FATE OF RADON IN GROUNDWATER AND INDOOR AIR: SHOWER STALL MODEL

K.Y. Lee, K. S. Ko, S.Y. Cho, D. H. Kim, D. C. Koh, K. Ha

Geologic Environment Division, Korea Institute of Geoscience and Mineral Resources, 124 Gwahag-ro, Yuseong-gu, Daejeon, Korea, kylee@kigam.re.kr

Radon (^{222}Rn) is a radioactive gas formed by the decay of radium (^{226}Ra) within the uranium (^{238}U) series. Radon has been recognized as a lung carcinogen by the World Health Organization (WHO, 2009) and considered to be the major contributor to public exposure from natural sources (UNSCEAR, 2000). Radon in water usually originates in water wells that are drilled into bedrock containing radon gas. These wells could be private water wells or wells that are utilized by a public water supply system. Dissolved radon in groundwater will transferred into indoor air during household utilizations such as showering, laundering, and dishwashing. Estimates are that indoor air radon concentrations increase by approximately 1 pCi/L for every 10,000 pCi/L in water (Bryan Swistock, 2016). In this work, transition rate of groundwater radon into indoor air using a shower stall model. Removal rate of indoor air radon by air change rate was also measured using the shower stall model.

I. INTRODUCTION

Radon is an inert, water soluble radioactive gas produced by the decay of radium (^{226}Ra) which is also a decay product of uranium (^{238}U) decay series. Radon is present in trace amount almost everywhere on earth being distributed in the soil, groundwater and in the lower levels of the atmosphere. The major source of radon in the indoor air is the uranium present in the soil and rocks beneath the house as well as the drinking water, building material and the cooking gas we use. Based on data from a national survey on radon concentrations in groundwater wells (2,788 wells: 1,808 public water supply systems, 980 private water wells) in Korea during 1999 – 2012, 15 % of which were found to be above the US EPA's Alternative Maximum Contaminant Level (AMCL) of 148 Bq/L. In Korea Institute of Geoscience and Mineral Resources (KIGAM), various researches have been conducted to provide clean groundwater to residents in rural communities in Korea, where residents have used groundwater for all the life activities such as cook and wash in house as well as used it for agriculture and to breed livestock. In this work, transition of radon from groundwater to indoor air was measured experimentally using a shower stall with shower head and kitchen faucet. Additionally, removal rate of indoor radon by air change rate was also measured using the shower stall model.

II. EXPERIMENTAL

The shower stall was constructed with dimensions of 50 cm (Φ) and 150 cm height with a volume of 295 L and consisted of a shower head at 150 cm height and a kitchen faucet at 50 cm height from the bottom. During the experiment, the shower stall was supplied groundwater containing around 155 Bq/L of radon. Three different water utilization methods were examined to measure the transition effects by water utilization methods. At first, groundwater was supplied through the shower head with flow rate of 10 L/min for 2 hours. Secondly, groundwater was supply through the kitchen faucet with the same methods as in the shower head experiment. Finally, shower head and kitchen faucet were utilized simultaneously to supply the groundwater into the shower stall with flow rate of 15 L/min for 2 hours. The groundwater supplied into the shower stall was drained continuously through the bottom drainage of the stall. Radon activity concentrations were measured continuously during air injection into the shower stall with difference air change rate. Continuous radon monitoring in air of the shower stall was performed using radon-in-air monitor (RAD7, Durridge, US)

III. RESULTS

Radon in air of the shower stall was measured continuously during groundwater utilizations with Rn-in-air monitors (RAD7, Durridge Co., US) in closed loop. Transition rate (T_r) of radon from groundwater to air of the shower stall was estimated using the Eq. (1),

$$T_r = \frac{C_a V_a}{C_w V_w} \qquad (1)$$

Where, C_w and C_a are radon activity concentration (Bq/L) of radon in water and air, respectively. V_w and V_a.

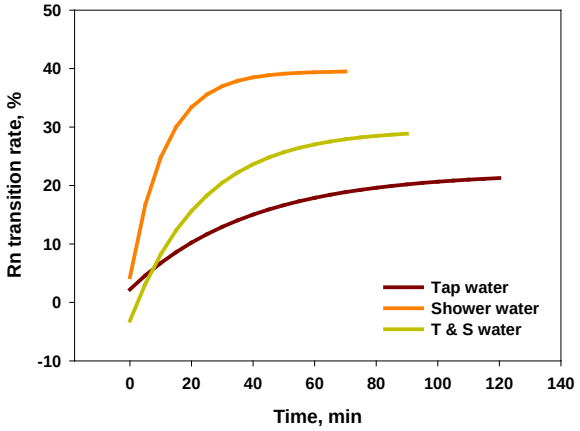

Fig. 1. Transition rate of groundwater water radon in indoor air of the shower stall model.

IV. CONCLUSIONS

A simple and convenient method for the determination of radon emanation fractions from rock and soil samples has been studied by growth and decay curves of radon using gamma-ray spectrometry. The emanation fractions of radon could be used to study the sources of radon in groundwater.

REFERENCES

1. P. K. Hopke, et al., "Health Risk Due to Radon in Drinking Water," *Envir. Sci. Tech.* **34**, 921-926 (2000).
2. Y. Yasouka, et al., "A case study on the effect of water from groundwater sources on indoor radon level," J. *Radioanal. Nucl. Chem.* **275**, 165-172 (2008).
3. K. Y. Lee, S. Y. Cho, Y. Y. Yoon, Y. N. Jang, "Determination of the radon emanation fraction from phosphogypsum using LSC," J. Radioanal. Nucl. Chem. **291**, 197–200 (2012).