§11. Study on Development of Dynamic Compartment Model for Estimation of Environmental Tritium Behavior at the Site of NIFS

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To assess the impact on public health caused by nuclear fusion facilities, it is necessary to understand the behavior of tritium in terrestrial environment for estimation of internal dose by ingestion of tritium reasonably. Therefore, we are developing a dynamic compartment model to predict tritium behavior in terrestrial environment. In this study, we tried to develop a dynamic compartment model to predict the tritium behaviors in ‘atmosphere – soil – river and groundwater flow’ system at the site of NIFS.

In a dynamic compartment model, the environment for the assessment is described as an assembly of compartments. The environment is divided to some parts, appropriately. Every compartment in the model is corresponding to environmental part. Simultaneous ordinary differential equations are used to describe the change of inventories of tritium in each compartment. In this study, the migration prediction code, MOGRA[1] was used for development of the dynamic compartment model and case studies.

The conceptual illustration of major transfer pathways of environmental tritium considered in this study is shown in Fig. 1. The area considered in the study is upper air and soil of the site of NIFS.

The structure of dynamic compartment model is shown Fig. 2. In this study, both of HT and HTO are considered in air and soil. The wind flow causes inflow and outflow of HT and HTO in air. The HT and HTO in air are deposited into soil by dry deposition or wet deposition mechanisms. The deposited HT from air into soil is oxidized to HTO by a microorganism in soil rapidly. A part of HTO in soil is reemitted into air and the remainder is eliminated from soil by surface flow or infiltration.

For an analysis by using dynamic model, it is necessary to determine the values of the transfer coefficients among compartments, inflow rate into each compartment and outflow rate from each compartment, appropriately. In general, these values were determined by using sub-models and parameters used in the sub-models. The sub-models describe the transfer mechanisms of tritium in the environment. For an estimation of parameter values used in the sub-models, we use some monitoring data and references. For example, it is assumed that the mean concentrations of HT and HTO in air are 8 mBq m^{-3}-air and 4 mBq m^{-3}-air by using recent monitoring data at the site, respectively. The values of some parameter such as deposition velocity of HT and THO were determined with reference to ACUTRI code[2].

The case studies were carried out in a steady-state condition for a validation of the model, sub-models and parameter values. We assumed both of rainy condition and unrainy condition. The amount of eliminated tritium from soil compartment was estimated at 4×10^{5}Bq h^{-1} and 3×10^{4} Bq h^{-1} in rainy condition and unrainy condition, respectively. It was estimated that the mean tritium concentration in outflow water from the site was about 2 Bq L^{-1}. This estimated concentration is several times higher than the measured concentration at the downstream of the site. This result suggests that the model, sub-models and parameters used in this study are appropriate for safety assessment of nuclear fusion facilities because internal dose by ingestion of drinking water is overestimated. However, it was suggested that more detail information and discussion are required for more realistic simulation of tritium behavior in a terrestrial environment. Especially, it is important to understand the behavior of HTO at rainy condition.

1) Amano, H. et al.: J. Nucl. Sci. Technol., 40, (2003) 975-979.
2) Yokoyama, S. et al: JAERI-Data/Code 2002-022 (2002).

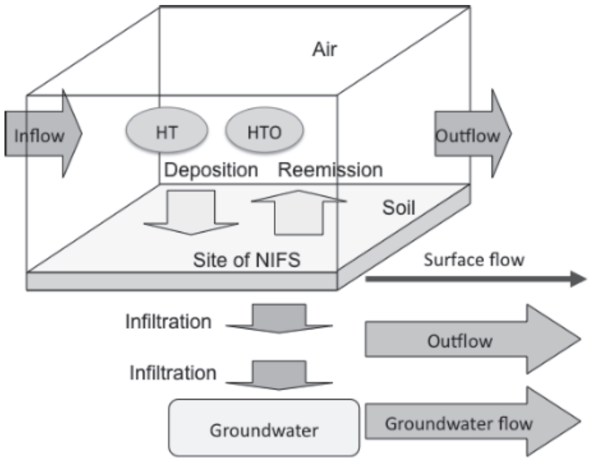

Fig. 1. Conceptual illustration of major transfer pathways of environmental tritium.

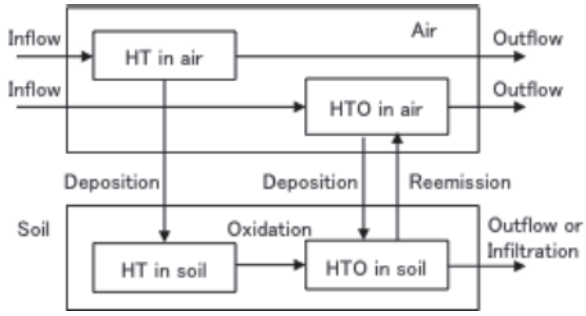

Fig. 2. The structure of dynamic compartment model developed in this study.