Assessment of Radon Content in Water of Oil Exploration Areas using Smart RnDuo in Mizoram, India

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Abstract **- The presence of radon gas everywhere in nature is well known. WHO publication on the effect of radioactive gas shows that inhalation of a small amount of radon gas can lead to lung cancer. According to Population based Cancer Registry at the Civil Hospital, Aizawl, during 2010-2014 [1], Mizoram has the highest lung cancer incidence rate with 32.6 and 29.3 per 100,000 in male and female respectively. The urgent requirement to carry out The measurement of Radon gas concentration in every parts of the state is eminent. In locations where petroleum and gas products are drawn, survey of the radon gas concentration is done to see its variation with the worldwide average concentration. Survey of radon gas concentration in some available water source is carried out from all the oil exploration areas using Smart RnDuo, an electrical devices that detect Radon and its progeny. Two available water source each were collected from all the six oil exploration areas. Water samples for assessment were collected from stream water and spring water only. The radon content in water collected from all the areas ranges between 0.34Bq/L at Meidum-1 location to 4.33Bq/L at Maubuang-2 location. The overall average content of radon in water was found to be 1.26 Bq/L. The radon content measured for all the sources were found to be well within the range which is considered safe (EPA 1998).**

Key words: Smart RnDuo, water source, radon content in water.

I. INTRODUCTION

The Radon gas is a naturally occurring radioactive inert gas, with a half-life of 3.8 days only produced from the decay product of uranium to radium and then to radon. With the decay of radium, radon is formed which is released into air or water containing pores within the soil and rock particles. If this release occurs near the soil surface, some percentage of radon may be released to ambient air. At the same time it has the tendency to be dissolved into ground water [2]. The presence of radon in water is predominantly due to the decay of radium found in rock and soil and does not mainly originate from the radium dissolved in water [3]. The principle characteristic of radon that gives it more radiological significance than earlier member of the uranium decay chain is the fact that it is a noble gas. Once it is formed, the transport and release from a soil into air or water occurs through diffusion and flow of the air or water [4]. Radon can therefore reach air or water to which humans have access, provided that transport took place before the radon decay [5]. The major contribution of radiation dose in uranium decay series comes from Radon (222Rn) which makes it one of the largest single source of radiation exposure to the population [6]. From the total radiation received by humans, radon and its decay products contributes 51% through inhalation and 0.21% through ingestion [7]. The measurement of radon concentration in water is also very significant for understanding radon migration processes [8]. Therefore proper assessment of radon is required to assess the concentration of radon in water as it can associate with the public health. As such is the case, studies have been carried out in all the available oil exploration areas within Mizoram, India.

II. STUDY AREA

Figure 1 shows the geographical sites of all the oil exploration areas in Mizoram. In Mizoram oil and natural gas exploration is carried out in six areas. Mizoram is a hilly areas with mountains in almost all parts of the land. The exploration of oil and natural gas is carried out at Zanlawn village and Meidum village in kolasib district; Keifang village area, Phulmawi village area and Maubuang village area in Aizawl district. In Serchhip district the search for oil and natural gas is carried out at Thenzawl village areas. The elevation of the study area ranges from 291ft to 2956ft above sea level. Whereas some parts of the land is quite high from the sea level, some areas are quite low from the sea level. It is a tropical region with moderate climate and the temperature varies mainly from 11^0C to 31^0C throughout the year. The state, so far, never experience high temperature of above 40^0C throughout the year. The sampling area extends from 23˚18'08.3'' to 24˚10'12.9'' latitude and 92˚35'54.4'' to 92˚57'1.7'' longitude. Mizoram is such a state where water

sources are found in many locations alongside the highway. The water source are mainly originated from the mountains. As such, alongside the oil exploration areas some water source are available. Two Water samples were collected from each oil and natural gas exploration areas. The water samples were put in an air tight sampling glass bottle. The samples were studied as early as possible to avoid any loss of radon concentration.

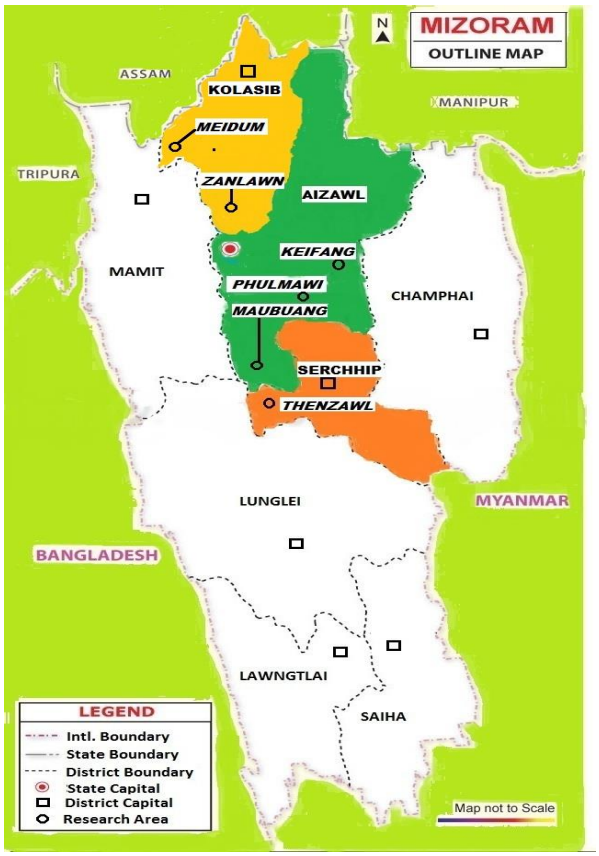

Fig.1, Map of Mizoram, India, showing Oil exploration areas

III. MATERIALS AND METHOD

Radon content in water was obtained using Smart RnDuo detector by means of scintillation cell method. Smart RnDuo instruments is a specially designed electrical instruments that is programmed to measure the radon content in water as well as in soil. It is an inbuilt instruments that can make all the necessary counts once the setup has been finalized. Once the instrument is put to ON position, the machine make us choose between Rn220 and Rn222. Rn220 is meant to study Thoron and Rn222 is meant for Radon. The next steps is to make set the cycle and timings. In order to measure the radon content in water, the scintillation cell is flushed for 5 minutes. This is carried out with the help of an inbuilt pump attached in the instruments itself. This is done in order to eliminate all the background counts. RnDuo monitor is then connected with provided bubbler which is attached to the sampling bottle. This connection is done with the help of a flexible tube as shown in Figure 2. All the connecting materials are air tight such that no outside air has the chance to interrupt the radon counts. After the background gas removal process has been completed, the Pump is put ON again for 3 minutes to ensure that any dissolved radon gas may escape in to the tubing. Thus the instruments is ready for taking a fresh readings. After the necessary setting are done, the measurement of radon gas concentration in the water sample is taken. The reading is taken in 15 minutes cycle. This cycle is taken for 1 hour which means that four sets of readings are obtained in an hour. This is done to ensure that the readings are taken accurately. The mean readings are taken as the final reading. This final reading gives the desired counts for the calculation of radon gas concentration in the chosen water sample. The process is repeated for all the samples and necessary reading are obtained. With the help of the collected date, the radon concentration in liquid (C_{liq}) (Bq/m3) from the concentration measured in air (C_{air}) is calculated by using the equation:

$$C_{liq}=C_{air}(K+Vair/Vliq) \quad (1)$$

Where K is partition coefficient of radon in liquid with respect to air,
V_{air} is volume of air and V_{liq} is volume of liquid in sampling bottle.

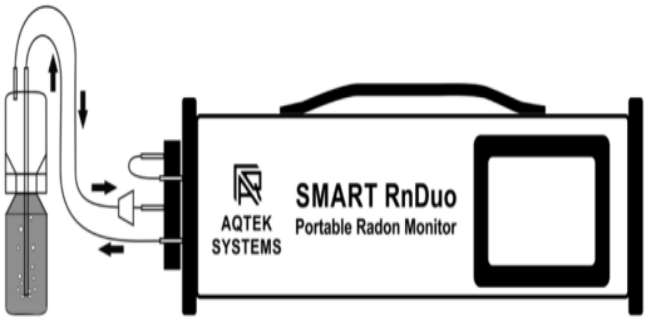

Fig. 2, Smart RnDuo Set up for Measurement of radon in water

IV. RESULTS

All available water source in the nearby areas were detected. Depending upon the locations of the oil field the number of available water source are different. Out of the total available water source at different field two water sample each were collected from each oil and natural gas exploration areas. Thus, twelve water samples were studied. Most of the water samples were collected from Spring and Stream water source. The water samples give different radon content. In general the radon content are more or less of the same range except for Maubuang water sample that give a higher radon content as compared to the rest. The minimum radon concentration is obtained at Meidum oil and gas exploration area. This area has the lowest height from sea level with an elevation of around 291ft only. The maximum concentration is obtained at Maubuang oil exploration areas where the elevation from sea level is above 2895ft. After performing necessary calculation with the equation (1) given above, the radon content in water was found to vary from 0.34Bq/L at Meidum area to 4.33Bq/L at Maubuang area

$\alpha + \beta = \chi.$

with an average value of 1.26Bq/L. The Table.1. shows the radon content in water for the collected samples.

Table 1: Radon concentration in water samples of Oil exploration Areas in Mizoram

Sl. No	*Sample Code*	*Water Source*	*Radon in water (Bq/L)*
1	Maubuang-1	Spring Water	1.02
2	Maubuang-2	Spring Water	4.33
3	Keifang-1	Spring Water	0.39
4	Keifang-2	Spring Water	0.40
5	Phulmawi-1	Stream Water	0.41
6	Phulmawi-2	Stream Water	0.49
7	Thenzawl-1	Stream Water	0.41
8	Thenzawl-2	Stream Water	0.45
9	Zanlawn-1	Stream Water	0.40
10	Zanlawn-2	Stream Water	0.37
11	Meidum-1	Stream Water	0.34
12	Meidum-2	Stream Water	0.41

V. DISCUSSION

. The radon content in water of oil exploration areas were rather low or not high as compared to the worldwide average concentration. A minimum radon concentration were found to be only 0.34Bq/L at Meidum-1 location. And a maximum concentration of 4.33Bq/L is obtained at Maubuang-2 location. The average radon content in water from all the oil exploration areas were found to be 1.26Bq/L. The radon concentration thus obtained is not high. This may indicate that the water sources alongside the oil and natural gas exploration areas does not necessarily contain high percentage of radon gas concentration. The earth where oil and natural gases were extracted does not have significant effect to the radon gas concentration. The average value thus obtained is well within the safe limit of 11Bq/L prescribed by US EPA [9]. None of the individual radon content from the study areas were found to be higher than the safe limits.

The Radon concentration in water obtained from Maubuang-1 and Maubuang-2 locations are high as compared to the rest. This may be due to high altitude as compared to Meidum areas that has the minimum concentration. As the radon content in all the available water source of oil and gas exploration areas in Mizoram, India, is lower to the world average it may be summarized that the areas were safe for dwellings.

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