PARTITIONING TEST FACILITY CONSTRUCTED IN NUCEF

Y. Morita, I. Yamaguchi, T. Fujiwara, K. Mizoguchi, M. Kubota

Radioactive Waste Partitioning Research Laboratory
Department of Chemistry and Fuel Research
Japan Atomic Energy Research Institute

Partitioning Test Facility was constructed in NUCEF (Nuclear Fuel Cycle Safety Engineering Research Facility) at JAERI, Tokai, in order to demonstrate the 4-group partitioning process developed in JAERI using real high-level liquid waste (HLLW). The present paper shows the purpose of the facility, the equipments in the facility and the preliminary results of the partitioning tests with simulated HLLW.

In the partitioning facility, 2 to 20 L of HLLW (5000 Ci at maximum) can be treated per experiment. Main components in the facility are a vessel for denitration, a filter unit, extractors (two 16-stage mixer-settler units), adsorption columns and the related equipments.

Partitioning tests with simulated HLLW are now in progress. The results will be compared with those of the tests with real HLLW. In the latest test, lanthanides were almost completely extracted with DIDPA and well back-extracted with 4 M HNO_3.

1. Purpose of the facility

The main purpose of the facility is to demonstrate the 4-group partitioning process developed in JAERI using real high-level liquid waste (HLLW). The results of the partitioning tests with real HLLW are compared with those of the tests with simulated HLLW. The comparison and the further examination on the properties of real HLLW and on the influence of radiation would give validity and limitation of the experiments with simulated HLLW, which have been carried out before and will be performed in the future from the viewpoints of basic chemistry and chemical engineering.

The facility will be used also for the test of the optimized or advanced process and a new partitioning process to which new extractants, new adsorbents and new methods are applied. The facility has enough flexibility.

2. The 4-group partitioning process

The flow scheme of the 4-group partitioning process is shown in Fig. 1. In this process, elements in HLLW are separated into four groups: transuranium elements (TRU), Tc - platinum group metals (PGM), Sr - Cs and the other elements. For the TRU separation, extraction with diisodecylphosphoric acid (DIDPA) has been studied. One of the extraction process established is shown in Fig. 2, which includes the separation of Am, Cm from lanthanides by selective stripping with diethylenetriaminepentaacetic acid (DTPA). For the separation of Tc and PGM, two methods were studied; one is the precipitation by denitration and the other is the adsorption with active carbon. An adsorption method with inorganic ion exchangers (titanic acid and zeolite) was developed for the separation of Sr and Cs.

3. Outline of the facility

In the partitioning facility, 2 to 20 L of HLLW (5000 Ci at maximum) can be treated per experiment. The reprocessing facility, which was installed in the same hot cell in NUCEF, will provide real HLLW. The partitioning facility can also accept HLLW from other reprocessing plants.

Main components in the facility are Denitration and Concentration Vessel, Filter Unit, Extractors, Adsorption Columns and the related equipments. In the Denitration and Concentration Vessel, 6 L of HLLW can be concentrated and 2 - 3 L of HLLW can be denitrated. Precipitates formed in this vessel are separated by sintered-metal filter in the Filter Unit. Two 16-stage mixer-settler units are installed for the separation of TRU from HLLW. The process to be tested with these extractor units is composed of the following three steps: extraction with DIDPA, back-extraction with 4 M HNO_3 and back-extraction with $H_2C_2O_4$, steps surrounded by broken lines in Fig. 2. Other steps of extraction and back-extraction can also be tested by changing the reagents and by changing the mixer-settlers if required. Particularly, the separation of Am, Cm from lanthanides by selective stripping with DTPA is one of the most important items to be tested in the future. The Adsorption Columns can be used in two adsorption processes; one is adsorption of Tc and PGM with active carbon and the other is adsorption of Sr and Cs with inorganic ion exchangers. Precipitation of Tc and PGM by denitration is also examined using the Denitration and Concentration Vessel.

The flow sheet of the partitioning test facility is shown in Fig. 3. The facility is also equipped with a vessel for oxalate precipitation.

4. Partitioning tests with simulated HLLW

Partitioning tests with simulated HLLW are now in progress. The results will be compared with those of the tests with real HLLW, as mentioned above. The tests with simulated HLLW showed that all the components in the facility could be operated safely and remotely.

In the latest test, phosphoric acid was added to HLLW before denitration as pre-treatment for the DIDPA extraction in order to completely remove Zr, which sometimes disturbs the DIDPA extraction. About 99.5 % of Zr were removed from the simulated HLLW as a precipitate in this pre-treatment step. In the DIDPA extraction step, lanthanides were almost completely extracted with DIDPA and well back-extracted with 4 M HNO_3. Table 1 shows fractional distribution of each element. The ratio of Nd extracted was more than 99.99 %. Since the extraction behavior of Am is very similar to that of Nd, Am would also be extracted with the high yield in this step. The back-extraction of lanthanides was not complete but would be improved by

adding one more stage (presently 5 stages) and/or by raising temperature. Other elements except Fe were not extracted and therefore well separated from lanthanides. Fe was stripped from the solvent in the second back-extraction step with $H_2C_2O_4$ with a yield of 99.8 %.

Element behavior at the following steps in the 4-group partitioning process will be investigated in the next test.

5. Future plan

In 1996 - 97, tests with some tracers (^{237}Np, ^{99}Tc, etc.) in simulated HLLW will be performed to examine the behaviors of the elements that are not contained in the simulated HLLW. Partitioning tests with real HLLW are scheduled in 1998. The separation of Am and Cm from lanthanides will be included in the test with real HLLW. Further, the facility will be used for the test of a new partitioning process with real HLLW.

Table 1 The fractional distribution (%) of each element at the DIDPA extraction step in the partitioning test with simulated HLLW at NUCEF.

Element	Raffinate	Back-extracted with 4M HNO_3	Solvent
Y	< 0.002	5.6	94.4
La	< 0.06	> 99.93	< 0.01
Nd	< 0.01	98.7	1.3
Gd	< 0.04	97.5	2.5
Fe	4.64	0.52	94.84
Ru	98.7	0.2	1.1
Rh	> 99.0	0.9	< 0.1
Pd	98.2	0.8	1.0
Sr	> 99.98	0.02	< 0.001
Ba	> 99.99	0.01	< 0.001
Rb	> 99.96	< 0.03	< 0.01
Cs	> 99.90	< 0.07	< 0.03

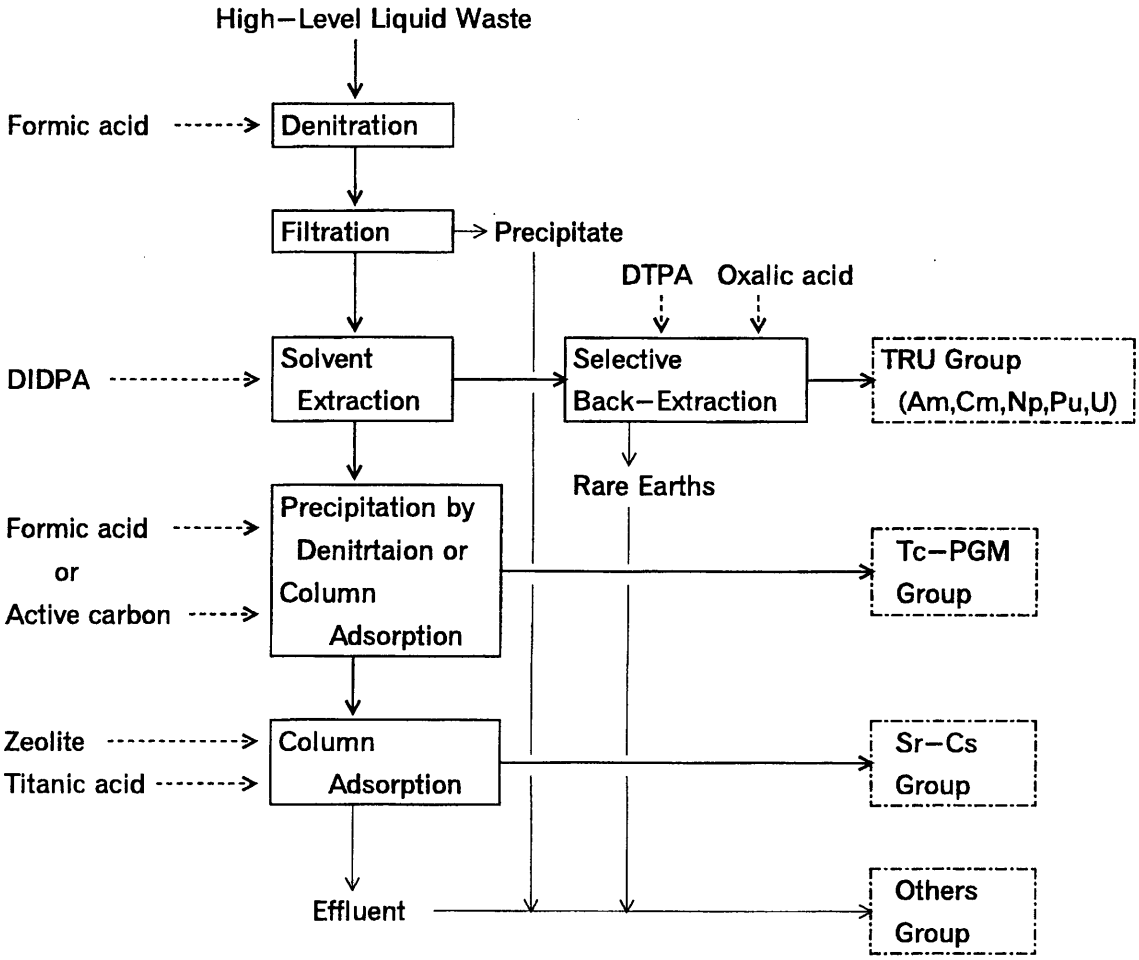

Fig. 1 The 4-Group Partitioning Process to be tested in NUCEF using real high-level liquid waste

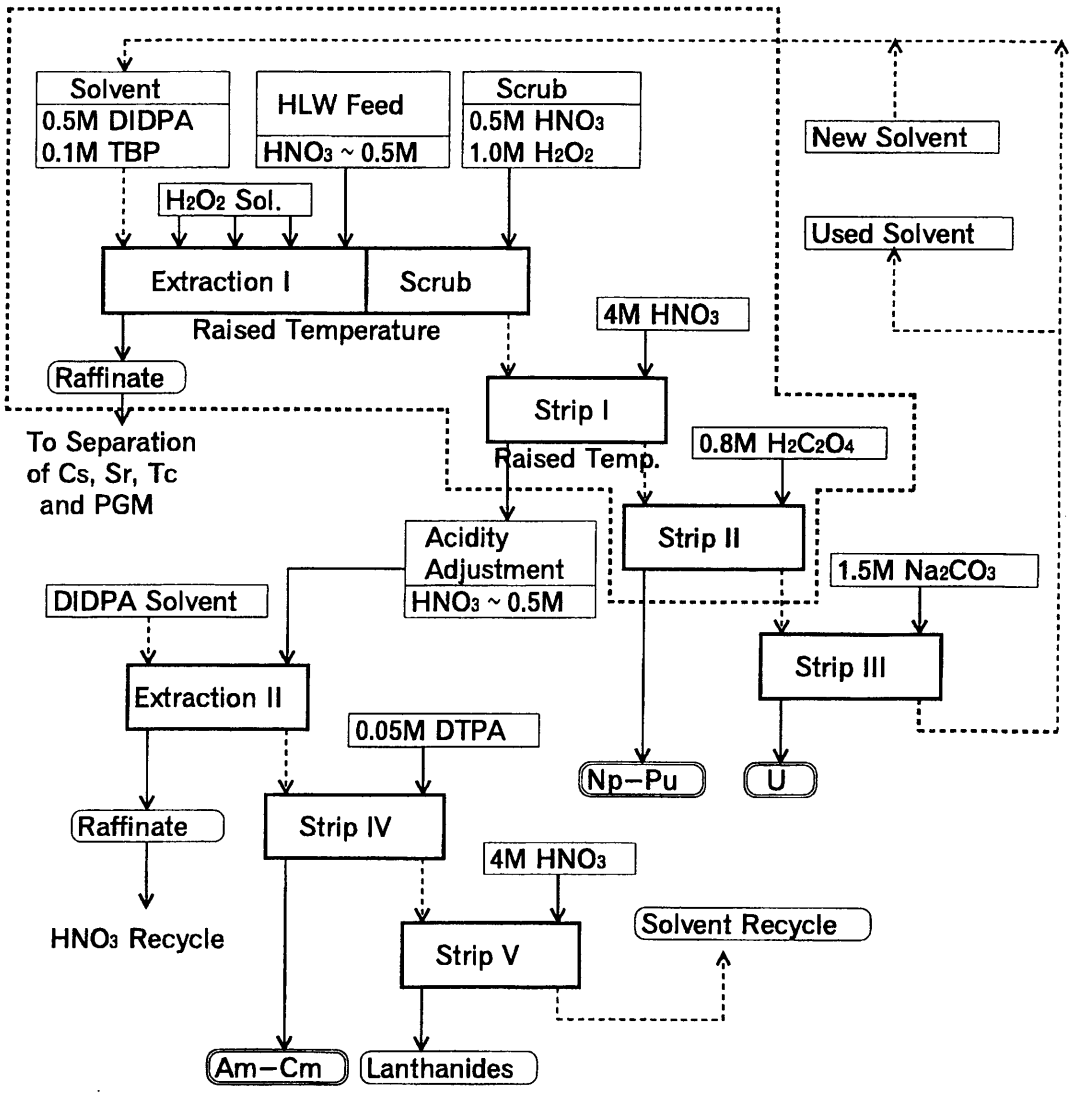

Fig. 2 DIDPA Extraction Process including the Separation of Am and Cm from Lanthanides. – Two-Cycle Process –

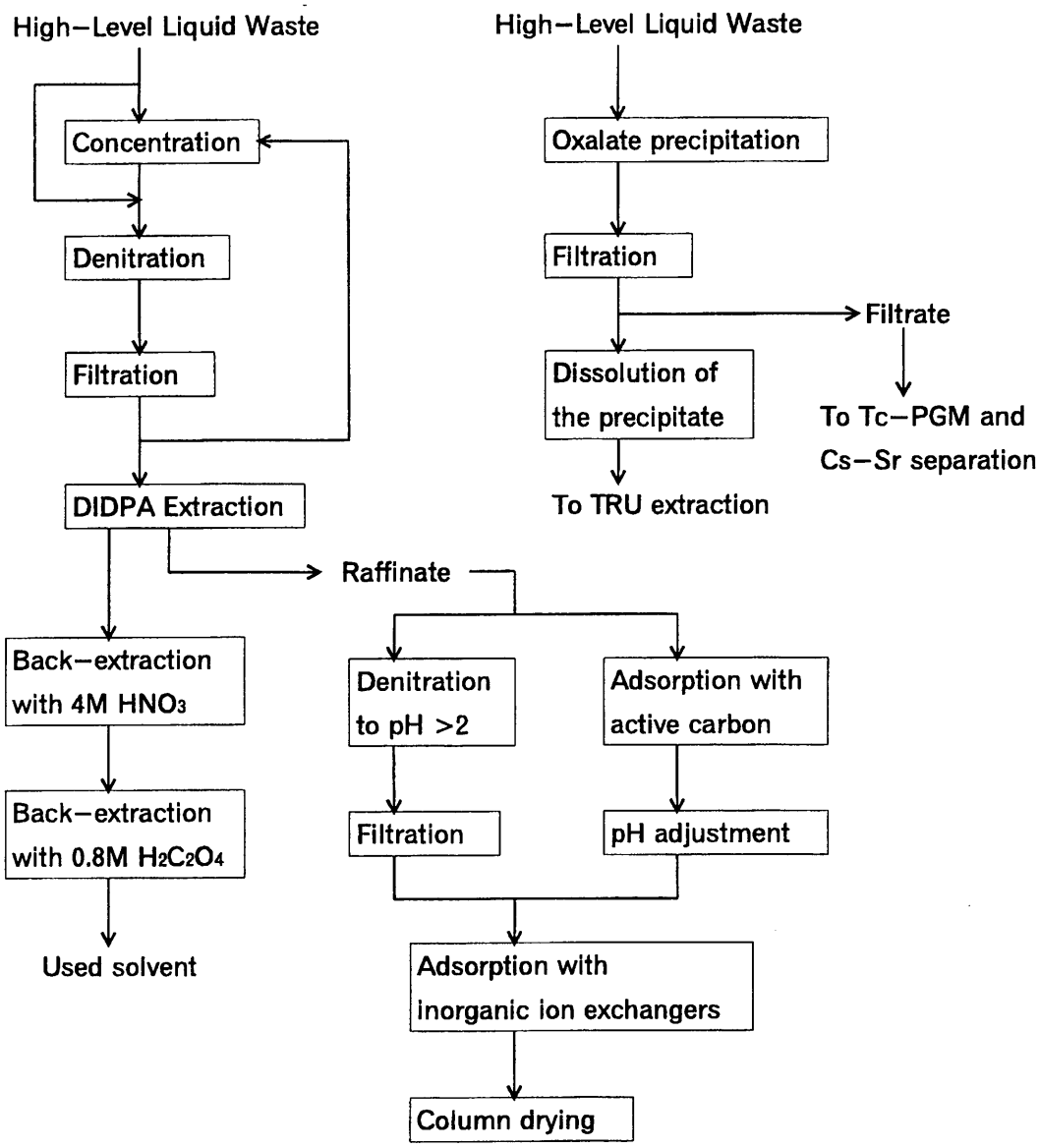

Fig.3 Flow Sheet of the Partitioning Test Facility in NUCEF