REFERENCES

1. HENRY C. OTT, "Comments on 'Economic Alternatives for the Long-Term Use of Plutonium Produced in Light Water Reactors,'" *Nucl. Technol.*, **34**, 461 (1977).

2. K. HNILICA, H. P. HOLLEY, K. LAHNER, and H. SCHMALE, "Economic Alternatives for the Long-Term Use of Plutonium Produced in Light Water Reactors," *Nucl. Technol.*, **31**, 53 (1976).

A SHORT-DURATION LEACH TEST FOR RADIOACTIVE WASTE FORMS

The leach resistance of solid forms of radioactive waste is of major importance in determining the release rate of radioisotopes during long-term storage. Hespe[1] proposed the standard International Atomic Energy Agency leach test to provide a comparison of the leachability of the various forms of radioactive waste being developed. This test requires leaching for ~24 h (depending on pH of leachate) and analysis of the leachate for cations of interest by atomic absorption spectroscopy (AAS).

During the course of the Sandia program for solidification and consolidation of liquid radioactive waste by ion exchange with a hydrated titanate complex, a large number of samples were generated. The leach test proved to be the most time-consuming step in the evaluation of the various samples. By experimenting with various exposure times, it became apparent that in the case of crushed or powder samples, measurable leaching took place in a very short time. Those observations and the advantage of having a test of short duration led to the development of the instantaneous leach test.

The instantaneous leach test consisted of placing a crushed sample (not screened) into a 25-ml Royal Berlin Porcelain filter crucible with a porous bottom, with an average pore size of 7 μm, and pouring 100 ml of deionized water through with the aid of suction. Sample sizes of 1 g or less were used, and flow was adjusted to give water contact times of 3 to 4 min. Weight loss was determined on the sample, and AAS was used to analyze the leachate. The samples were dried for 1 h at 110°C and cooled in a desiccator for 0.5 h prior to weighing. A complete set of data can be obtained within 4 h depending on the number of elements analyzed for in the leachate. The results are typically expressed as grams of a given element leached per gram of sample, e.g., grams of cesium leached per gram of sample. The results can also be expressed as the fraction of an element leached from the sample.

The instantaneous leach test has proven to be surprisingly reproducible, considering that no attempt is made to control or determine the surface area of the sample. The results for three separately hot-pressed pellets (A1, A2, and A3) of the same material are shown in Table I. The scatter in the results are well within the acceptable error for measurements of this type. Comparison of A and B demonstrates the wide range of leachabilities encompassed by this test, while B1 and B2 demonstrate the reproducibility of the method for materials that are highly leachable. A total mass balance was not attempted because the number of elements of interest was limited. The apparent discrepancy in the mass balance is due in part to the ionic species that is leached, i.e., molybdenum, which is present as molybdate compounds in the solid. Any other differences may be due to leaching of other anionic species, the loss of small particles through the filter, or experimental error.

TABLE I
Short-Time Leach Test Data for Various Crushed Pellet Waste Forms

Sample	Total Mass Loss (mg/g)	AAS Elemental Analysis (mg/g)		
		Na	Cs	Mo
A1	0.09	0.038	0.007	0.010
A2	0.14	0.016	0.006	0.005
A3	0.12	0.016	0.005	0.006
B1	15.4	1.7	4.7	5.3
B2	14.7	1.3	5.2	4.9
C	5.5	0.47	2.2	1.6
D (-Mo)	0.25	0.009	0.03	ND[a]
E	17.9	1.6	5.9	5.8
E+ 5% glass	6.2	1.0	0.82	2.5
E+ 30% glass	0.72	0.16	0.017	0.25

[a]Not detected.

The instantaneous leach test was also important for evaluating the effects of composition on the leaching behavior. Samples C and D in Table I demonstrate the effect of molybdenum on the leachability of cesium. Sample D is the same as sample C except that it contains no molybdenum. The E sample series demonstrated the effect of 5 and 30 wt% additions of borosilicate glass on sample leachability. The glass was added to serve as a consolidation aid.

It must be emphasized that the instantaneous leach test reveals nothing of the long-term or high-temperature behavior of a sample, which can be varied and complex. Also, due to the randomness of the sample and unknown surface areas, the data are not comparable to those of Hespe or any other standard leach test. However, the test has proven to be a highly reliable, self-consistent means for quickly screening and order ranking materials in a development program. Candidate materials can then be subjected to the more exhaustive, longer time leach tests.

A. W. Lynch

Sandia Laboratories
Albuquerque, New Mexico 87115

March 4, 1977

ACKNOWLEDGMENT

This work was supported by the U.S. Energy Research and Development Administration.

REFERENCE

1. E. D. HESPE, "Leach Testing of Immobilized Radioactive Waste Solids," *At. Energy Rev.*, **9**, 195 (1971).