Interpretation of radiounclide-migration in the unsaturated zone

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1. Introduction

A decommissioning of retired nuclear facilities is performed for a reuse of their nuclear sites. Also, the residents adjacent to the zone of retired nuclear facilities should be safe from radiation exposure. Consequently, the contamination zone around a nuclear facility in Korea is necessary to explain the nuclide concentration distribution systems because of influx of the contaminant from earth surface to groundwater.

Recently, Korea institute of nuclear safety developed the simplified approximation method of the multi-compartments model [1] about the contaminant migration in the unsaturated zone.

In this study, we have developed numerical cord in order for the interpretation of radiounclide-migration in the unsaturated zone. The hydraulic parameters of the unsaturated soil have investigated form using the soil around a nuclear facility in Korea. Also, we have analyzed the unsaturation factors affect in radiounclide-migration in the unsaturated zone.

2. Contaminant migration-model development in the unsaturated zone

2.1 Water flow mathematics model in unsaturated zone

The unsaturated soil water migration can be described by Richards' equation (1) and Van Genuchten equation (2) [2].

$$\frac{\partial \theta}{\partial t} = \frac{\partial}{\partial x}[K(h,x)\frac{\partial h}{\partial x}] \quad (1)$$

$$K(h,x) = K_s(x)K_r(h,x)$$

$$F(\theta) = [1 - (\frac{\theta - \theta_r}{\theta_s - \theta_r})^{1/m}]^m \quad (2)$$

$$\theta(h) = \theta_r + \frac{\theta_s - \theta_r}{(1 + |\alpha h|^n)^m} \qquad m = 1 - 1/n$$

$$K_r(\theta) = \sqrt{\frac{\theta - \theta_r}{\theta_s - \theta_r}}[1 - F(\theta)]^2$$

2.2 Contaminant migration-model in the unsaturated zone

The contaminant migration-model [3] can be described by the following convention-diffusion equations (3).

$$\frac{\partial \theta C}{\partial t} + \frac{\partial \rho s}{\partial t} = \frac{\partial}{\partial x}(\theta D \frac{\partial c}{\partial x}) - \frac{\partial qc}{\partial x} - \mu_w \theta c - \mu_s \rho s \quad (3)$$

$S = kc^{\eta}$ $(nonlinear\ Freundlich isotherm)$

D : *dispersion coefficient* q : *water velocity*

μ_w, μ_s : *first – order decay*

3. Method and measurement

3.1 Contaminant migration program in the unsaturated zone

Figure 1. shows main flow chart of contaminant migration program in the unsaturated zone. Also, the numerical programs used the Galerkin finite element technique in order to calculate Richards'equation and convection-dispersion equation.

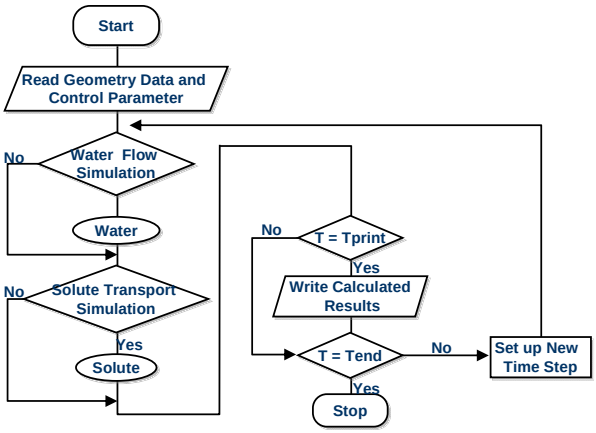

Figure 1. Main flow chart

3.2 Hydraulic parameter measurement

In this paper we have used the soil around a nuclear facility in Korea and measurement values were shown in Table 1.

Table 1. the hydraulic parameters of the soil around a nuclear facility

	Bulk density	Moisture content	Particle density	porosity
1st	1.479	0.145	2.430	0.365
2nd	1.477	0.125	2.370	0.395
Aver.	1.478	0.135	2.400	0.380

4. Results and discussion

Figure 2 shows the effect analysis of cobalt transport by unsaturation factor n. The higher the value of n-factor is, the more the cobalt concentration was aggregated.

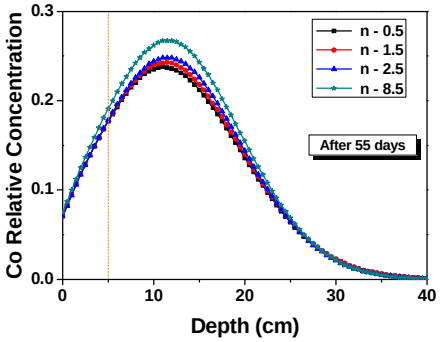

Figure 2. The effect analysis of cobalt transport by unsaturation factor n.

Figure 3 shows the effect analysis of cobalt transport by unsaturation factor α. The larger the value of α-factor is, the faster transport of cobalt be. In addition, the cobalt concentration becomes more aggregation.

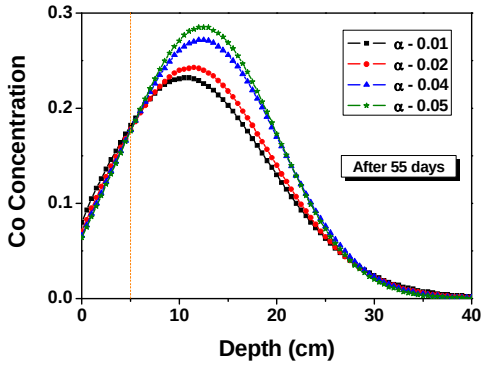

Figure 2. The effect analysis of cobalt transport by unsaturation factor α.

5. Conclusion

We was developed numerical cord in order to interpretation of nuclide-migration in the unsaturated zone. Therefore, the program is possible to analyze the distribution of contamination concentration along depth in the unsaturated zone. It will be also possible to decide a decontamination depth of the contaminated site.

REFERENCES

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