FORMATION, ENTRY, AND ACCUMULATION OF RADON IN RESIDENTIAL AREAS: A DYNAMIC MODELING APPROACH

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Introduction

Radon is a naturally occurring radioactive gas that poses significant health risks, particularly when accumulated indoors. It originates from the natural decay of uranium present in soil, rocks, and building materials. Due to its colorless, odorless, and tasteless nature, radon can easily infiltrate residential buildings without being detected. The inhalation of radon and its decay products is associated with an increased risk of lung cancer, making it a critical public health concern. In Uzbekistan, where diverse geological conditions and climatic factors influence indoor air quality, understanding the behavior of radon is of paramount importance.

The present study aims to develop a comprehensive dynamic model for predicting the formation, entry, and accumulation of radon in residential buildings. Furthermore, experimental research will be conducted in a typical residential house in Uzbekistan to assess the actual radon concentration and the impact of climatic conditions. The results will be valuable in formulating preventive strategies to reduce radon exposure in homes.

Main Part

Radon is produced through the radioactive decay of uranium-238 and radium-226, commonly found in soil and rock formations. Once formed, radon gas migrates through soil pores and fractures, eventually penetrating residential buildings through foundational cracks, gaps around pipes, floor-wall joints, and even construction materials containing trace amounts of uranium.

Several factors influence the rate and volume of radon entry into living spaces. These include soil permeability, building structure, ventilation systems, indoor-outdoor pressure differences, and seasonal temperature variations. In Uzbekistan, residential buildings are often constructed using locally available materials that may contribute to increased radon levels. Additionally, the climatic conditions, characterized by hot summers and cold winters, create pressure differentials that facilitate radon entry.

The development of a dynamic model to predict radon accumulation is crucial for effective indoor air quality management. The model considers:

1. **Geological and Soil Characteristics:** Assessing uranium content, soil porosity, and permeability.
2. **Building Characteristics:** Analyzing construction materials, structural integrity, ventilation patterns, and foundation types.
3. **Environmental Factors:** Monitoring temperature, humidity, and atmospheric pressure variations.
4. **Radon Decay Dynamics:** Accounting for radon's half-life and its interaction with indoor air components.

The model integrates these parameters into a mathematical framework that calculates radon concentrations under different scenarios. Simulation data are compared with experimental measurements to validate model accuracy.

An essential part of the study involves conducting experimental measurements in a selected residential house that reflects typical building practices in Uzbekistan. Sensors and monitoring devices will be installed to measure radon levels continuously over a defined period. Data on temperature, humidity, and atmospheric pressure will also be recorded to assess their correlation with radon concentration.

Preliminary studies indicate that radon levels in some residential areas may exceed recommended safety limits, particularly during colder months when ventilation is reduced. Real-time monitoring will help identify peak radon periods and establish patterns related to building usage and environmental changes.

Results and Discussion

The dynamic model's predictions are expected to align with the experimental data, highlighting key factors influencing radon entry and accumulation. Early findings suggest that older buildings with poor ventilation and damaged foundations exhibit higher radon levels. Additionally, the use of certain building materials appears to contribute to elevated indoor radon concentrations.

Addressing the radon issue in Uzbekistan requires both technical and educational interventions. Homeowners should be made aware of potential risks and preventive measures, including sealing foundation cracks, improving ventilation, and conducting regular radon testing. Policymakers should also consider updating building codes to mandate radon-resistant construction practices.

Radon poses a significant threat to public health, particularly in residential areas where natural and construction-related factors contribute to indoor accumulation. This study provides a comprehensive dynamic model to predict radon formation, entry, and accumulation, supported by experimental validation in a typical Uzbek residential building. By understanding radon's behavior and identifying critical risk factors, it becomes possible to develop more effective mitigation strategies and protect residents from long-term health risks.

Future research should expand the scope of field measurements to include various building types and geographical locations. Moreover, public awareness campaigns and the implementation of mitigation techniques are crucial to reducing radon exposure and safeguarding community health.

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