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Numerical analysis of a pollutant dispersion in subsurface soil

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ABSTRACT

A hydraulic scale model was used in a laboratory experiment for the purpose of understanding the characteristics of a pollutant dispersion in subsurface soil. The experimental site was an area near a radioactive waste repository in the Republic of Korea. The hydraulic scale model was designed and manufactured in geometric similarity to the actual site. The tracer ^{99m}Tc which has a short half-life was injected instantaneously into the soil. Numerical simulations were performed to compare the measured radioisotope data and to investigate the overall dispersion patterns. The calculated concentrations are in good agreement with a time series of the measured concentrations at the midpoint of the detection lines.

1. Introduction

A radioactive waste repository is being constructed in the Republic of Korea for the burial of low and intermediate-level waste. The planning and construction of the repository feature various safety systems that prevent the leakage of radionuclides. One long-term safety feature is the assessment of the groundwater that flows into the repository. Analyzing the transport of radionuclides in subsurface soil is also a crucial aspect of the environmental safety and monitoring systems in the vicinity of a nuclear waste repository [1–3]. On-site investigations including geological and hydrological analyses are conducted near the waste repository as part of the overall environmental assessment [4–6]. Furthermore, numerical models are used to simulate the groundwater flow and pollutant migration near the repository [7,8]. The understanding of the characteristics of advection and dispersion is important for describing the movement of pollutants in subsurface soil.

In this study, numerical simulations and laboratory-scale experiments with radioisotopes were conducted for the purpose of evaluating the characteristics of the transport and dispersion of pollutants in the soil. The radioactive waste repository near Gyeongju in the Republic of Korea was selected as the experimental area and the laboratory-scale hydraulic model was manufactured in geometric similarity to the Gyeongju site. The construction of the hydraulic model was based on real conditions such as the geological formations and topographical shape near the repository. Numerical models were used to compare the experimental results and to analyze the overall transport characteristics of a pollutant. The hydraulic models were widely applied to investigate the groundwater flow and pollutant transport in the soil; in most cases, the tracers were chemicals or dyes [9,10]. A radiotracer was used in the laboratory experiments to investigate the mixing time and flow rate required for industrial processes [11,12].

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