Approach to the chelate effect for a safety assessment by MASCOT

Sung Ho Lee, Yong Soo Hwang, Youn Myung Lee
Korea Atomic Energy Research Institute, 1045 Daedeokdaero, Yuseong, Daejeon
Shlee10@kaeri.re.kr

1. Introduction

According to the determination of the Kyungju repository for low-level radioactive waste, KAERI and KHNP are preparing reception criteria for the radioactive waste disposal. It is essential to include several quantitative numerical values for the repository's safety in the criteria. Among many values, chelate is expected to have an effect on the repository system. In this study, the chelate effect on the repository system is assessed using the MASCOT and AMBER codes.

2. Methods and Results

For the study, the existing program is used which was developed for the preliminary assessment of the Kyungju repository. The existing program needs the basic information on solubility limited source term, nuclide inventories, container, buffer, silo, underground flow and other.

2.1 Basic concept of chelate effects for accessment

Chelate agents form stable coordination compounds by the coordinate bonding with a central metal ion. Especially, the formation of a ring type complex is expected that nuclides collected at the ring are not adsorbed in the physical barriers during the travel time. Also, when chelate agents react with metal ions, they usually collect the same number of metal ion.

The above characteristics of chelate compounds make it possible to establish an assessment model.

2.2 Establishment of an assessment model

Based on the characteristics of the chelate compounds, it is possible to establish a scenario in which a metal ion collected by a chelate agent passes the physical barriers irrelevant to the adsorption. To realize the scenario, nuclide inventories are divided into two groups. One is the inventories related to a combination with chelate, the other is the inventories irrelevant to the chelate. It is very difficult to determine the amount of chelate, because there may be various chelate agents. Therefore, the inventories related to chelate are simply determined by the percentage of chelate.

Actually, the contents of chelate to be simulated are determined as 0.1%, 1% and 8%. For example of 8%-chelate, 92% of each nuclide inventory should pass the physical barriers in the process of a sorption and retardation and the other 8% of each nuclide inventory should pass the physical barriers irrelevant sorption.

To express no sorption in the physical barriers, Kd=0 is defined at all physical barriers of the MASCOT program. And then two streams of 92% inventories and 8% inventories are combined in the sea in the follwing figure 1.

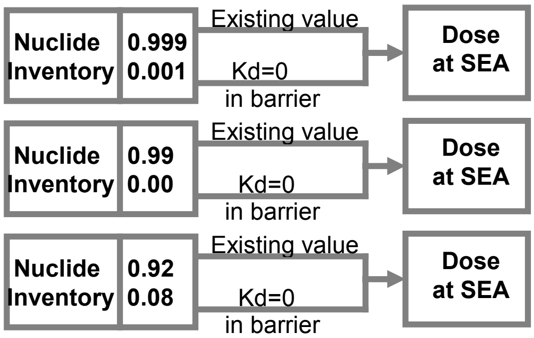

Figure 1. Assessment scheme

2.3 Simulation

Simulations are carried out and a total of 9 assessment results can be obtained from the process time. Each figure shows the final results of the divided inventories.

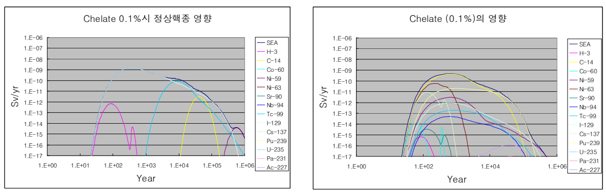

Figure 2. Dose distribution at chelate contents = 0.1%

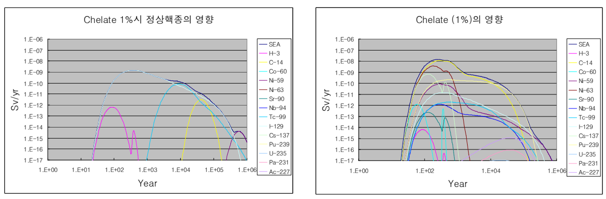

Figure 3. Dose distribution at chelate contents = 1%

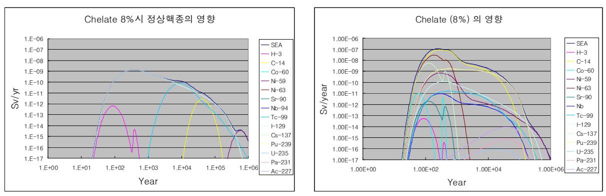

Figure 4. Dose distribution at chelate contents = 8%

In figure 5, the first graph means the total dose combined 0.1% inventory related chelate with 99.9% inventory. The second graph means total combined dose, 8% inventory related chelate with the 92% inventory.

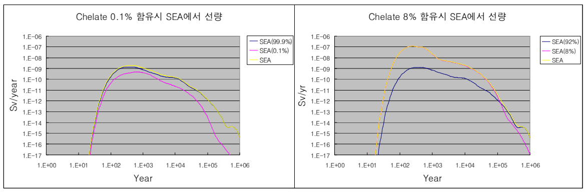

Figure 5. Integrated doses at chelate contents = 0.1% and 8%

2.4 Assessment results

In the process of modeling, molecular weight of chelate can not be determined exactly, because there may be various kinds of chelates. For that reason, it is impossible to define the molecular weight, reactivity and selectivity of chelate with regard to its reaction with a metal ion. In consideration of this limitation;

First, each nuclide inventory graph(90%, 92% and 99%) using an existing value shows that the nuclide transportation results are similar with each other based on the doses in the sea.

Second, each nuclide inventory graph related to the chelate(8%, 1% and 0.1%) shows that the nuclide transportation results are very sensitive to a change of the Kd value.

Third, though the nuclide inventories related to the chelate are small, they can have more effects on the total dose than the major nuclide inventories of (92%, 99% and 99.9%) as shown in figure 5.

3. Conclusion

The chelate effects are assessed by the MASCOT and AMBER codes to establish how much of the chelate effect on the repository.

The results show that chelate can have an effect on the repository safety even though their amount is small. Especially, in case of that Ni-63, I-129 and Pu-239 react with chelate easily, they can be major nuclides which can cause relatively high doses due to a repository.

Also, influences of some nuclides such as H-3, C-14 and I-129 should be reviewed in more detail. In spite of the fact that the above nuclides can not be metal ions, they should be assessed as metal ions like other nuclides.

REFERENCES

[1] F. A. COTTON, G. WILKINSON, C. A. MURILLO, M. BOCHMANN, Advanced inorganic chemistry

[2] J. E. SINCLAIR, P. C. ROBINSON, N. S. COOPER, K.J. WORGAN and K. A. CLIFFE, MASCOT AND MOP PROGRAMS FOR PROBABILISTIC SAFETY ASSESSMENT PART B : MASCOT TECHNICAL DETAILS

[3] J. E. SINCLAIR, P. C. ROBINSON, N. S. COOPER, K.J. WORGAN and J. J. WILLIAMS, MASCOT AND MOP PROGRAMS FOR PROBABILISTIC SAFETY ASSESSMENT PART D : MASCOT USER GUIDE

[4] P. J. AGG, M. J. HOPPER, J. E. SINCLAIR and P. J. SUMNER, MASCOT AND MOP PROGRAMS FOR PROBABILISTIC SAFETY ASSESSMENT PART E : MOP USER GUIDE

[5] J. E. SINCLAIR and P. J. SUMNER, MASCOT AND MOP PROGRAMS FOR PROBABILISTIC SAFETY ASSESSMENT PART F2 : GUIDE TO RUNNING MASCOT AND MOP ON A SILICON GRAPHICS WORKSTATION