

# Variation of Radon with Relative and Absolute Humidity- II

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**Abstract:** In continuation with study of variation of RH and AH with  $EEC_{Rn}$ , Temperature and RH were used as variables to calculate AH using 3D MATLAB Program. An equation relating AH, RH and T with  $EEC_{Rn}$  was obtained. Calculated AH values were plotted vs measured  $EEC_{Rn}$ . At all places positive slope has been found between RH and  $EEC_{Rn}$  whereas AH vs  $EEC_{Rn}$  curves have negative slope at all the places confirming our previous results for Amritsar.

**Keywords:**  $EEC_{Rn}$ , DSAABC Method, Relative Humidity, Absolute Humidity, 3D MATLAB equation.

## 1. Introduction

It has been observed that inhalation of radon and its short lived progenies is responsible for more than 50% of annual effective radiation dose from all natural sources [1]. Radon and its decay products cause hazardous effects on health. A large number of measurements of Radon and its progeny have been published ([2]-[8]). Majority of reports have shown their measurements for indoor and outdoor. In the present work results of Radon daughter products are determined from gross beta counts by Defined Solid Angle Absolute  $\beta$  Counting method [7]. The  $EEC_{Rn}$  was computed from activity concentrations by use of Bateman differential equations [9]. The effective dose rates of Radon have been calculated from activity concentrations. Measurements were taken from two sites in Amritsar & Bathinda, Pb. and two sites Hamirpur, Chakmoh, Himachal Pradesh of India. These measurements were made three times a day morning, noon and evening.

The DSAABC method [7] has various advantages over old alpha counting methods and gamma spectrometry [10]. Gamma spectroscopy is low efficiency, high background and high cost technique. A low permeability membrane filter and low air flow rate are major requirements of alpha counting methods to prevent strong self-absorption and energy degradation of alpha particles. In beta counting method high air flow rate and glass fibre can be used. As beta particles have high penetration power than alpha particles, sensitivity is also higher. The method developed by Papp and Daroczy [7] is used to measure the counting efficiency of radon and its progeny one by one, having errors less than 10%. RH and Temperature values have been used to calculate AH using MAT Lab 3D equation. Correlations between  $EEC_{Rn}$  vs AH, and  $EEC_{Rn}$  vs RH were determined graphically.

## 2. Methodology

It has been estimated that the airborne concentration level of radon progeny depends on the meteorological conditions such as rainfall, snow, wind, humidity and temperature after

creeping out from cracks. Out of these parameters temperature, absolute humidity and relative humidity variation has been studied. To measure individual concentrations of radon progeny DSAABC method has been used at four sites of Punjab and Himachal. For each site 40 observations were taken. The measured values of RH and Temperature were used to calculate AH using 3D MATLAB program equation [11]. The data has been listed in Table-1. Graphs between  $EEC_{Rn}$  and RH are listed shown in Figure-1 and those between  $EEC_{Rn}$  and AH in Figure-2.

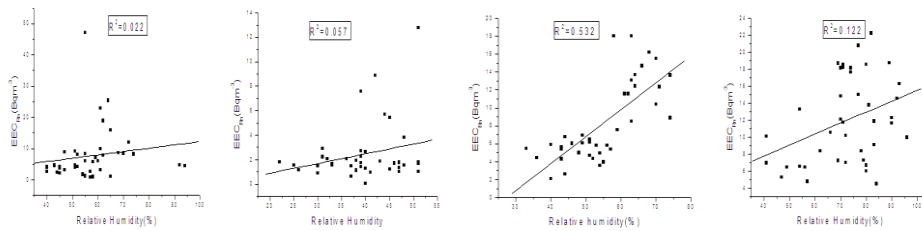
**Table 1:**  $EEC_{Rn}$ , RH and AH at Four sites (Two in Punjab and Two in Himachal Pradesh)

Amritsar			Bathinda			Hamirpur			Chakmoh		
EEC	RH	AH	EEC	RH	AH	EEC	RH	AH	EEC	RH	AH
4.49	94	10.60	1.79	22	12.53	18	63	3.36	17.7	74	6.88
4.62	92	11.15	1.55	25	11.59	5.42	43	5.32	20.8	77	4.35
1.66	54	23.05	1.15	26	14.26	6.17	51	4.07	10.1	41	5.65
0.9	58	24.97	0.9	30	14.45	11.6	62	3.35	18.1	70	5.52
1.19	55	31.55	1.46	30	15.74	6.79	44	5.07	22.2	82	3.72
0.98	65	28.60	2.91	31	10.77	5.83	56	4.97	6.54	54	6.67
0.75	57	23.99	2.23	31	11.18	13.1	63	3.29	18.7	69	5.05
8.56	68	8.48	2.07	32	11.89	5.89	40	4.59	15	77	7.87
2.4	44	10.69	1.65	33	13.32	6.09	49	3.98	6.47	56	9.76
4.09	45	6.25	1.57	33	16.01	13.7	64	3.41	18.6	71	6.81
8.39	70	7.98	2.07	36	13.37	6.95	49	6.58	13.8	81	5.72
3.18	47	9.14	0.64	37	18.85	18	58	5.27	4.79	57	8.45
2.14	45	9.60	1.45	37	15.73	14.7	66	3.65	11.7	71	6.32
5.9	55	10.41	1.13	38	18.72	6.02	46	6.20	16.3	93	15.12
8.14	74	9.31	1.93	38	16.72	6.5	51	5.40	6.69	80	18.18
3.21	61	8.75	7.6	39	14.65	16.2	68	4.67	11.9	83	12.74
15.81	65	6.13	1.4	39	19.58	7.56	59	8.45	14.6	92	15.46
3.14	47	8.26	2.7	39	13.82	8.87	74	7.74	7.24	69	16.34
4.56	43	5.78	2.26	39	19.69	13.6	74	5.00	12.1	70	10.04
4.02	40	6.38	1.75	39	18.59	5.62	43	6.09	11.6	90	12.85
3.91	51	7.01	0.06	40	18.02	2.07	40	4.27	6.97	41	6.60
18.84	62	8.64	2.66	40	15.88	2.63	44	3.73	18.2	71	6.01
2.67	40	6.85	1.29	40	19.99	11.6	61	3.42	5.29	47	7.02
6.06	60	7.76	0.95	41	14.06	5	48	6.22	13.3	54	5.90
11.91	72	7.59	8.87	42	13.24	4.32	52	4.92	18.6	80	6.47
3.55	45	7.76	1.87	43	13.48	4.93	54	7.84	14.9	70	7.61
2.52	57	7.63	5.72	44	15.08	15.5	70	10.26	18.1	74	7.05
8.38	55	20.25	5.43	45	13.85	6.23	51	7.17	6.48	49	9.67
8.12	52	17.78	1.23	45	20.41	3.94	55	8.66	10.2	72	7.53

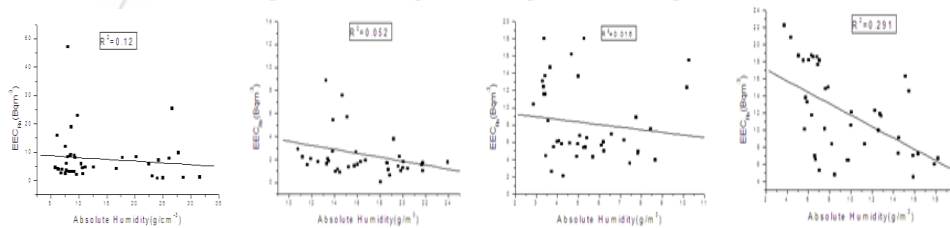
4.64	51	12.65	1.7	46	21.72	12.4	71	10.16	18.7	89	6.29
7.12	59	24.18	1.01	47	19.82	4.71	51	7.83	8.36	62	11.31
5.7	58	22.50	1.33	47	15.21	3.55	54	7.45	8.36	78	8.21
4.16	52	16.67	1.79	47	16.27	8.51	63	3.55	10.5	66	10.01
9.8	61	27.74	1.76	47	23.93	4.29	43	5.69	4.51	84	15.87
25.36	64	26.64	3.79	48	19.19	5.36	57	5.26	9.95	96	12.59
7.84	62	26.09	1.55	48	21.67	10.4	70	2.87	5.99	80	17.84
8.9	47	9.21	1.01	51	21.73	4.42	36	3.45	9.12	83	14.50
22.84	61	9.75	12.77	51	15.87	5.8	53	4.20	12.3	90	12.26
9.1	51	8.54	1.69	51	18.61	12.4	64	3.34	7	72	15.84
47.02	55	8.00	1.81	51	20.02	5.49	33	3.82	7.26	79	14.44

### 3. Results and Discussion

From Figure-1, The plots between  $EEC_{Rn}$  and RH for (a) Amritsar, (b) Bathinda, (c) Hamirpur and (d) Chakmoh reveal positive slopes between  $EEC_{Rn}$  and RH at all the



**Figure 1:**  $EEC_{Rn}$  vs. RH (a) Amritsar (b) Bathinda (c) Hamirpur (d) Chakmoh



**Figure 2:**  $EEC_{Rn}$  vs. AH (a) Amritsar (b) Bathinda (c) Hamirpur (d) Chakmoh

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### References

- [1] UNSCEAR, 1993. United Nations scientific committee on the effects of atomic radiation. Sources and effects of ionizing radiation. 1993 Report to the General Assembly with annexes, United Nations, New York, 1993.
- [2] Arabzedegan, M., Carroll, E.E, Wethington, J.A, 1982. Random noise technique applied to radon flux measurements. Proceedings of the Second Special Symposium on Natural Radiation Environment, Bombay, India, 621-626.
- [3] Bochicchio, F., Venuti, G.C., Nuccetelli, C., Risica, S., Tancredi, F., 1996. Indoor measurements of  $^{220}Rn$  and  $^{222}Rn$  and their decay products in a Mediterranean climate area. Environ. Int. 22 (Suppl. 1), S633-S639.
- [4] S.A. Hsu, 1980. Diurnal variations of radon and mixing heights along a coast: A case study. Journal of Geophysical Research, 85:4107-4110.
- [5] G. Keller and K.H. Folkerts, 1984. Radon-222 concentrations and decay product equilibrium in dwellings and in open air. Health Physics, 385-398.

places. Similarly the plots with  $EEC_{Rn}$  and AH at all the places show negative slope. These are in line with our earlier findings [10], [11] and contradict those of Blaauboer and Smetsers [12] which shows positive slope between  $EEC_{Rn}$  and AH. The correlation coefficients of  $EEC_{Rn}$  vs RH and  $EEC_{Rn}$  vs AH are listed in Table 2. The correlation coefficient  $EEC_{Rn}$  and RH at Hamirpur is significant and Correlation coefficient  $EEC_{Rn}$  and AH at Chakmoh is also higher than at other places.

**Table 2:** Correlation coefficients between  $EEC_{Rn}$  vs RH and AH at four sites

	Amritsar	Bathinda	Hamirpur	Chakmoh
<b>RH</b>	R=0.15	R=0.24	R=0.73	R=0.35
<b>AH</b>	R=-0.11	R=-0.23	R=-0.13	R=-0.54

- [6] D.L. Henshaw, 1993. Radon exposure in home: its occurrence and possible health effects. Contemporary physics, 34:31-48.
- [7] Papp, Z., Daroczy, S., 1997. Measurement of radon decay and thoron decay products in air by beta counting using window Geiger-Muller counter. Health Phys. 72(4).
- [8] Tilahun Tesfaye, Harinder Kaur, and Sahota H.S. Sahota, 1998. Variation of indoor and outdoor radon content. Research journal of Chemistry and Environment, 2(3).
- [9] Bateman, H. (1980). Solutions of a system of differential equations occurring in the theory of radioactive transformation. Proc. Chambr. Philos. Soc. 15, 423.
- [10] Singh Kulwant, Singh Manmohan, Singh Surinder, Sahota H.S., Papp Z., 2005. Variation of Radon ( $^{222}Rn$ ) Progency Concentration in Outdoor air as a function of time, temperature and R.H., Journal Radiation Measurements, Vol 39, Issue 2, 213-217.
- [11] Kaur Kirandeep, Luxmi Vijay, Sahota H.S. 2015, Variation of Radon with Relative and Absolute Humidity-I, International Journal of Sci & Research, volume 4, Issue 2, Pages 1789-1791.
- [12] Blaauboer, R.O., Smetsers, R.C.G.M., 1997. Outdoor concentrations of the equilibrium-equivalent decay products of  $^{222}Rn$  in the Netherlands and the effect of meteorological variables. Radiat. Prot. Dosim. 69 (1), pp7-18