International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Variation of Radon with Relative and Absolute Humidity- I

Kirandeep Kaur[1], Vijay Laxmi[2], H. S. Sahota[3]

[1]Research Scholar of Punjab Technical University & lecturer in Department of Applied Science, SBBSIET, Khiala, Padhiana, Jalandhar- 144030, India

[2]Assistant Professor, Guru Kashi University, Talwandi Sabo 151302, India

[3]Dean Research and Development, JSS Group of Institutes, Kauli, Patiala, Punjab, India

Abstract: ***Radon gas a decay product of Uranium-238 is direct descendent of*** ^{226}***Ra. It is affected by Temperature, pressure and humidity. The temperature variation of Effective Equivalent concentration of radon is well established and so also is relative humidity variation. The former having negative slope and later positive. However absolute humidity variation of*** EEC_{Rn} ***is disputed by Blaauboer and Smetsers and Singh et.al. This has been resolved in this work using 3D MAT lab relations between RH, AH and Temperature. All the measured values of*** EEC_{Rn} ***yield negative slope with AH supporting results of Singh et.al.***

Keywords: Radon, EEC_{Rn}, Relative Humidity, absolute humidity, MAT lab.

1. Introduction

$^{222}R_n$ and its progeny deliver the highest radiation dose among all naturally occurring radioactive sources in the environment. It has the largest contribution to collective exposition to natural radiation of world's population [1]**,** [2] .The estimated amount of these short lived radioactive products is more than 50% of the total effective dose from natural radioactive sources[3]. Radon gas is decay product of Radium-226. It decays to ^{218}Po, short lived solid product, which further decays by alpha emission. The radon progeny remain suspended in air which people may inhale. The deposition of radioactive decay products on both the Bronchial stem cells and secretion cells may adhere to the lung linings, irradiating the lung tissues. Highly ionized alpha radiations strike these sensitive lung tissues, may release enough harmful radiation and damage the DNA of lung cells. Hence radon exposure may develop lung cancer [4]**.**

The radon level depends on many climatological factors. Several scientists have done measurement of its concentration. **Arabzedegan et.al.** [5] estimated that radon flux has no correlation with temperature, humidity and pressure. **Raghavayya et.al.**[6] observed that radon emanation and temperature are dependent on each other but it is not the function of pressure. Whereas **Porstendorfer**[7] **, Chen et.al.** [8] **and Bochicchio et al.** [9] **, Ortega and Vargas** [10] reported the existence of negative correlation between radon level and temperature. **Nagaraja et.al.** [11] found that radon level and its progeny exhibit a positive correlation with relative humidity and negative correlation with temperature. In the present work we have tried to find out correlation of the variation of radon with relative humidity, absolute humidity and temperature.

2. Methodology

It has been observed that the airborne concentration level of radon and its progeny depends on the meteorological conditions such as rainfall, snow, speed, wind, humidity and temperature after emanating from cracks .Out of these parameters temperature, absolute humidity and relative humidity variation has been studied. No independent measurement has been undertaken on temperature, absolute humidity and relative humidity dependence. To measure the variation level of radon with temperature, absolute humidity and relative humidity, data has been collected from web address-
(www.crescentok.com/staff/jaskew/isr/tigerchem/gas_laws/humiditychart.jpg) [12]

Taking the available data (e.g. temperature from +50 to 0^0C , relative humidity from 10% to 100% and absolute humidity from 8.3 to 83) 3D graph has been plotted using Mat lab software. This 3D graph has been used to find out the relation among the three parameters given in the humidity chart and found an equation with 95% confidence level as follows:

$$z = P_{00} + x.P_{10} + y.P_{01} + x^2.P_{20} + xy, P_{11} + y^2.P_{02} \quad (1)$$

where

P_{00} = 7.239 (4.712, 9.765)
P_{10} = -0.07071 (-0.1489, 0.007444)
P_{01} = -0.9421 (-1.067, -0.8166)
P_{20} = 0.0001071 (-0.0005456, 0.0007597)
P_{11} = 0.01493 (0.01389, 0.01597)
P_{02} = 0.01868 (0.01653, 0.02083)

Using the above equation approximately same (with 95% limits) values of AH are found, where z is mathematical symbol used for A.H., x is for R.H. and y is for temperature. Further P_{00}, P_{10}, P_{01}, P_{20}, P_{11}, P_{02} are the corresponding coefficients. Our observation is that the concentration of ^{222}Rn decreases with increase in temperature and absolute humidity and decrease in relative humidity(Table 1).

Table 1: Comparative table of RH, AH and temperature with variable AH

	RH	10	20	30	40	50	60	70	80	90	100
TEMP	AH VALUES										
50	OLD	8.3	16.6	24.9	33.2	41.1	49.8	58.1	66.4	74.7	83
	NEW	13.6	20.4	27.2	34	40.9	47.77	54.7	61.58	68.52	75.48
45	OLD	6.5	13.1	19.6	26.2	32.7	39.3	45.8	52.4	58.9	65.4
	NEW	8.69	14.7	20.8	26.9	33	39.13	45.3	51.45	57.64	63.86
40	OLD	5.1	10.2	15.3	20.5	25.6	30.7	35.8	40.9	46	51.1
	NEW	4.72	10	15.3	20.7	26	31.42	36.8	42.25	47.69	53.16
35	OLD	4	7.9	11.9	15.8	19.8	23.8	27.7	31.7	35.6	39.6
	NEW	1.68	6.23	10.8	15.4	20	24.64	29.3	33.98	38.68	43.4
30	OLD	3	6.1	9.1	12.1	15.2	18.2	21.3	24.3	27.3	30.4
	NEW	-0.4	3.37	7.2	11	14.9	18.81	22.7	26.65	30.6	34.58
25	OLD	2.3	4.6	6.1	9.2	11.5	13.8	16.1	18.4	20.7	23
	NEW	-1.6	1.46	4.53	7.63	10.8	13.9	17.1	20.25	23.46	26.69
20	OLD	1.7	3.5	5.1	6.9	8.7	10.4	12.1	13.8	15.6	17.3
	NEW	-1.8	0.47	2.8	5.16	7.53	9.928	12.3	14.79	17.25	19.73
15	OLD	1.3	2.6	3.9	5.1	6.4	7.7	9	10.3	11.5	12.8
	NEW	-1.1	0.42	2	3.61	5.24	6.891	8.56	10.26	11.97	13.71
10	OLD	0.9	1.9	2.8	3.8	4.7	5.6	6.6	7.5	8.5	9.4
	NEW	0.48	1.3	2.14	3	3.88	4.787	5.71	6.659	7.627	8.616
5	OLD	0.7	1.4	2	2.7	3.4	4.1	4.8	5.4	6.1	6.8
	NEW	3.05	3.12	3.21	3.32	3.46	3.618	3.8	3.996	4.218	4.461
0	OLD	0.5	1	1.5	1.9	2.4	2.9	3.4	3.9	4.4	4.8
	NEW	6.54	5.87	5.21	4.58	3.97	3.382	2.81	2.268	1.743	1.239

***OLD- Observed values taken from table cited at crescentok.com/staff/jaskew/isr/tigerchem/gas_laws/humiditychart.jpg [12]**
***NEW-New values calculated by taking observed values using 3D equation.**

Algorithm: . Input the AH, RH and T in MAT LAB in row vector.

1. Find the relationship among AH, RH and T using MATLAB simulation.
2. Simulation yields the relation
   $z = P_{00} + x.P_{10} + y.P_{01} + x^2.P_{20} + xy.P_{11} + y^2.P_{02}$
   where z is mathematical symbol used for A.H., x is for R.H and y is for temperature . Further P_{00}, P_{10}, P_{01}, P_{20}, P_{11}, P_{02} are the corresponding coefficients.
3. The 3D equation is found having coefficients at 95% confidence bounds.

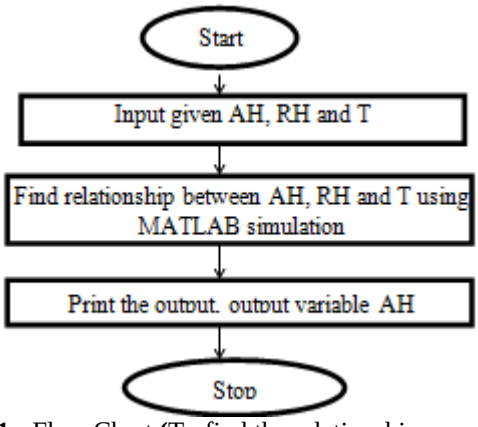

Figure 1: Flow Chart **(**To find the relationship among AH, RH and T)

3. Results and Discussion

Above equation shows that at given temperatures such as 50^0C, $+40^0$C, $+30^0$C up to 0^0C there is significant increase in absolute humidity along with the increase in relative humidity. Results of Table 1 show that AH values calculated from the equation deduced from 3D MAT LAB programme are in good agreement with old values given in the original table **crescentok.com/staff/jaskew/isr/tigerchem/gas_laws/humiditychart.jpg)[12]** especially in temperature range 30-45^{0}C and RH range 30-80% usually encountered in this region during April to September during which data was collected. As temperature increases radon and its progeny get dispersed, due to surface air circulation and high temperature .This fact is in agreement with the earlier work of **Chen etal.**[8]. It gives positive correlation of radon concentration with R.H. and negative with temperature which is in direct agreement with the study done by **Blaauboer and Smetsers**[13]. According to them there is positive correlation between EEC_{Rn} and absolute humidity measured in gm^{-3} .This result was contradicted by the work done by **Singh et.al.,** [14]**,** who found the correlation of EEC_{Rn} with relative humidity positive , while negative with temperature and absolute humidity. The RH and Temperature values were taken from the work of Singh et.al. and AH values were calculated according to these from equation no.1 .All these values have been put in the tabulated form (TABLE 2). Then EEC_{Rn} vs calculated AH and EEC_{Rn} vs RH have been plotted in Figure 3 and Figure 2 respectively:

Table 2: Correlation table for Absolute humidity and EEC_{Rn}

EEC_{Rn} in Bqm^{-3}	Relative Humidity in %(x)	Temperature in ^{o}C (y)	Absolute Humidity in gm^{-3}(z)Calculated By 3D Eq.1
2	20	50	20.4
3	30	45	20.8
4	40	40	20.7
5	50	30	14.9
6	60	25	13.9
7	70	15	8.56
8	80	10	6.65

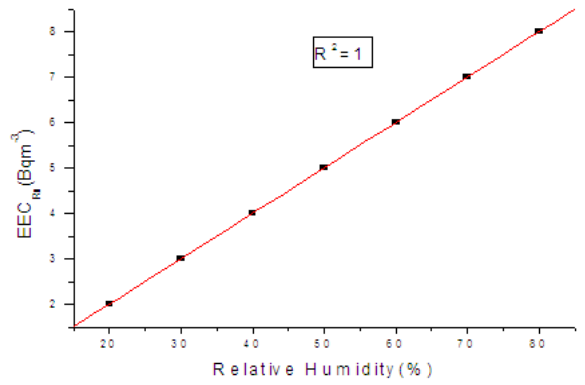

Figure 2: Correlation between EEC_{Rn} and Relative humidity. The present study contradicts the **Chen etal.,**[8] and **Blaauboer and Smetsers**[13] while supports the **Singh et.al.,** [14] work and concluded through the 3D graph equation that there exist positive correlation of EEC_{Rn} with relative humidity and negative correlation of EEC_{Rn} with absolute humidity.

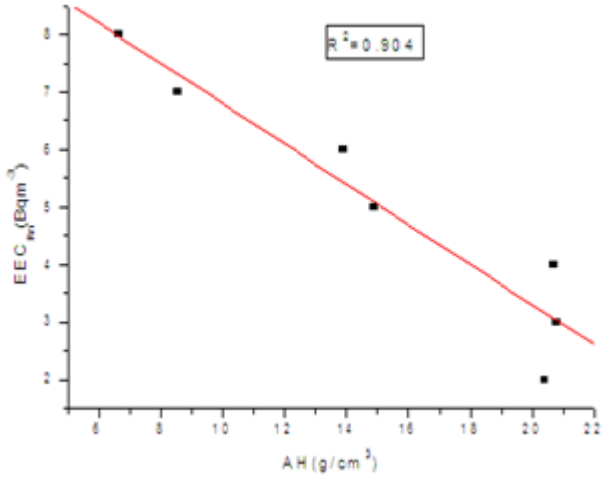

Figure 3: Correlation between EEC_{Rn} and Absolute humidity

4. Acknowledgements

Ms. Kirandeep Kaur wants to thank the Director of Sant Baba Bhag Singh institute of Engineering and Techecnology, Khiala, Distt. Jalandhar for permitting her to pursue her research work.

References

[1] IAEA, 1989. Facts About Low Level Radiation. IAEA/PI/A9E 85-00740.American Nuclear Society.
[2] Nazaroff, W. W., Nero, A. V., 1988. Radon and its decay products in indoor air. Wiley, New York.
[3] 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.
[4] BEIR VI, 1999.The health effects to exposure to indoor radon. Biological Effects of Ionizing Radiation(BEIR) VI Report, National Academy of Science, Washington, D.C.
[5] 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.
[6] Raghavayya, M., Khan,A.H., Padmanabhan, N., Srivastava, G.K., 1982.Exhalation of Rn-222 from soil: some aspects of variation.Proceedings of the Second Special Symposium on Natural Radiation Environment, Bombay, India, 584-591.
[7] Porstendorfer, J., 1994.Properties and behaviour of radn and thoron and their decay products in the air. J. Aerosol Sci.25,219-263.
[8] Chen, C.J., Liu, C.C., Lin, Y.M., 1996.Diurnal variation of radon progeny in indoor and outdoor air of a subtropical city. Environmental International 22(Suppl.1), 5723-5728.
[9] 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.
[10] Ortega, X., Vargas, A., 1996.Characteristics and temporal variation of airborne radon decay progeny in the indoor environment in Catalonia(Spain). Environ.Int. 22(Suppl.1),S149-S159.
[11] Nagaraja, K., Prasad, B.S.N.,Chandrashekara M.S.,Paramesh L, Madhava M.S., 2006, Inhalation dose due to radon and its progeny at Pune, Indian Journal of Pure and Applied Physics, 44, 353-359.
[12] (crescentok.com/staff/jaskew/isr/tigerchem/gas_laws/humiditychart.jpg)
[13] 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), 7–18.
[14] Singh Kulwant, Singh Manmohan, Singh Surinder,Sahota ,H.S., Papp Z., 2005,Variation of Radon ($^{222}R_n$) Progency Concentration in Outdoor air as a function of time,terperature and R.H.,Journal Radiation Measurements,Vol 39,Issue 2, 213-217.