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SSNTD'S – Based Determination of Radioactive Radon Concentration in Jaunpur District

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Abstract: This study evaluates the indoor and outdoor radon gas concentration across various residential environments in the Jaunpur district of Eastern Uttar Pradesh, India. To assess the potential health hazards associated with this radioactive gas, solid state nuclear track detectors (SSNTDs), specifically [insert detector type, e.g. LR-115 plastic track detectors], were utilized in a bare and cup mode configuration. Radon is a colourless and odourless radioactive gas. Radon exists in building materials and in indoor and outdoor environments. SSNTDs were used with 25 dosimeters for indoor measurements and 25 dosimeters in outdoor to determine the radon concentration in a total of 50 houses in Jaunpur district in Eastern Uttar Pradesh of India. SSNTD's technique was used for the present work in selected indoor and outdoor environments of Jaunpur district. The detectors were mounting for a fixed duration of 90 days. After the exposure period, the detectors were chemically etched, and the track density was obtained using an optical microscope or G.M. Counter to determine the radon concentration in Jaunpur district.

Keywords: *Radon Concentration, Indoor and Outdoor, Jaunpur District, SSNTDs, Dosimeter.*

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I. INTRODUCTION

Radon (^{222}Rn) is a naturally occurring, colourless, odourless and tasteless radioactive noble gas. It is produced continuously in the Earth's crust through the radioactive decay series of uranium and thorium, which are naturally present in varying amounts in almost all soils, rocks and water. I visited to Jaunpur district. I found some specific region(Kerakat, Mariahu,Rampur,Singhramau) in Jaunpur district to determine the radon concentration using solid state nuclear track detectors. In the present investigation, the concentration of radon was measured in different houses. We want to study indoor and outdoor radon concentrations in Jaunpur district, situated in the eastern part of Uttar Pradesh, India. We will divide Jaunpur district in four zone i.e. east, west, north and south from the district Headquarter. I mounted the nuclear track detector in the we were choosing Jaunpur district. SSNTD's mounting for 90 days. It helps for determination of radon concentration.

➢ *Experimental Details*

Radon are radioactive noble gas which are present in the dwellings and indoor and outdoor environment. The solid-state nuclear track detector used to measure the radon concentration in indoor and outdoor environment of Jaunpur district. We will divide district Jaunpur in four zones i.e. east, west, north and south from the district Head quarter. This will give us average radon concentration of district Jaunpur. The SSNTD's will be mounted on each zone in all 4 seasons (summer, winter, spring and rainy) for 30 days. LR-115, type II plastic track detectors commonly called as SSNTD's. The detector after exposure for 30 days would be removed from each zone and season. The solid-state nuclear track detector after exposure would be etched with 2.5 N NaOH solution at 60°C for 2 hours. Tracks revealed after etching would be counted by optical microscope or G.M. counter. Total number of tracks so obtained would be used for the calculation of radon concentration in district Jaunpur of Eastern Uttar Pradesh.

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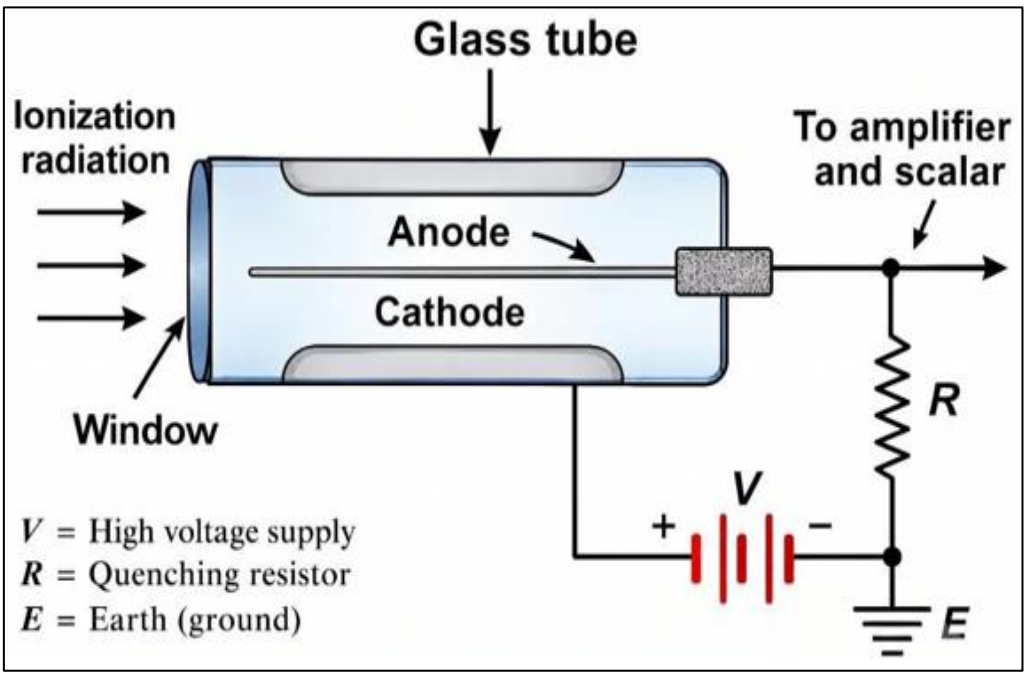

Fig 1 G.M. Counter

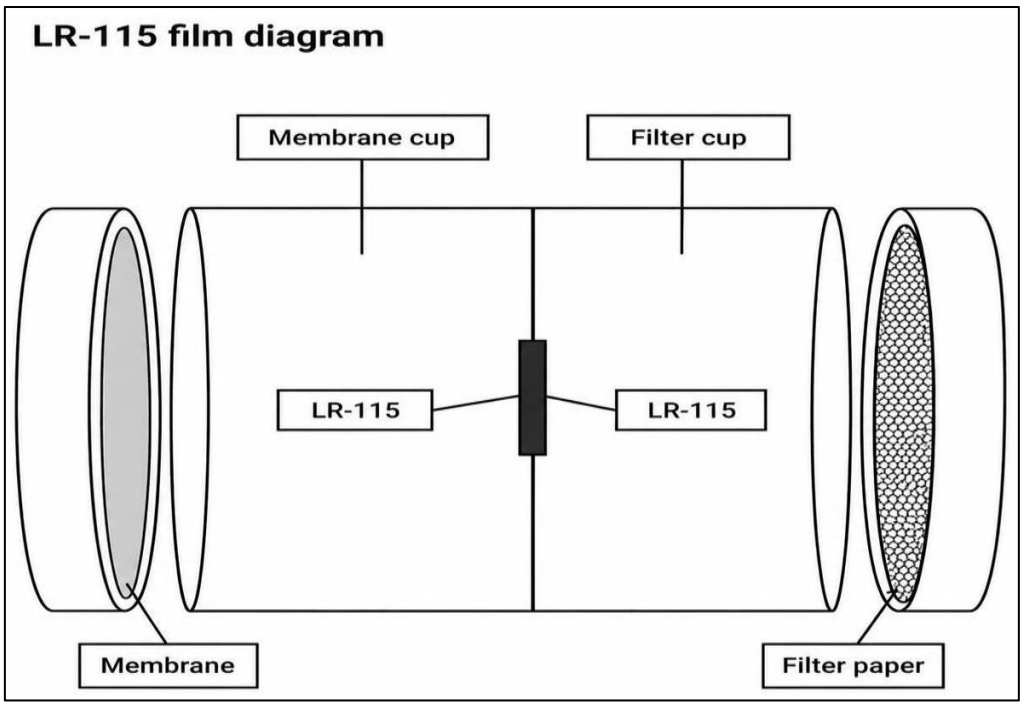

Fig 2 LR-115 Track Detector

II. AREA OF STUDY

➢ *Jaunpur District*

Jaunpur district is one of the districts of Uttar Pradesh State. India. and a part of Jaunpur Division. Jaunpur town is the district headquarters.The district lies between the parallels of 25.7487° North Latitude and 82.6984° East longitude. Its maximum length from north to south is about 70 to 80 km. and breadth from east to west about 55 to 65 km.The district lies between newly created district Gazipur on the east and Pratapgarh and Sultanpur on the west. On the south, the Varanasi and Bhadohi On the north it is bounded by district Azamgarh. So its soil are mainly alluvial in nature, main types soil found in Jaunpur district, - New Alluvial soil (khadar), old alluvial soil(Bhangar),sandy loam soil, clayey loam soil.

The common crops grown in jaunpur district-Rice,Wheat,Sugarcan,Pulses,oilseeds,Maize&Coarse cereals, Vegetables.

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Table 1 Radon Levels in Jaunpur District: Jaunpur District

Sample location in Area	Detector code	Track density rate (Tracks cm^{-2} d^{-1})	PAEC (m WL)	Concentration of Radon (Bq/m^3)
Jaunpur	JNP1	5.16	4.71	45.41
	JNP2	3.63	6.65	54.10
	JNP3	5.72	6.59	71.82
	JNP4	7.15	7.18	76.47
	JNP5	3.44	4.49	50.29
Kerakat	JNP6	4.84	6.55	46.73
	JNP7	6.24	5.10	59.51
	JNP8	3.62	7.23	48.24
	JNP9	5.71	7.60	70.55
	JNP10	7.22	9.71	79.59
Singramau	JNP11	4.93	4.62	46.82
	JNP12	2.74	5.59	58.71
	JNP13	6.67	8.40	70.23
	JNP14	7.32	5.50	50.18
	JNP15	6.03	7.11	84.21
Mariahu	JNP16	4.05	6.76	48.11
	JNP17	4.94	5.71	53.35
	JNP18	6.37	7.53	74.46
	JNP19	5.55	3.29	69.80
	JNP20	3.86	5.04	55.90
Rampur	JNP21	4.90	3.61	52.71
	JNP22	6.69	7.54	71.82
	JNP23	3.72	4.22	56.59
	JNP24	4.30	7.29	52.03
	JNP25	6.43	6.71	79.46

Table 2 Observed Indoor Radon Concentration and Outdoor Radon Concentration at Different Area in Jaunpur District

Sample Location Area in	Detector code	Concentration of Radon (Bq/m^3)	Concentration Radon of (Bq/m^3)
		Indoor	Outdoor
Jaunpur	JNP1	45.31	24.94
	JNP2	55.97	34.39
	JNP3	72.83	40.00
	JNP4	74.47	46.55
	JNP5	49.31	27.16
Kerakat	JNP6	47.12	26.29
	JNP7	56.52	32.24
	JNP8	50.11	27.97
	JNP9	67.97	39.74
	JNP10	80.59	47.08
Singramau	JNP11	43.31	24.84
	JNP12	56.77	33.82
	JNP13	67.30	35.60
	JNP14	51.61	29.56
	JNP15	75.22	41.98
Mariahu	JNP16	45.11	25.97
	JNP17	54.30	33.60
	JNP18	71.47	40.24
	JNP19	68.81	39.32
	JNP20	58.95	32.97
Rampur	JNP21	43.90	29.78
	JNP22	74.83	50.90
	JNP23	57.49	35.80
	JNP24	40.03	25.01
	JNP25	80.49	57.97
Minimum Concentration		43.32 Bq/m^3	24.39 Bq/m^3
Maximum Concentration		80.84 Bq/m^3	57.42 Bq/m^3
Average Concentration		57.46 Bq/m^3	31.20 Bq/m^3

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The value of radon progeny (PAEC) in (mWL) is determine with the formula:

$Cp\ (mWL) = \rho / Kt$

The SSNTD's method is used for the determination of radon concentration. It is very useful and less expensive method for determine radon concentration.

K is the sensitivity factor with a value which depend on the configuration of the SSNTD's. The value of K can be determined for various geometries, always better to use the calibrated value of K obtained from laboratory calibration experiments using a standard radon chamber.

Where ρ is the corrected track density, in tracks/cm²

t is the time of exposure.

PAEC (mWL) is the potential alpha energy concentration.

The average calibration factor for SSNTD's in the BARE on card mode reaches 625 T cm^{-2} d^{-1} WL.

For the determination of radon concentration:

$C_{rn} = WLconc. \times 3700 / F_r$

$C_{rn} = PAEC \times 3.7 / F_r$

Where F_r is the equilibrium factor, we use value 0.4 for indoor environment and 0.7 for outdoor environment.

C_{rn} is the radon concentration in Bq/m³.

III. RESULTS AND CONCLUSION

From table (1) and table (2) we find the PAEC levels of radon daughter in WL and track production rate along with the calibration factor for BARE on card mode and dosimeter.

This study successfully evaluated the indoor and outdoor radon concentration levels across the various locations (Rampur, Kerakat, Singaramau, Mariahu) in the Jaunpur district using SSNTD's. Significant changes of radon concentration were found in the various types of houses in Jaunpur district.

From the data in table (1) and table (2), all measured values were found to be well within the safe limit recommended by the International Commission on Radiological Protection (ICRP). The indoor concentration of radon changes from 43.32 to 80.84 Bq/m³ with an average value of 57.46 Bq/m³ and the outdoor concentration of radon changes from 24.39 Bq/m³ to 57.42 Bq/m³ with an average value of 31.20 Bq/m³. So, no action is required in Jaunpur district.All the measurements took place at noon/night in winter seasons. However, the recorded value of radon and the resulting gases fall well below the international recommended level, which clearly shows the houses in Jaunpur district are quite safe in terms of protection from any radiation. The maximum radon concentration level were found in winter season because in the winter season the door is closed for long period of time and minimum radon concentration level were observed during summer season due to the house doors are open for a long time, which in turn increases the rate of air exchange.

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