-11]. The aim of the present study was to find out the effect of ventilation, height from ground level, wind direction and materials present inside the room on the concentration of indoor radon, using LR-115 plastic track detector.

Experimental details—Some residential and non-residential rooms of the Guru Nanak Dev University campus were chosen for the study. LR-115 type-2 plastic track detectors were mounted on the walls at different positions inside the rooms and left exposed for one month. All the detectors were then removed and etched in 2.5 *N* NaOH solution at 60°C in a constant temperature bath for 2 hr. The detector films were scanned under an optical microscope at a magnification of 600 × for measurements of the track density. The correction for background track density was applied by using a reference LR-115plastic track detector. The radon alpha tracks (Fig. 1) were calibrated by taking ^{241}Am alpha tracks (Fig. 2) as standard. The calibration constant (35.6 tracks/cm^2 = 1 pCi/l for 30 days exposure) determined by Singh *et al.*[12] in this laboratory was used to express the radon activity in terms of pCi/l.

Results and discussion—As many as 104 films of LR-115 detectors exposed in 26 rooms were ex-

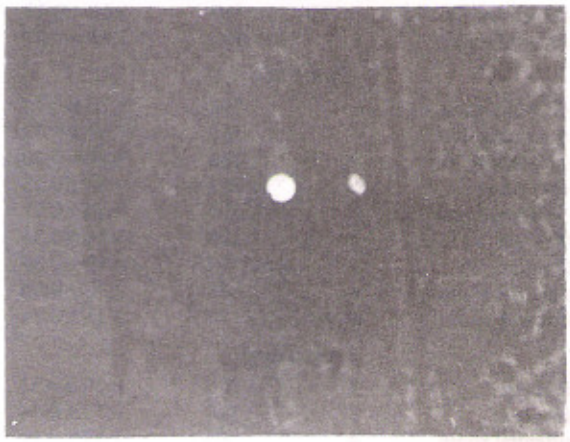

Fig. 1—Microphotograph radon alpha tracks in LR-115 plastic track detector

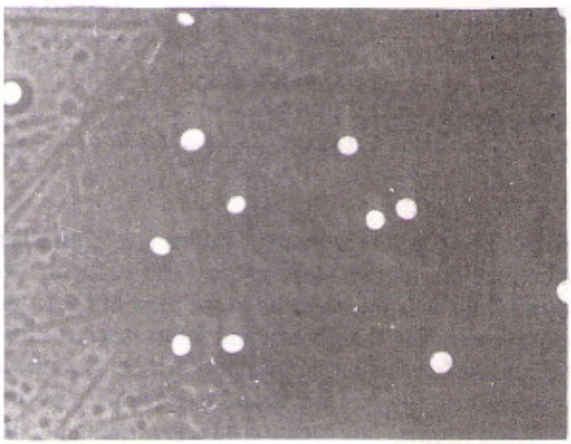

Fig. 2—Microphotograph of ^{241}Am alpha tracks in LR-115 plastic track detector

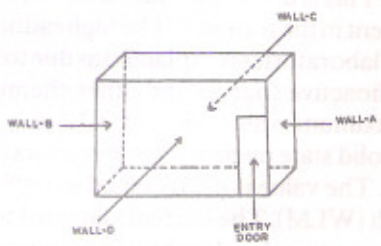

Fig. 3—Shape of residential room

Table 1—Radon Concentration in Different Rooms

Place of mounting	No. of samples exposed*	Track density (tracks/cm^2)	Radon concentration (pCi/l)
	Basement		
Store room	5	162	4.55 ± 0.45
Store room	3	181	4.08 ± 0.46
Store room	4	199	5.59 ± 0.48
Store room	5	136	3.82 ± 0.48
Working room	5	134	3.76 ± 0.36
Working room	4	116	3.26 ± 0.38
	Ground floor		
Staf room	4	250	7.02 ± 0.62
Work shop	5	83	2.33 ± 0.30
Residential room	4	110	3.09 ± 0.25
Residential room	4	100	2.81 ± 0.23
	First floor		
SSNTD laboratory	4	292	8.20 ± 0.32
Nuc. counting lab	4	161	4.52 ± 0.23
Geo-chemical lab	3	128	3.60 ± 0.20
Library room	4	165	4.63 ± 0.25
Lib. reading room	6	116	3.26 ± 0.21
Staff room	3	126	3.54 ± 0.34
Staff room	4	147	4.13 ± 0.39
Residential room	4	89	2.50 ± 0.26
Residential room	4	77	2.16 ± 0.21
	Second floor		
Staff room	4	198	5.56 ± 0.51
Staff room	3	120	3.37 ± 0.34
Residential room	4	65	1.83 ± 0.16
Residential room	4	35	0.98 ± 0.11
	Third floor		
Class room	3	50	1.40 ± 0.18
Staff room	3	63	1.77 ± 0.22
Staff room	4	53	1.49 ± 0.17

*Exposure period = 30 days

Table 2—Variation of Indoor Radon Concentration with Height

Place	Track density (tracks/cm^2)	Radon concentration (pCi/l)
Ground floor	105	2.95 ± 0.17
First floor	83	2.33 ± 0.17
Second floor	50	1.40 ± 0.10

Table 3—Variation of Radon Concentration Inside the Ventilated Rooms

Place of mounting	Wall direction	Track density (tracks/cm^2)	Radon concentration (pCi/l)
Ground floor	A	77	2.16 ± 0.20
	B	100	2.81 ± 0.22
	C	128	3.60 ± 0.25
	D	135	3.79 ± 0.32
First floor	A	48	1.35 ± 0.16
	B	75	2.11 ± 0.19
	C	85	2.39 ± 0.22
	D	99	2.78 ± 0.29
Second Floor	A	17	0.48 ± 0.06
	B	49	1.38 ± 0.15
	C	21	0.59 ± 0.06
	D	60	1.69 ± 0.18

A—Ventilated, B—Partially ventilated, C—Poorly ventilated D—Non-ventilated

amined. The results are given in Tables 1-3. The radon concentration in the staff room (Table 1) on the ground floor was found to be more than in the other rooms (excluding the library and laboratory rooms). The reason for this is the ventilation[13], as the radon concentration is generally found to be high in poorly ventilated rooms. The radon concentration in the library rooms on the first floor is found to be somewhat more than that in the corresponding rooms on the same floor. This is due to the radioactive behaviour of books present in the rooms.[14]. The high radon content in research laboratories is explained as due to the presence of radioactive sources and other chemicals.

The maximum value (8.20 ± 0.32 pCi/l) is recorded in solid state nuclear track detectors (SSNTD) laboratory. The value is nearly equal to 0.08 working level month (WLM). The current standard for cumulative exposure to radon daughters was recommended at 2 WLM in any three-months period[15]. Hence the maximum value recorded in the laboratory is quite low and within safe limits.

The study of residential rooms with identical shape and same ventilation conditions shows that radon concentration in the rooms on the ground floor is higher than those on other floors (Table 2). This decrease of indoor radon concentration with height from the ground level is due to exponential decay of radon in open atmosphere[16]. The study of identical residential rooms (Fig. 3) under the same ventilation conditions reveal that for each room, the radon concentration is lowest near the wall A and highest near the wall D (Table 3). This is explained as due to air entry along the wall A and its accumulation near the wall D.

Conclusion—Radon concentration in the indoor atmosphere varies with the ventilation conditions, height from ground level, type of materials present and the direction of air entry. It is, therefore, suggested that the residential room must be well ventilated and free from the radon rich materials to reduce the health hazard effects of radon.

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