New-type of Multi-purpose Standard Radon Chamber in South Korea

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Abstract

Radon is an inert and a radioactive gas which is colorless, tasteless and odorless. As the radon decay proceeds, and if DNA damage continues beyond repair capacity of cells in the human body, it can cause severe health problems such as lung cancer in the long-term. There is a tendency that those countries where legal restriction on radon is strict, various studies related to radon are under way. In South Korea, radon has been regulated under recommendation level. Even though there are about 3 standard radon chambers in Korea, they have not been in an active use because of lack of demand. Also, most of them are specialized in calibration of radon detectors only. Recently, Korean government started giving some attention to radon issue and supporting radon research fields. Thus, this study was carried out to develop a new type of radon chamber for multi-purpose such as 1) radon emission rate from natural and artificial radon sources; 2) calibration of radon detectors; 3) evaluation of radon mitigation efficiency.

Keywords: Radon, Radon Chamber, Indoor Air Quality, Chamber Design

1. Introduction

Radon is an inert radioactive gas that arises directly from the decay of radium-226, which widely exists in soils and rocks. Radon is, therefore, a product of the uranium-238 decay series. Once released, radon may diffuse to a free surface and then escape into the air or water. Radon has 3.82 days of half-life and decays into a series of short-lived radioisotopes such as Polonium-218, Lead-214, Bismuth-214, etc until Lead-206. Causing DNA damage beyond repair capacity of cells in the human body, if such a state continues, interior concentration of radon is high, can cause lung cancer in the long term. In developed countries, a lot of effort has been going on to induce the public to mitigate radon concentration in their own houses due to the risk of radon. Also, most countries constructed standard radon chambers and help radon researchers, detectors and mitigators with calibration and detection. Using those chambers, various studies have been performed. However, in South Korea reliable method and scientific criteria are still necessary to manage radon for governmental regulation because most of radon chambers are hardly in use due to lack of demand. This study was carried out to construct new type of standard radon chamber and compact multi-purpose and evaluate various radon issues such as radon emission rate, radon mitigation efficiency and radon detector calibration.

2. Materials and methods

2.1 Radon Chamber Design

Multi-purpose standard radon chamber aims to develop evaluation model of radon flow and radon emission resulting from natural and artificial radon sources considering various factors such as indoor air flow, temperature, humidity, etc. Also, this chamber can be applied to assess radon mitigation system. Moreover, Computational Fluid Dynamics (CFD) can simulate inside of the chamber and mathematically interprets indoor radon flow to predict radon movements and control strategy.

Dimension of multi-purpose standard radon chamber is 2000 mm x 2000 mm x 2400 mm. Fig. 1 describes a general drawing of the chamber.

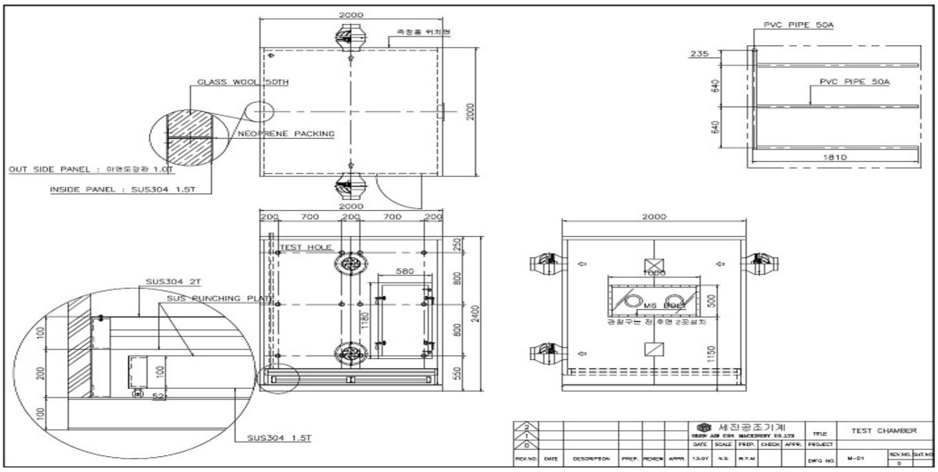
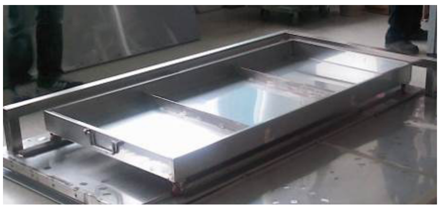
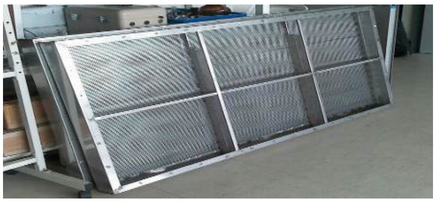


Fig 1. General drawing of multi-purpose radon chamber

Multi-purpose radon chamber consists of soil tray (85 mm (H) × 1,750 mm (L) 2 EA) so that natural radon source(soil) can be used for emission rate evaluation. Moreover, various factors such as temperature, humidity and air flow can be considered during the test.

2.2 Measuring the Concentration of Radon Activity

Multi-purpose radon chamber, aims to develop an evaluation model to account for the factor with variety flow of air in a room, temperature, humidity, radon emitted and flow into the chamber from natural and artificial radon source. The most important parts in the chamber are SUS material for duration, air-tightness for accuracy and strictly controlled environment for evaluation of various conditions. Steady temperature/humidity controller will be installed to evaluate radon emission rate, radon mitigation efficiency, etc. under different temperature/humidity conditions.

Soil Test Tray	Exhaust test tray SUS
	
Soil test tray and exhaust pipe	Soil exhaust pipe
	
Observation sights	Full wall insulation

	
Exhaust ventilation pipe	Soil exhaust ventilation pipe
	

Fig2. Construction of standard radon chamber

Fig 3.Munti-purpose radon chamber

2.3 Calibration of radon measuring device

Calibration of detector is required periodically in order to evaluate the accuracy of the active radon detectors. Most of all, to perform the calibration, radon concentration must be steadily maintained in the chamber. Indoor radon gas concentration is not significantly influenced by temperature and humidity, but the filter and adsorbent to collect radon progeny can be affected by temperature and humidity. For this reason, temperature and humidity control have to be performed in case of need. So far, a number of international goverments run standard radon chambers, and they are broadly useful. In South Korea, only three orginizations(Korea Research Institute of Standards and Science, Korea Testing Laboratory and Yonsei University) run standard radon chamber. However, because the legal force related to radon regulation is too low (indoor radon has been regulated by recommendation level in Korea) and the demand is also low, these chambers are hardly in use.

2.4 Efficiency evaluation of reduction and equipment radon release rate

Most of the radon penetration is caused by he soil and rock of the ground of the building, and the radon keeps accumulated from the bottom of the building continuously. Because the pressure in the indoor space is lower than the pressure in the soil, radon flows into the indoors through the walls and floors of the building. Also, radon can enter the building through other passages such as cracks on the wall. Once this radon engers, it will stay indoors until the air ventilation occurs. In particular, Computational Fluid Dynamics(CFD) can simulates radon flow in the chamber resulted from radon source materials so that we can interpret the flow mathematically and predict its movements. Eventually, we will be able to control the indoor radon gas in advance.

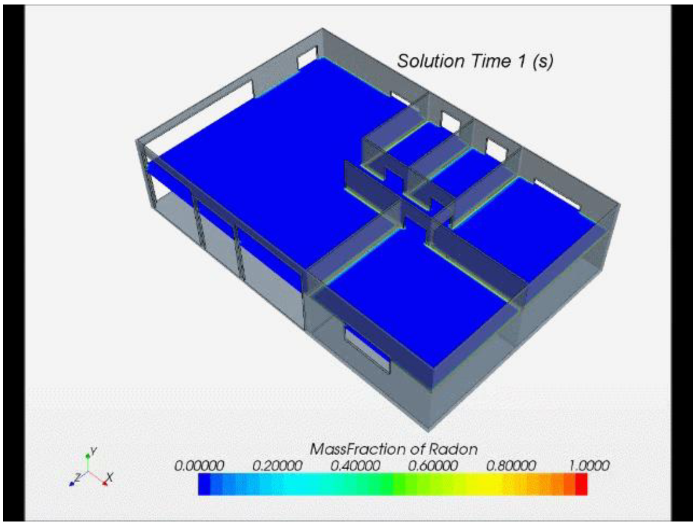


Fig 4. Simulation of radon emission from the building materials and indoor radon distribution

3. Discussion

Radon is a radioactive substance that occurs naturally and has been classified as a major factor that causes lung cancer followed by smoking. Radon has been interested from the 1980s past in Korea, but it has not been developed in the field of management and reduction. It is because the public has not been aware of how dangerous this radon is and how to detect and manage. However, the Korean government recently started focusing on radon issues and supporting radon detection and management. This multi-purpose radon chamber is possible to experiment considering many factors such as airflow, temperature, humidity, and radon emitted into the chamber from natural and artificial radon source. Furthermore, it is possible to predict the movements of indoor radon through simulation by CFD. Also, it is possible to evaluate the radon emission rate under various conditions. Compared to existing standard radon chambers in other organization, this chamber can be a multi-purpose tool for radon research field. Radon emission rate of natural and artificial radon source considering various factors can be carried out. Also, calibration of radon detectors can be performed as well. Finally, radon mitigation systems can be applied to the bottom of this chamber and evaluated their efficiency as well. Therefore, this study is possible to contribute to development of the official radon test and analysis method and establishment of a scientifically accurate regulation.

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