Available online at www.pelagiaresearchlibrary.com

Pelagia Research Library

Advances in Applied Science Research, 2013, 4(3):226-231

Pelagia Research Library

ISSN: 0976-8610
CODEN (USA): AASRFC

Survey of radon concentration in drinking water samples of Hoshiarpur and Ropar districts of Punjab, India

[1]Navjeet Sharma* and [2]Rajesh Kumar Sharma

[1]Post-Graduate Department of Physics, DAV College, Jalandhar, India
[2]Post-Graduate Department of Physics, DAV College, Amritsar, India

---

ABSTRACT

A survey of radon concentration in drinking water samples in Hoshiarpur and Ropar districts of Punjab, India, has been conducted. A total of 54 samples from the two districts were analysed for dissolved radon using solid state alpha based detector RAD7. The concentration of radon has been found to be varying from 8.7 pCi/L to 123.2 pCi/L in Hoshiarpur district while the values lie in the range from 12.1 pCi/L to 130.6 pCi/L for Ropar district. Assessment of radiation dose due to ingestion of radon from drinking water and associated cancer risk has been made. Water samples were also analysed for other parameters such as pH, Conductivity and TDS and Salinity to assess the overall quality of drinking water of the study area. All the measured parameters were found to be within the permissible limits.

Key words: Radon, Inhalation, Exposure, Dose, Salinity

INTRODUCTION

Radioactivity present in human environment is the major source of radiation dose being received by population. Radiation exposure, beyond permissible, limits is a major health hazard. ^{222}Rn is considered as the potential health hazard [1]. In addition to the radon present in ambient air, radon dissolved in drinking water can lead to significant health problems for humans [2]. Radon dissolved in water can cause radiation exposure through inhalation and ingestion. The organ at most risk from radon dissolved in water is stomach. This has led to many extensive studies of radioactivity in drinking waters worldwide in recent years [3,4,5,6]. The source of radon in groundwater is presence of uranium in earth's crust. The concentration of uranium in igneous rocks is generally in the range 0.01 to 10 ppm [7]. Radium, the immediate parent of radon is readily soluble in low pH water and its concentration in water can be related to total dissolved solid (TDS) content of water. Newly formed radon, generated from decay of radium, can leave the mineral grain, where it is generated, by alpha recoil. The generated radon can get transported away from its place of generation by movement of ground water. The maximum limit of concentration of radon in water proposed by US Environmental Protection Agency (USEPA) is 300 pCi/L which corresponds to a life time cancer risk of about 1 in 10^4 [8]. The major risk of radon dissolved in water comes from ingestion & its contribution to indoor air. It is estimated that for every 10000 pCi/L of radon in water, about 1 pCi/L is released into air [9].

In a recent study, elevated levels of uranium in ground water in Malwa belt of Punjab has been confirmed. It has been concluded that high salinity, TDS and high ionic conductivity increases the solubility of uranium, which may be responsible for the elevated levels of uranium being recorded in measurements [10]. Also pH is one of the important parameters influencing the uranium content and its mobility. In the light of these facts, the present survey

for measuring the radon concentration in water along with pH, salinity, TDS (total dissolved solids) and conductivity has been carried out.

MATERIALS AND METHODS

Experimental technique

Solid state alpha detector based RAD7 (Durridge Co. USA) has been used to measure the concentration of dissolved radon in water. The RAD7 is a continuous radon monitor based on the alpha spectrometry technique. It uses a solid state semiconductor detector that directly converts an alpha radiation to electrical signal. Its accessory RAD H2O is used to measure the radon in water over a wide range of concentration. It is a portable and battery operated instrument and measurement is fast and accurate. A schematic diagram of RAD H2O is shown in figure 1.

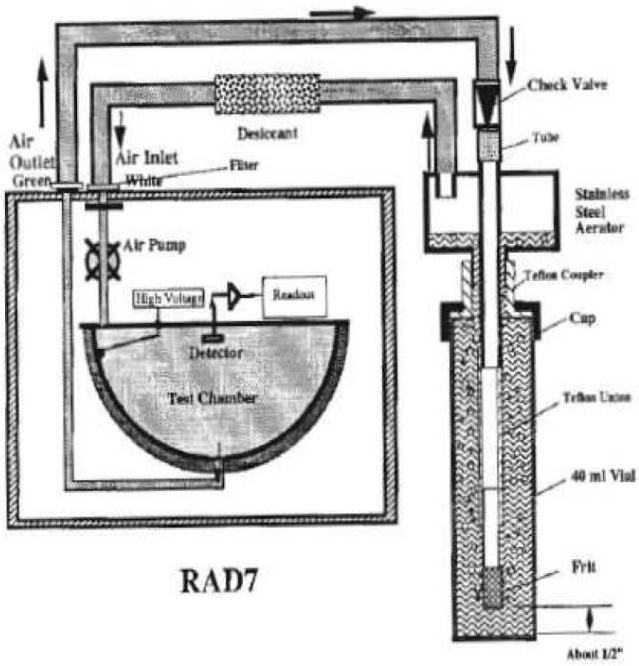

Figure 1. Schematic Diagram of Experimental Setup

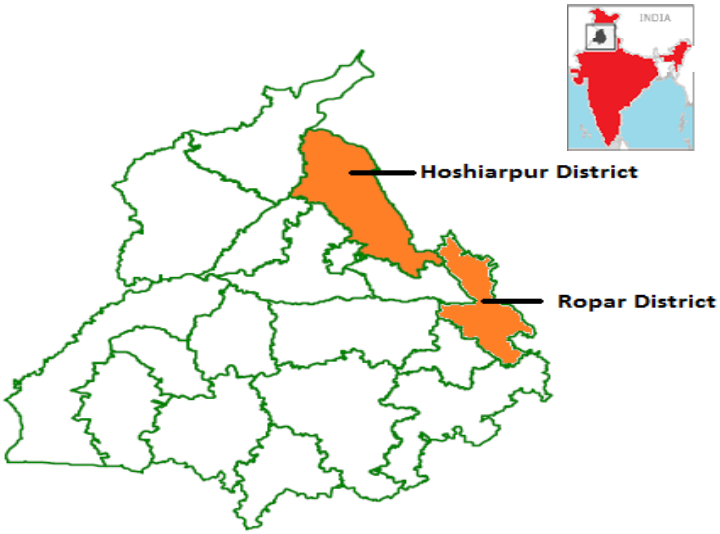

Figure 2. Map of Punjab State Indicating Study Areas

The RAD-H2O method employs a closed loop aeration scheme in which the air is re circulates through the water sample collected in vial and the radon is continuously extracted until a state of equilibrium develops. The RAD-H2O system reaches this state of equilibrium within about 5 minutes, after which no more radon can be extracted from the water. The extracted radon is pumped in the test chamber the detector measures the radon concentration.

The representative water samples were collected from the study areas in 250 ml vials using the standard technique, taking care that the collected water samples is not exposed to atmospheric air before sealing. Salinity, TDS, pH and Conductivity has been measured with standard solution analyser kit.

Study Areas

Geology of the Area

The study areas are shown in the map in figure 2. Both the districts lie in the eastern part of Punjab State. While the Hoshiarpur district is bounded by North latitudes 30°58′30″ and 32°08′00″ and East longitudes 75°28″00″ and 76°30′00″, the Ropar district is bounded by North latitudes 76°19′00″ and 76°45′00″ and East longitudes 30°44″00″ and 31°25′00″. Hoshiarpur district forms a part of Indo-Gangetic plain and Sutlej sub-basin of main Indus basin. The Upper Shiwaliks and the Quaternary deposits constitute the main geological formations of the area. The Upper Shiwaliks comprise conglomerate beds, friable sandstone, siltstone and clay beds. Stray pebbles of granite, limestone and sand stones are also present. Quaternary deposits constitute gravel beds, alluvial fans and river terraces. They contain sand and clay in varying proportions. Gravel beds constitute an important source of white quartzite fragments. The area comprises three distinct geomorphological units, viz, hilly area in the northeast, piedmont zone belt and the alluvial plains occurring south western part of the district. The district is drained by two major rivers, Beas in the North and north west and Satluj in the south. In general the soils are yellowish brown to dark brown in colour. These range from calcerous sand to fine sandy loam to silts. Unconsolidated alluvial sediments mainly occupy the district.

Ropar district can be divided into 4 units-Siwalik Hills, Intermontane valley of Sutlej, Kandi/Sirowal formations and alluvial plains. The area is drained by Sutlej river basin. The Siwalik Hills separates the main Himalayan ranges from the Indo-Gangetic alluvial plain. The coarse sediments brought down by hill torrents, forms the alluvial fan deposits.

These alluvial fans coalesced to form Kandi and Sirowal formation. The southern part of the district is mainly alluvial plain, which forms a part of Indo-Gangetic alluvial plain. Two types of soils are found in the district-Reddish chestnut soils which is found in the northeastern part of the district, mainly in the Ropar and Anandpur Sahib blocks. These soils are loam to clay-loam in nature and decalcified and other Tropical Arid Brown soils are mainly in rest of the area which are mainly calcareous sandy loam [11].

RESULTS AND DISCUSSION

The results of measurements are summarized in tables 1 & 2. A total of 54 samples, 28 from Hoshiarpur and 26 from Ropar district were analysed. The concentration of radon has been found to be varying from 8.7 pCi/L to 123.2 pCi/L in Hoshiarpur district while the values lie in the range from 12.1 pCi/L to 130.6 pCi/L for Ropar district. Values of radon concentration in water in two districts of Hoshiarpur and Ropar lies in the same range as reported for other districts of state [12]. Since the distribution of radon in water has been found to be lognormal in both the districts, so G.M. and G.S.D. values have been calculated and represented in tables. Positive value of Kurtosis for radon values in both the districts indicate relative peakedness of distribution as compared to normal distribution. All the values are within the prescribed safe limit by USEPA. United States Environmental protection agency (USEPA) recommends a maximum value of 300 pCi/L for radon in water. The normal values of radon measured in ground water is justified considering the that fact that alluvial sediments occupy both the district while the high radioactivity in underground water is generally associated with areas having granitic bedrocks [13].

The pH value of the water samples analysed has been found to be in the range 7.36 to 8.22 for Hoshiarpur district and in the range 7.01 to 8.41, while the commonly accepted range is 6.5 to 8.5. So pH of all samples is within the acceptable range. However, the results indicate that the water is slightly alkaline, a fact also supported by Central Ground Water Board, Govt. of India, report. The TDS value for analysed samples lies in the range 0.140 ppt to 0.701 ppt for Hoshiarpur district and 0.180 ppt to 0.659 ppt while the maximum permissible limit is 0.5 ppt. The conductivity values lie in the range 0.280 mS/cm to 1.372 mS/cm for Hoshiarpur and 0.355 mS/cm to 1.314 mS/cm

for Ropar district. The salinity values for analysed samples lie in the range 0.208 ppt to 1.030 ppt and 0.265 ppt to 0.989 ppt for Hoshiarpur and Ropar districts respectively. Kurtosis values for these parameters for both the districts are negative indicating a flat distribution.

Table 1. Results of measurement of radon concentration, pH, conductivity, TDS and salinity in drinking waters of Hoshiarpur district, Punjab, India

S. No.	Location	Radon (pCi/L)	pH	Cond (mS/cm)	TDS (ppt)	Salinity (ppt)
1	Tanda	44.4	7.36	0.963	0.481	0.720
2	Kurala Kalan	28.0	7.8	1.045	0.522	0.781
3	Dasuya-I	20.3	7.58	0.783	0.390	0.583
4	Sagran	80.2	7.95	0.765	0.336	0.747
5	Nangal	26.1	7.36	0.701	0.347	0.517
6	Hajipur	31.8	7.6	0.543	0.271	0.405
7	Roli Ka Mor	43.2	7.4	0.280	0.140	0.208
8	Talwara	30.4	7.47	0.429	0.213	0.318
9	Rakri Da Har	49.9	7.64	0.325	0.163	0.242
10	Daggan	8.7	8.09	0.306	0.152	0.225
11	Kaluchang	54.7	7.71	0.406	0.201	0.301
12	Galrian	42.6	7.76	0.591	0.294	0.438
13	Mukerian-I	87.0	7.77	0.813	0.405	0.606
14	Mukerian-II	123.2	7.68	0.837	0.416	0.622
15	Ehama Mangat	80.0	7.65	0.393	0.197	0.293
16	Chak Kasim	81.0	7.71	0.634	0.316	0.474
17	Dasuya-II	69.1	7.55	1.198	0.599	0.896
18	Safdarpur Kulian	37.9	7.45	0.763	0.379	0.565
19	Alampur	22.6	8.22	0.444	0.221	0.330
20	Miani	54.2	7.39	1.372	0.686	1.030
21	Daburji	18.5	7.54	1.304	0.652	0.978
22	Rarra	26.6	7.46	0.808	0.403	0.603
23	Nur Talai	21.1	7.81	0.514	0.394	0.484
24	Sherpur	42.4	7.42	0.711	0.582	0.219
25	Katowal	34.6	8.11	1.013	0.476	0.986
26	Bihala	56.4	7.62	0.862	0.701	0.549
27	Jatpur	31.9	7.84	0.924	0.272	0.646
28	Sahri	28.1	7.92	0.442	0.563	0.742
	Mean	45.5	7.67	0.720	0.385	0.554
	SD	26.0	0.24	0.299	0.166	0.244
	GM	39.1	7.67	0.659	0.348	0.499
	GSD	1.8	1.03	1.554	1.598	1.618
	Kurtosis	1.51	-0.17	-0.41	-0.84	-0.72

Correlation analysis of radon with the other physico-chemical parameters measured i.e. pH, TDS, Conductivity and Salinity, were carried out, but the values of correlation coefficients were been found to be less than the significant values required for the present data set. So it is safe to assume that no correlation exist between these quantities. Musa, investigated the effect of presence of various stable chemical elements in addition to factors like, pH, conductivity, NO_3, SO_4 and total organic carbon on radon in natural water [14]. Several parameters like U, pH, fluoride etc. were identified for predictive use of radon. The investigations revealed strong radon-fluoride relation for radon transfer to air from water, at low pH. However the effect at 6-9 pH range is nominal. Due to this reason, correlation between radon concentration and pH values is not reflected in generated data.

The United Nations Scientific Committees on Effects of Atomic Radiation (UNSCEAR) recommends a conversion factor of 0.037 x 10^{-8} Sv/pCi for an adult, 0.074 x 10^{-8} Sv/pCi for a child and 0.259 x10^{-8} Sv/pCi for an infant, for dose due to ingestion of radon in drinking water [15]. Annual effective dose to local adult population of Hoshiarpur district, from drinking water, assuming a daily consumption of 2L, is found to be varying from 2.35 µSv to 33.3 µSv with a mean value of 12.3 µSv. For Ropar district, annual effective dose varies from 3.27 µSv to 35.3 µSv with an average value of 18.2 µSv. The values of annual effective dose due to ingestion from radon in water are within the limit of 0.1 mSv recommended for general public. Estimating risk of developing cancer from this exposure, it is found that extra risk of getting cancer from this exposure comes out to be nearly 2 in 100000 which can be designated as minimal risk.

Table 2. Results of measurement of radon concentration, pH, conductivity, TDS and salinity in drinking waters of Ropar district, Punjab, India

S. No.	Location	Radon (pCi/L)	pH	Cond (mS/cm)	TDS (ppt)	Salinity (ppt)
1	Dumewal	77.5	7.01	0.790	0.394	0.590
2	Fukapur	75.4	7.37	0.697	0.348	0.520
3	Bharatgarh	35.4	7.51	1.1	0.552	0.828
4	Gardala	37.1	7.54	0.643	0.321	0.479
5	Jakhian	35.9	7.54	0.832	0.416	0.622
6	Rauli	72.4	7.86	0.852	0.632	0.641
7	Daddi	57.8	7.43	0.355	0.180	0.265
8	Nalhouti	82.2	7.23	0.961	0.479	0.717
9	Katla Samlah	59.5	7.21	1.314	0.659	0.989
10	Anandpur Sahib	24.9	7.54	0.461	0.231	0.346
11	Ropar City	12.1	7.59	0.770	0.384	0.575
12	Dher	82.2	7.97	0.676	0.336	0.503
13	Majara	114.7	7.26	0.929	0.463	0.693
14	Gar	88.6	7.37	0.770	0.383	0.573
15	Jhazz	79.8	7.31	0.492	0.244	0.365
16	Jhazz Chowk	102.1	7.33	0.809	0.404	0.605
17	Kiratpur Sahib	52.5	7.54	0.450	0.224	0.335
18	Singhpur	73.2	7.46	0.718	0.358	0.535
19	Nurpur Bedi	83.5	7.26	0.699	0.348	0.522
20	Alipur	45.9	7.55	0.856	0.428	0.642
21	Talma	130.6	7.18	1.146	0.572	0.858
22	Bunga Sahib	55.2	7.56	0.607	0.302	0.466
23	Tajpura	72.4	7.42	0.655	0.352	0.615
24	Shampur	41.9	7.53	0.725	0.465	0.749
25	Mirpur	76.3	7.29	0.741	0.441	0.553
26	Mehrauoli	78.3	8.41	0.929	0.456	0.678
	Mean	67.2	7.47	0.768	0.399	0.587
	SD	27.3	0.28	0.217	0.119	0.166
	GM	60.6	7.47	0.738	0.381	0.563
	GSD	1.67	1.04	1.34	1.37	1.35
	Kurtosis	0.19	4.35	0.69	0.07	0.47

CONCLUSION

All the parameters measured i.e. radon and other chemical parameters except TDS for few samples, are well within the prescribed safe limit. So overall quality of groundwater is good for public consumption in Hoshiarpur and Ropar districts.

REFERENCES

[1] *UNSCEAR*, Sources and Effects of Ionising Radiations, United Nations, NY, **1993** p. 73.
[2] K. N. Yu, Z. J. Guan, M. J. Stokes and ECM Young, *Appl. Radiat. Isot.*,**1994**, 45, 809.
[3] V. M. Choubey and R. C. Ramola, *J. Environmental Geology* **1997**, 32(4), 258.
[4] L. Salonen and P. Huikuri, *High Levels of Natural Radiation and Radon Areas: Radiation Dose and Health Effects. General Exposure Assessment*, **2000**, 24, 87.
[5] Ganesh Prasad, Yogesh Prasad, G. S. Gusain and R. C. Ramola, *Radiation Measurements*, **2008**, 43(1), 375.
[6] M. Asikainen and H. Kahlos, *Health Physics*, **1980**, 45, 73.
[7] M. Ivanovich and R. S. Harmon, *Uranium series disequilibrium: applications to earth, marine and environmental sciences*. ISBN 0-19- 854423-5, Clarendon Press, Oxford **1982**.
[8] *USEPA*:. National Primary Drinking Water Regulations for Radionuclides, Washington DC, US, **1991**.
[9] H. M. Prichard, *J. American Water Works Association*, **1987**, 79(4), 159.
[10] Ajay Kumar, S. Rout, U. Narayanan, M. K. Mishra, R. M. Tripathi, J. Singh, Sanjeev Kumar and H. S. Kushwaha, *J.Geology and Mining Research* **2011**, 3(5), 137.
[11] *CGWB*, Central Ground Water Board, Govt. of India, **2007**.
[12] Navjeet Sharma, Rajesh Sharma and H. S. Virk, *Adv. in Applied Sci. Res.*, **2011**, 2(3), 186.
[13] Xavier Ortega, Isabel Vallés and Isabel Serrano, *Environment International* **1996,** 22, 347.

[14] Musa Isam Salih M: *Radon in Natural Waters*. Ph.D. Thesis in Faculty of Health Sciences, University of Linkoping, Sweden; **2003**.
[15] UNSCEAR: Sources and Effects of Ionising Radiations, United Nations, NY, **2000**.