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RESEARCH ARTICLE

Assessment of average annual effective dose and study of radon concentration in different types of water samples

M.S.A. Khan
Department of Physics, Gandhi Faiz-E-Aam College, Shahjahanpur
Email: salim_labphysics@rediffmail.com

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ABSTRACT

Radon and its decay products are the main source of natural radiation exposure. Alpha particle emissions of radon in drinking water increase the absorbed dose by the respiratory and gastrointestinal systems, which can lead to cancer. In the present study, annual effective dose and radon concentration measurement has been carried out in four different types of water samples i.e. (mineral water, distilled water, tape water and surface water) in Shahjahanpur city of Uttar Pradesh by using sensitive plastic track detector (CR-39). It is observed that our results are less than the maximum contaminant level of 11Bq/L (300pCi/L) and 1-10mSv/y for annual effective dose for the US Environmental Protection Agency.

Key words: *Annual effect dose, CR-39 detector, Radon concentration, Water samples*

INTRODUCTION

Radon is a naturally occurring radioactive gas and highly soluble in water. Radon in water enters the human body by two different paths, Firstly escape from household water and become a source for indoor radon, secondly from drinking water enters directly through the gastro-intestinal (GI) [1]. Most public water supply have very low levels, even if the water comes from municipal wells not be considered a public health concern. This is primarily because such wells tend to tap sand and gravel ground water aquifers with low levels of radon. Public water supplies also stand for a period before they are consumed and some decay of the radon takes place in that time. Radio-nuclides emit ''ionizing radiation'' when they naturally decay [2]. In 1991, the United States Environmental Protection Agency (EPA) proposed a National Primary Drinking Water Regulation (NPDWR) for ^{222}Rn with a maximum contaminant level (MCL) of 11 Bq L^{-1} (300 pCi L^{-1}) [3, 4]. The aim of present study is to measure the average annual effective dose and radon concentration in different types of water by sensitive plastic track detector (CR- 39).

EXPERIMENTAL TECHNIQUE

For the measurement of radon concentration and assessment of average annual effective dose in different types of water (mineral water, distilled water, tape water and surface water) sensitive plastic track detector (CR- 39) was used. The Technique to determine the alpha intensity in water samples by CR-39 detector is shown in figure 1. Taking 200 ml from each type of water put in a plastic cup then fixed the plastic detector (CR-39) in the bottom of the cover 5 cm above the surface of the sample as shown in figure 1. Two samples for each type of water were used, and taking the average. When alpha particles strike the CR-39 cause damage tracks. After a period of thirty days 30 days all the detector films are collected and then etched with 2.5N NaOH solutions for a period of 90 minutes at 60°C in a water-bath. When alpha particles strike the detector films, it creates narrow trails called tracks. The tracks produced by alpha particles in the detector films were counted by

using a spark counter. The radon concentration in different types of water was calculated by using the formula [2].

$$C_{Rn} = \rho / kT$$

Where, C_{Rn} is the radon concentration [Bq/m^3], ρ is the track intensity [Track/cm^2], k is the calibration factor. The calibration factor for α-tracks is equal to 0.163 ± 0.002 [cm^{-2}d^{-1}per Bqm^{-3}] [5] and T is the exposure time in hours. The annual effective dose for different types of water was calculated by using the following equation:

$$D\ (mSv/y) = (C_{Rn} \times t \times F \times 8760h) / (170h \times 3700 Bqm^{-3})$$

where, C_{Rn} is the radon concentration, F is the equilibrium factor equal 3.88, t is the fraction of time spent indoors equal 0.4, 170 is the number of hours per working month and 8760 is the number of hours per years [6].

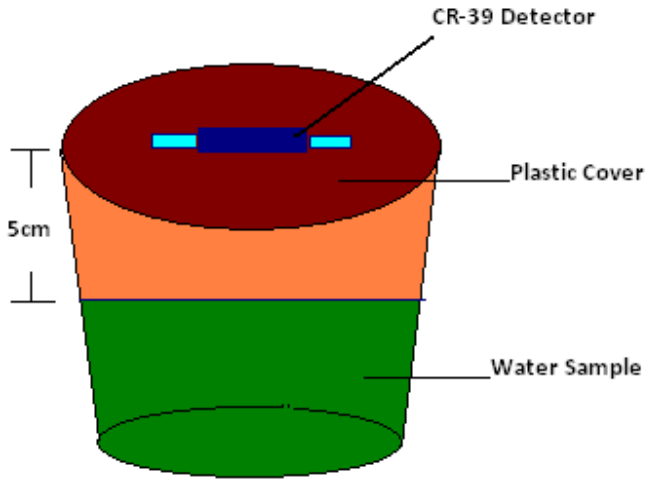

Fig. 1: Experimental setup to determine the alpha intensity in water by CR-39 detector

RESULTS AND DISCUSSION

The observed values of radon concentrations and annual effective dose in different types of waters *i.e.,* mineral water, distilled water, surface water and tap water are given in table 1. It is shown that the radon concentration in each type of water are less than the maximum contaminant level for the US Environmental Protection Agency which equal 11 Bq/L and 1-10 mSv/y [7 and 8] .The variation of radon concentration in different types of water samples is shown in figure 2.

Table 1: Observed values of radon concentration in different water sample

S.No.	Water Samples	Radon concentration (Bq/L)
1	Mineral Water	10.85
2	Distilled water	7.02
3	Surface Water	2.30
4	Tape Water	4.67

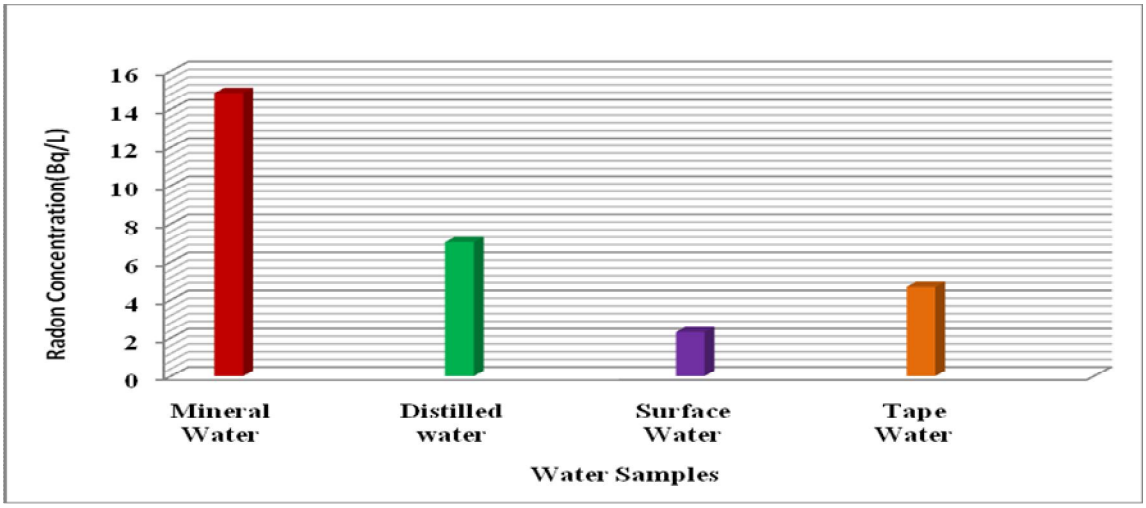

Fig. 2: Variation of radon concentration in different water samples

The calculated annual effective dose received by the people from corresponding radon concentration in mineral water, distilled water, surface water and tap water are shown in table 2. It is shown that the average annual effective dose received by the people of the study area in each type of water is blow than the recommended limit of the public of (1-10), mSv/y. The variation of annual effective dose received by the people of the study area in different types of water samples is shown in figure 3.

Table 2: Average value of annual effective dose in different water sample

S.No.	Water Samples	Average annual effective dose(mSv/y)
1	Mineral Water	0.25
2	Distilled water	0.17
3	Surface Water	0.03
4	Tape Water	0.05

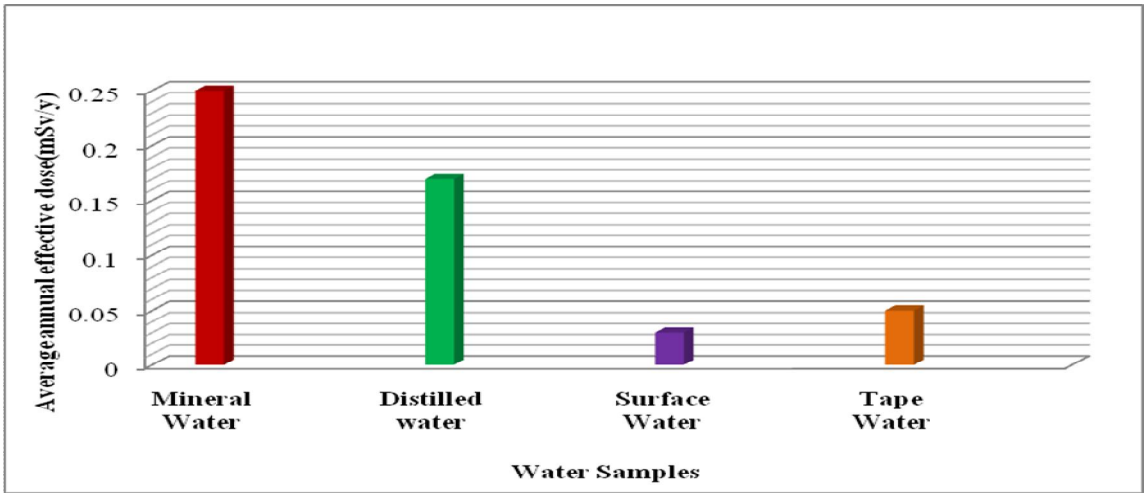

Fig. 3: Average radon concentration at different locations

CONCLUSION

The radon concentration and average annual effective dose received by the people of the study area in each types of water samples i.e. mineral water, distilled water, surface water and tap water and they have been estimated using a plastic track detector (CR-39). We observed that our results are less than the maximum contaminant level for the US Environmental Protection Agency. Thus different types of water samples in the study area are clear from radiation and safe to use.

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