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Stochastic seepage model in repository of low and intermediate level solid radioactive wastes

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Abstract

Repository of Low and Intermediate Level Solid Radioactive Wastes (ILRW) is accepted to deal with the ILRW produced from fast development of nuclear power industry and other fields. In performance assessment of the potential geologic repository, modeling plays a very important role in addition to experimental inverstigations. In addition to experimental inverstigations modeling has also to be used for these purposes. In the paper, stochastic mathematical theories were used for calculating the radionuclide transport in fractured rock masses at Repository of Low and Intermediate Level Solid Radioactive Wastes. To better understand about the dangers of public for radiation and the nuclides transport in fractured rock masses at low and intermediate level solid radioactive waste disposal, the paper builds three dimensional stochastic seepage grid model to describe radionuclide transport in fractured rock masses based on three-dimensional directional seepage theory that is built into percolation mechanics, sets up a rigorous computer simulating system to calculate the radionuclide transport and safety performance of the Repository of Low and Intermediate Level Solid Radioactive Wastes based on computing technology. Finally, To illustrate the precision and validity of this model that is built into the stochastic mathematical theories or computing technology, the simulation experiments are carried out to understand law of radionuclide transport.

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Keywords: Radioactive waste disposal, Radionuclide transport, Stochastic process, Seepage Model, Simulation

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1. introduction

In the ordinary course of event[1][2][3], the determinate model is used for studying on the radionuclide migration in disposal field of Low and intermediate level solid radioactive wastes. However, the process of the radionuclide migration along with the groundwater flow is often influenced by many factors, which have strong uncertainty. For example, hydrogeological, rock and soil microstructure, initial conditions, boundary conditions, natural conditions, etc[4]. Due to the uncertainty of the factors, the results obtained by using the deterministic radionuclide migration theory may be inconsistent with the actual situation[5]. Therefore, it is very necessary to introduce the stochastic mathematical theory into the analysis of the radionuclide migration in disposal field of Low and intermediate level solid radioactive wastes. In this paper, a three-dimensional random seepage model is established, which is based on the theory of stochastic process and fluid percolation theory. At the same time, a rigorous computer simulating system based on computer technology has been established to simulate the radionuclide migration and safety performance of the disposal field of Low and intermediate level solid radioactive wastes, the computer simulating system can quantitatively describe the characteristics of the soil parameters, and can be repeated for simulating the radionuclide migration in disposal field of Low and intermediate level solid radioactive wastes.

2. The theory of three dimensional stochastic seepage

A random process is formed to describe fractured rock masses in disposal field of Low and intermediate level solid radioactive wastes. Namely, the state $\xi_t \subset Z^d$ is a d dimensional integer lattice, **"Z" denotes** all integers **and "d"** is equal to 1, 2, 3. Therefore, if **"d"** is equal to 3, then $Z^d = \{(m,n,k): m,n,k \in Z\}$. The point in the $\xi_t \subset Z^d$ indicates the pore position of cross section that is built into fractured rock masses in disposal field of Low and intermediate level solid radioactive wastes. The random process ξ_t is a random sets in the three-dimensional integer lattice figure, and indicates A group of random sets when the distance t changes between 0 and *L*, and can show that the interconnected pores in disposal field of Low and intermediate level solid radioactive wastes varies according to the distance t. Consequently, Random medium field can describe the fractured rock masses in disposal field of Low and intermediate level solid radioactive wastes, and can accept the uncertainty and complexity of the microstructure of fractured rock masses in disposal field of Low and intermediate level solid radioactive wastes, and can accept the heterogeneous distribution of the attributes of fractured rock masses in disposal field of low and intermediate level solid radioactive wastes. At the same time, the fractured rock masses of the disposal field has the characteristics of heterogeneity and geological statistics. Therefore, random process ξ_t can represent the overall characteristics of the heterogeneity of fractured rock masses of the disposal field, and can been used for building the radionuclide transport model that will be more effective for calculating the radionuclide transport in fractured rock masses of the disposal field.

A mathematical model for the radionuclide transport in fractured rock masses is built by three-dimensional directional seepage theory. That the underground water flows through fractured rock masses of disposal field (random medium field) is simplified as the three-dimensional stochastic seepage grid model (Fig.1). In the fig.1, each section of line is called edge, the connection point of the edge and edge is called a point or position, each position (Point" O "said) forward leads to three directional edges (three edges of a cube) to three positions(Point" ● "said) ,then each position of three positions(Point" ● "said) forward leads to three directional edges to three positions(Point" O"said),the position (Point" ● "said) and (Point" O"said)of three-dimensional stochastic seepage grid alternately move forward ,and the position moves forward when the position (Point" ● "said) and (Point" O"said) are alternately. The switching of each edge of the fig.1 is carefully dominated by the random mechanism, the underground water flow only can move forward. As shown in Figure 1, the underground water flow