

The Sources of Radon (Rn222) and its Radiological Effect

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Abstract

Radon and its isotopes Rn^{222} and Rn^{220} are found in the naturally occurring elements present in earth's crust. Exposure to radon Rn^{222} and its progeny in indoor atmosphere can result in significant inhalation risk to the population particularly where the concentration of Rn^{222} is high. For assessment of radiological hazards due to inhalation of radon and its decay products, the indoor concentrations are more important than the outdoor concentration. The National Academy of Science (NAS) estimated that 15000 – 22000, Americans die every year from radon related lung cancer. However, almost 90% of those deaths were from lung cancer caused by inhaling radon released to indoor air from water. Only about 10% of the deaths were from cancers of internal organs. Prominent process of Rn^{222} entry in most of the residence appears to be the pressure driven flow of soil gas through cracks or through other openings in the basement slab or subfloor. This is an important health consequence and efforts have to be made to reduce the harmful effects due to Rn^{222} and its progeny.

Keywords: Radon and its progeny

I. INTRODUCTION

The sources of low level radiation in the environment and radon and its progeny, which are considered to be responsible for significant dose to man are naturally occurring element present in earth's crust.

Rn isotopes, Rn^{222} and Rn^{220} are found in the uranium and thorium series. Rn^{226} and Ra^{224} give rise to the isotopes of Rn. High concentration of these elements in uranium and other mines have led to an increase in the incidence of lung cancer among the

mine workers (Evan et. Al., 1981). The average dose to the lung from Rn^{220} has been estimated to be about 25% of that from Rn^{222} progeny due to its relatively rapid decay (UNSCEAR, 1986). The health risk associated with Rn is due to the alpha decay of its short lived progeny, Po^{218} and Pb^{214} . These nuclides are solid atoms unlike the Rn gas and so can adhere to surfaces like air borne particles, room walls and lung tissues.

The important factors that have got influence upon the indoor Rn concentrations are i) Properties of the building materials and the ground. Here the Rn exhalation from the building materials or the ground is dependent on the radium content, density and the porosity of the material. ii) Building construction. Here the indoor Rn concentrations are influenced by the ventilation rate.

The ventilation rate is dependent on the properties of the building such as the use of insulating materials, artificial ventilation system etc. iii) Meteorological parameters. Here the atmospheric pressure, wind direction and the temperature is the most important one and these have influence both on the Rn exhalation and ventilation. iv) Human activities. Here Rn

concentration in indoor air is strongly dependent on each other.

THE SOURCES OF RADON

When radon is inhaled, the alpha particles from its radioactive decay get trapped in the lungs and directly strike sensitive lung tissues causing damage that can lead to lung cancer. However, since Rn is a gas, most of it is exhaled. The radiation dose comes largely from radon's progeny. They enter the lungs on dust particles that lodge in the airways of the lungs. These radio nuclides decay quickly lung tissue to damage and producing other radionuclide that continues damaging the lung tissue. As they continue to break down the particles release tiny burst of energy which can damage the lungs.

There is no safe level of radon any exposure poses some risk of cancer. The National Academy of Sciences (NAS) studied and reported on the causes of lung cancer in the 1999 reports. They concluded that radon in indoor air is the second leading cause of lung cancer in the U.S. after cigarette smoking.

The NAS estimated that 15,000-22,000 Americans die every year from radon-related lung cancer. When people who smoke are exposed to radon as well, the

risk of developing lung cancer is significantly higher than the risk of smoking alone. The chart-1 compares lung cancer cases caused by radon to the incidence of other forms of cancer.

The NAS also estimated that radon in drinking water causes an additional 180 cancer deaths per year. However, almost 90% of those deaths were from lung cancer caused by inhaling radon released to the indoor air from water. Only about 10% of the deaths were from cancers of internal organs, mostly the stomach, caused by ingesting radon in water.

Table – 1 gives the estimated annual dose rate from natural sources in the areas of background (UNSCEAR, 1982).

For assessment of radiological hazards due to inhalation of radon and its decay products, the indoor concentrations are more important than the outdoor concentrations, Indoor radon comes from different sources such that the soil or rock under the building, buildings materials, water supplies, natural gas and outdoor air etc.

1. Soil:-

Primary source of radon in indoor atmosphere is the soil, where it is

produced by radioactive decay of Radium, which is found in trace quantities, Soil and rock contain elements like U238 and Th232, which vary widely. Estimated average concentrations in soil due to Uranium and Thorium series are 25 Bq/kg each (UNSCEAR,1986). Rn gas, which is chemically inert, is transported through the soil into dwellings via, cracks and other openings in building material directly.

The rate at which the Rn accumulated in the soil gas and the mobility of it in the soil, depends on the physical and environmental parameters like moisture content of the soil texture etc (Nero et al., 1984a). the structure which affects the gas flow also appears to be an important factor. The Rn entry rate can also be much higher, due to either higher soil gas flow rates or due to higher concentration in soil gas itself or both.

In many cases entry rate of Rn bearing gas appears to be the predominant source of Rn in houses observed to have higher indoor levels. The structure which affects the gas flow also appears to be an important factor (Akerblom et al., 1984).

2. Buildings Materials:-

Building materials are more easily characterized as indoor Rn source than the

soil or a rock, which constitutes the building materials. But the emanation rate of Rn from this material is too small to cause any elevated indoor Rn concentration. Ingersoll (1983) has measured the emanation rates for number of building material. In concrete, the estimated emanation rate (average) is 7.7×10^{-6} Bq/kg/sec. For gypsum, it was found to be about 6.3×10^{-6} Bq/kg/sec Barretto et al., (1972) have also reported both emanation rate and ratio in soil and rocks.

3. Water Supply:-

Water born transport can be considered as an important means by which Rn enters to the dwellings. Generally the highest concentrations in water were observed in drill wells, especially in granite areas and the lowest in water from dug wells and surface water. Rn dissolved in water is a potential source of indoor air borne Rn, although the transfer factor relating to the resulting concentration in water is about 10^{-4} Bq/m³ (Nazaroff et al., 1985b). Studies of Rn transfer from the tap water to indoor air, gives an average per person water use of 0.2 to 0.4 m³/day, and use of weighted transfer efficiency of 0.5 – 0.6 (Gesell et al., 1978).

Thus, for about 4 persons living in a dwelling of a reference volume of 250 m³,

the Rn entry rate through domestic water supply, having a concentration of 105 Bq/m³ is expected to be in the range of 7 – 10 Bq/m³.

4. Natural Gas:-

Natural gas containing Rn may also be a source of importance. Like ground water, natural gas can accumulate Rn gas from Radium content in the rock structures, surrounding the gas formation. The Rn concentration in raw gas production wells vary from undetectable levels to 50 k Bq/m³ (UNSCEAR, 1982). It is estimated that at a typical residential gas use and air exchange rates, even for unventilated gas appliances, the contribution of indoor Rn from natural gas is less than 4 Bq/m³.

CONCLUSION

From the Table- 1 it is clear that 60% out of total dose received is due Rndon (Rn) , Thoron (Th) and their products. Therefore estimates have been made by the scientists to evaluate the lung cancer incidences due to Rn exposure among the general population. Exposure to higher Rn increases the risk proportionality. This is an important health consequence and efforts have to be made to reduce or control the excessive exposure to Rn and progeny and it deserves greater attention.

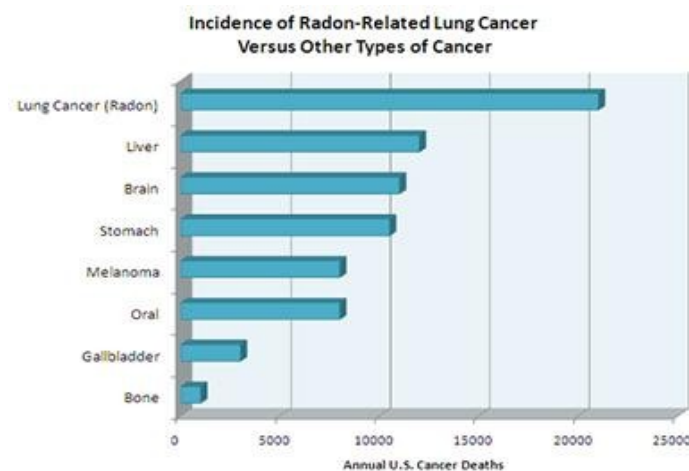


Chart - 1

Table - 1 Estimated annual effective dose equivalent from natural sources

Sources of Radiation	Annual Effective Dose Equivalent(mSv)		
	External	Internal	Total
<u>Cosmic Rays</u>			
Ionizing component			
Neutron Component	0.30	-	0.30
Cosmogenic Radionuclides	0.055	-	0.055
	-	0.015	0.015
<u>Primordial nuclides</u>			
Potassium – 40	0.15	0.18	0.30
Rubidium – 87	-	0.006	0.006
Uranium Series	0.10	1.24	1.34
Thorium Series	0.16	0.18	0.34
Total	0.765	1.621	2.356

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