Empirical Study Heating Processes Effect on the Decay of Irradiation Radon Gas Products and Calculation the Optimal Benefit Cost

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Abstract – Many organizations presented that the reference level for radon is (100 Bq/m3). United States Environmental Protection Agency encourages that the action be taken at concentrations as low as (74 Bq/m3). Radon has been produced commercially for use in radiation therapy, but for the most part has been replaced by radionuclides made in accelerators and nuclear reactors. Radon has been used in implantable seeds, made of gold or glass. Exposure to radon, a process known as radiation hormesis, has been suggested to mitigate auto immune diseases such as arthritis, So we design and purify a new process to handle radon resulting from the dissolution of depleted uranium using based on the method of hot mixing gaseous and use the high-voltage ionization chambers, where the total concentration has been reduced from (214 Bq/m3) to a levels within the acceptable global levels, also we study the accounting analysis to minimize the economic impact on people whom affected by the radioactive gas

Keywords – Reference Level, Radionuclide, Gaseous, Concentration, Exposure.

I. INTRODUCTION

An early 20th century form of quackery was the treatment of maladies in a radiothorium. It was a small, sealed room for patients to be exposed to radon for its medicinal effects. The carcinogenic nature of radon due to its ionizing radiation became apparent later on. Radon’s molecule damaging radioactivity has been used to kill cancerous cells. It does not, increase the health of healthy cells. In fact, the ionizing radiation causes the formation of free radicals, which results in genetic and other cell damage, resulting in increased rates of illness, including cancer. Radon is obtained as a by the product of uranium ores processing after transferring into 1% solutions of hydrochloric or hydrobromic acids. The gas mixture extracted from the solutions contains [H2, O2, He, Rn, CO2, H2O and hydrocarbons]. The mixture is purified by passing it over copper at (720 Co) to remove the [H2] and the [O2], and then used [KOH] to remove the acids and moisture by sorption. Radon is condensed by liquid of N2 and purified from residue gases by sublimation Radon commercialization is regulated, but it is available in small quantities for the calibration of Rn-222 measurement systems, at a price of almost($6,000) per milliliter of radium solution which only contains about 15 pictograms of actual radon at a given moment. Radon is produced by a solution of radium-226 (half-life of 1600 years). Radium-226 decays by alpha-particle emission, producing radon that collects over samples of radium-226 at a rate of about 1 mm3/day per gram of radium; equilibrium is quickly achieved and radon is produced in a steady flow. Radon gas escapes from the capsule through diffusion (1). Exposure to radon, a process known as radiation hormesis, has been suggested to mitigate auto immune diseases such as arthritis (2) and (3). As a result, in the late 20th century and early 21st century, “health mines” established in Basin, Montana attracted people seeking relief from health problems such as arthritis through limited exposure to radioactive mine water and radon. However, the practice is discouraged because of the well documented ill effects of high doses of radiation on the body (4). Radon and its first decay products being very short-lived, the seed is left in place. After 12 half-lives (43 days), radon radioactivity is at (1/2000) of its original level. At this stage, the predominant residual activity originates from the radon decay product 210Pb, whose half-life (22.3 years) is (2000 times) that of radon (and whose activity is thus 1/2000 of radon's), and its descendants 210Bi and 210Po. WHO organization presented in 2009 a recommended reference level which is (100 Bq/m3) for radon in dwellings. A national reference level should not be a limit, but should represent the maximum acceptable annual average radon concentration in a dwelling. The actionable concentration of radon in a home varies depending on the organization doing the recommendation. United States Environmental Protection Agency encourages that action be taken at concentrations as low as (74 Bq/m3) (2 pCi/L).

A primary measurement and calibration system for Ra-226 and Rn-222 has been maintained by National Institute of Standards and Technology. This system still one of the principal tools used to compare and trace radium standards to each other. The system consists of pulse ionization chambers which are used in conjunction with radium solution standards and ancillary gas handling and gas purification equipment. An ionization chamber measures the charge from the number of ion pairs created within a gas caused by incident radiation (5) and (6). It consists of a gas-filled chamber with two electrodes. The electrodes may be in the form of parallel plates or wires. A voltage potential is applied between the electrodes to create an electric field in the fill gas. When gas between the electrodes is ionized by incident ionizing radiation, ion pairs are created and the resultant positive ions and dissociated electrons move to the electrodes of the opposite polarity under the influence of the electric field. This generates an ionization current. In this method, the radon generated from the decay of radium in a sample or standard is physically separated from the radium, and...
quantitatively transferred to the ionization chambers. Alpha particles resulting from the decay of the radon and the radon decay products are then detected and counted in the chambers. The method also has been used to measure the radon content of the whole air samples. The system employs an internal gas counting technique in which a radon sample is introduced, together with a suitable filling gas, directly into a chamber. Their operating voltage is maintained in the ionization region (1200 V); and they are operated in a pulse counting mode. Each ion pair created deposits or removes a small electric charge to or from an electrode, such that the accumulated charge is proportional to the number of ion pairs created, and hence the radiation dose (7). This continual generation of charge produces an ionization current, which is a measure of the total ionizing dose entering the chamber.

II. MATERIALS

Radon is a member of the zero valence elements that are called noble gases (8). It is inert to most common chemical reactions, such as combustion, because the outer valence shell contains eight electrons. This produces a stable, minimum energy configuration in which the outer electrons are tightly bound. (1037 kJ/mol) is required to extract one electron from its shells which is known as the first ionization energy. However, in accordance with periodic trends, radon has a lower electro negativity than the element one period before it, xenon, and is therefore more reactive. Early studies concluded that the stability of radon hydrate should be of the same order as that of the hydrates of chlorine (Cl2) or sulfur dioxide (SO2), and significantly higher than the stability of the hydrate of hydrogen sulfide (H2S). Radon can be oxidized by a few powerful oxidizing agents such as fluorine, thus forming radon difluoride at a temperature above 250 °C. It has a low volatility and was thought to be (RnF2). Theoretical studies on this molecule predict that it should have a (RnF) (9) bond distance of (2.08 Å), and that the compound is thermodynamically more stable and less volatile than its lighter counterpart. The octahedral molecule (RnF6) was predicted to have an even lower enthalpy of formation than the difluoride. The higher fluorides (RnF4 and RnF6) have been claimed to exist, and are calculated to be stable, but it is doubtful whether they have actually been synthesized. The [RnF]+ ion is believed to form by the following reaction:

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Rn \text{ (gas)} + 2O2 + SbF6 \text{ (solid)} \rightarrow RnF + Sb2F11 \text{ (solid)} + 2O2 \text{ (gas)}
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Radon oxides are among the few other reported compounds of radon, only the trioxide has been confirmed. Radon carboxyl RnCO (10) has been predicted to be stable and to have a linear molecular geometry. RnF8 should be highly unstable chemically is due to the relativistic stabilization of the sixth shell see Figure 1. Since the electronic distribution of each shell is: (2, 8, 18, 32, 18, 8) and the form of electronic distribution is (4f14 5d10 6s2 6p6). Extract of this electron from the outer shell is by the process of mixing gaseous like: Hydrogen, Nitrogen, Oxygen, Carbon dioxide and some hydrocarbons which are pushing this mixture by a high-speed of air stream into the combustion chamber like a miniature oven heated by an external heat source to a temperature of (750 °C), where the explosion is happen inside the oven by a contactless circuit which designed for this purpose to get the energy of the first ionization which equal to (1037 KJ / mol). Then the gas mixture is paid to another furnace through cooling system of high efficiency, the mixture pass through two containers, the first contains wet carbon and the second contains calcium hydroxide, the mixture pass finally through the ionization chamber, where the maximum voltage up to 1500 volts, this voltage is higher than the ionization potential of radon gas. In the ionization chamber, ionic results from the disintegration are collected, so many pulsed currents are generated and counted during the specified time. Electron energy of hydrogen atom equals to (13.6 eV) and this energy is equivalent to the wavelength of the photon radiation in the Ultra violet region which is equal to (92 nm) and the enthalpy of the hydrogen combustion is equal to (-286kJ/mol).

Fig.1. Gas mixture technique to get ionization energy of the first level
III. RESULTS AND DISCUSSION

The new chambers are fabricated out of stainless steel with completely sealed welded seams. All of the interior surfaces are electro-polished to minimize electrostatic field irregularities and to minimize surface deposition of the radon decay products. Electrical insulation of the central electrode and guard ring is made with the vendor’s proprietary triaxial ceramic to metal seal that was welded as a complete assembly to the chamber top. The volume of the original chambers was measured by filling with water and was found to be (4.248 L). The new chambers have a minimum volume of (4.234 L) and the maximum volume is (4.261 L). The resolving time of the output signal pulses is approximately (10 microseconds). These pulses are amplified and pulse height analyzed in the system's own dedicated computer. Alpha particle spectrum shapes are developed in time after the introduction of radon into the chamber, followed by removal high percent of radon after ionization. Radon concentration before and after ionization process, see Figures 2 and 3.

![Fig.2. Radon concentration and purification after treatment](image1)

![Fig.3. Radon concentration and purification after treatment](image2)

![Fig.4. Material state losses for 30 patients injury with different types of cancer](image3)

![Fig.5. Chemotherapy and laser costs for different types of cancers](image4)

The main six types of cancerous diseases influential economical health caused by radon irradiation gas are: lung, colon, prostate, stomach, pancreatic, and liver cancers. Cancer is considered one of the most pathogenic cause of death which is higher than the mortality of heart disease by 20%. The colon cancer is the highest percentage of injury, then lung cancer, liver cancer, prostate cancer, stomach cancer, and brain cancer. We have been following up the case of injury to ten cancer patients and continuously for one year and the different stages of treatment have been studied and study the external factors of exposure. We also follow patients family history and residential sites and the possibility of their exposure to their areas earlier military operations and the type of food that has been handled before injury. This has required considerable effort in following up the health status of these patients and found that the cure rate for
people with prostate cancer up to 40% as the possibility of
the return of oncology begin to appear after six months of
treatment time while healing with tumors cancerous colon
rate was up to 65% if the tumor from the first and second
degree or in case of medium injury. The total material
state losses for (30 patients) equal to (881000$) in
comparison with the fee of the gas mixture treatment
technique (25000$). Cost results see Figure 4. Colon and
liver costs for laser and chemotherapy treatments are the
highest than other types of cancers as shown in Figure 5.

IV. CONCLUSION

Inhaled radon increases the risk of lung cancer via alpha
radiation from radon and its short-lived decay products
coming into direct contact with lung tissue. The weight of
evidence for the role of inhaled radon in causation of lung
cancer is very strong. Radon is classified as a known
human carcinogen. Radon can cause stomach cancer. The
risk from residential exposure to radon is primarily
estimated by extrapolating from lung cancer and other
types of cancer observed at high doses. For these reasons
we design the gas mixture technique using mixtures of
hydrogen, carbon dioxide, nitrogen, and oxygen. This
technique helps us to reduce radon concentration by 80%
to make it with the safe levels, this reduce the risk of this
gas on population. Design cost of this technique is so low
in comparisons with the materials state losses.

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