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Heat-air-moisture coupled model for radon migration in a porous media

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Abstract

Radon is one of the main causes of environmental pollution and lung cancer. The precipitation of radon from porous media is affected by the coupling of heat and moisture, which has not been considered in the existing knowledge. We present a model for predicting radon migration in porous media. This model combines the heat-air-moisture (HAM) coupling model of porous media with a radon migration model to establish three-dimensional partial differential equations for steady-state radon migration under HAM coupling conditions. The finite element method (FEM) was used to obtain a numerical solution. Experimental verification showed that the model had high calculation accuracy; the calculated maximum relative error did not exceed 15%. The results of the model were compared with the results of a conventional model that does consider the coupling of heat and humidity; the results showed significant differences in the radon concentrations and radon flux distribution curves for the two models. The newly developed model revealed that there is a significant coupling effect between migration and the distribution of the temperature field, the humidity field, and radon flux in unsaturated porous media. The radon exhalation rate on the surface of porous media increases linearly with the increase of permeability. The exhalation rate decreased exponentially with the increase in relative humidity. When the trend of the temperature gradient was consistent with the concentration gradient, the radon exhalation rate decreased linearly with the increase in temperature gradient. We establish a new model to study the radon migration in porous media under the coupling of heat and moisture. The model provides a theoretical basis for an effective and accurate analysis of the impact of radon exhalation on the environment.