A Study on a Computer Code Simulating a Metalization Process of Spent Oxide Fuels

Yun-Hee Lee, Hee-Sung Shin, Ji-Woon Jang, Ho-Dong Kim and Ki-Jung Jung
Korea Atomic Energy Research Institute, 150 Duck-Jin Dong, Yusung-Ku, Daejeon

Using a computer code which simulates a metalization process of spent oxide fuels is very desirable from various aspects before operating the actual process. GC code[1] simulated the pyrochemical process consisting of the reduction, electrorefining, transuranium extraction, and recovery processes, based on 300 batches with a 20kg batch of fuel. We have attempted to develop a computer code for simulating the process with a similar algorithm, apply it to the first batch, and compare our result with that of the GC code[2]. In this study, we conduct a simulation on a batch-by-batch basis of fuel by using our code made with the PV-WAVE programming language and then compare the result with that of a reference[1].

In the algorithm proposed at a reference[2], a chemical process, which reduces the corresponding metal of a spent oxide fuel, was regarded as an ideal process that appropriately deletes large quantities of the Li_2O complicating other reactions, especially at the reduction process. The code[2] has been extended for applying it to 300 batches of fuel. The values of input variables for the simulation have used the data within a database consisting of characteristics on the process, such as the initial quantities of the spent oxide fuels, gibbs free energies, and chemical reaction equations. After the first batch, the reduction salts accepted by the Zeolite module and remaining from the separation module are added to the next reduction module along with the UO_2 filtered from the electrorefining module. Salt makeup and other tanks support the accumulated quantities of the salts or fresh salts into each module to make the chemical reactions available. This procedure is repeated until the 300th batch.

We have compared the results of our code executed on the basis of 300 batches with those of the previous code. Figure 1 shows some important products and their quantities, which were produced and computed at the reduction module for the 1st, 50th, and 300th batch, respectively. Our results are almost the same as those of the previous code within the calculation error. Figure 2 shows the mole fraction values of a few reduction salts, which were the accumulated values of the quantities transformed from the reduction module at each batch. As the batch number increases, the values produced by our code are converged to each specific value as in a reference[1]. It appears that the physical state of the accumulated salts approaches a steady-state.

In this study, the algorithm applied to the chemical process, considered only an ideal process. It is necessary to correct the algorithm, especially because the reduction of some special actinide oxides such as PuO_2 and Am_2O_3, depends on the concentration of Li_2O. Our code thus will be adjusted after reflecting the conditions of the chemical reactions about the process as in detail as possible.

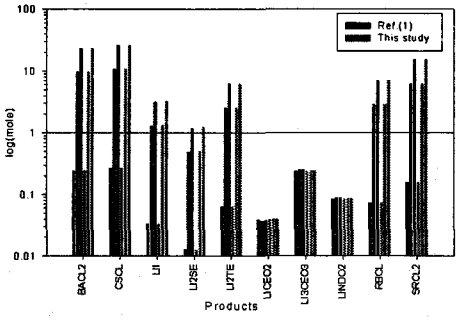

Figure 1. Quantities of the remaining reduction salts after a reduction process at 1, 50, and 300 batch.

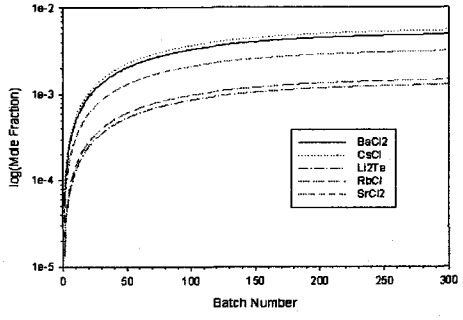

Figure 2. The accumulated quantities of some reduction salts as the number of batches increases.

REFERENCE

[1] RAhluwalia, and H.Geyer, The GC Computer Code for Flow Sheet Simulation of Pyrochemical Processing of Spent Nuclear Fuels, Nuclear Technology, v116, p.180-195(1996).

[2] Yun-Hee Lee, Hee-Sung Shin, Ji-Woon Jang, Ho-Dong Kim, Ki-Jung Jung, A Preliminary Study on the Simulation of a Spent Oxide Fuel Metalization Process, 한국원자력방사성폐기물학회 춘계학술발표회, 논문집, p.(2005).