Development of a Methodology for the Determination of Metal Reduction Yields of Highly Radioactive Nuclear Fuel

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1. Introduction

One of the key steps of pyroprocessing is electrolytic reduction of metal oxide fuel into metallic form. In this step, an appropriate analytical method is required to measure the metal conversion yield of the electrolytic reduction process product. One needs to develop a reliable analytical method to determine the metallic constituents in the metal and oxide mixtures. And system establishment for the implementation of chemical analysis of highly radioactive pyroprocessing materials has become an imminent task.

2. A Standard Procedure for Selective Dissolution of metallic phases by bromine method

One of the important task for chemical analysis is determination of metallic contents in multi-component composite materials like reduced spent fuel ingot. A general approach to solve this problem is to dissolve the metallic form selectively from its oxide form and analyze the dissolved contents. For the determination of uranium, a method of selective dissolution of metallic uranium by bromine-ethyl acetate has been proposed and has been applied for various purposes.

A standard bromine method has been established to meet the process materials for Korean concept of pyro electrolytic metal reduction process.

By applying the selective dissolution method in bromine-ethyl acetate solution together with total dissolution technique, it is proved possible to determine the metallic conversion yields of actinides and lanthanides elements in the samples of electrolytic reduction process for spent nuclear fuel. And finally a standard bromine method procedure has been established, and applied to the samples from PRIDE and ACPF facilities.

3. Shielded ICP-AES system

A shielded ICP-AES system has been established. A home-made glove box system was interfaced with ICP-AES spectrometer, and performance test has been done. A standard operation manual of the system has been prepared. And a radiation resistant, hot cell space saving, modular type centrifuge has been designed and built for use inside of the chemical hot cell. And radiological assessment of hot pyrochemical samples has been done to assist minimization of radiation exposure and radioactive wastes during the chemical analysis works.

A shielded ICP-AES system, chemical hot cell and apparatus will be effectively used to provide chemical analysis data of highly active pyroprocessing materials. Fig. 1 shows the installed shielded ICP-AES system in operation.

Fig. 1. Operation of shielded ICP-AES system.

4. Conclusion

A shielded ICP-AES system, chemical hot cell and apparatus will be effectively used to provide chemical analysis data of highly active pyroprocessing materials. Various samples of importance from pyro process streams have been characterized and quantified by applying the developed chemical pretreatment method and instrumental techniques.

REFERENCES

[1] Young Hwan CHO et al “Determination of lanthanide metallic contents by selective dissolution in bromine-ethyl acetate solution”, KAERI/TR-5299/2013 (2014).