SEPARATION OF SOME BURN-UP MONITORS FROM THE UO$_2$-Al NUCLEAR FUEL*

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The separation of caesium, cerium, neodymium, europium and uranium from the UO$_2$-Al fuel samples has been studied. Experiments were carried out with unirradiated and irradiated fuel samples. The dissolved samples contained a large excess of aluminium with respect to uranium (the molar ratio Al : U was $\sim 17 : 1$). The presence of aluminium particularly disturbed the chromatographic separation of the lanthanide burn-up monitors. The latter were separated from uranium and aluminium and from one another using the precipitation method with a cerium carrier, followed by extraction with HDEHP and a column separation with the same extractant. Aluminium and uranium first were determined together as precipitates with 8-hydroxychinoline, and then the uranium contribution was independently assayed potentiometrically with a K$_2$Cr$_2$O$_7$ solution.

Introduction

The first step in the radiochemical and mass spectrometric determination of nuclear fuel burn-up is the separation of the particular fission products, uranium and plutonium from irradiated fuel. The more important burn-up monitors currently used in our Laboratory are given in Table 1. The nuclear fuel currently used in the Polish reactor "EWA" is a UO$_2$-Al dispersion with an enrichment of $\sim 36\%$.

The selective methods developed for the separation of these fission products and uranium from the UO$_2$-Mg fuel formerly used in the reactor

"EWA"\textsuperscript{1-5} could not be used directly because of the disturbing influence of aluminium in the fuel solutions. Indeed, solutions of dissolved UO\textsubscript{2} - Al fuel contain a large amount of aluminium, the presence of which significantly effects the chromatographic separation of the lanthanide fission products: cerium, neodymium and europium.\textsuperscript{6}

In this paper experiments are described on the determination of the chemical composition of the UO\textsubscript{2} - Al fuel, and on the separation of uranium and the fission products Cs, Ce, Nd, and Eu from unirradiated and irradiated fuel samples.

**Experimental**

**Dissolution of the fuel**

The dispersion of UO\textsubscript{2} - Al fuel can be dissolved in HNO\textsubscript{3} using a mercury catalyst or applying a mixture of HCl and HNO\textsubscript{3} without any catalyst. The latter was used in our experiments. The fuel sample (0.3030 g) was placed in a 25 ml pycnometer and 6 ml of 4M HCl was added dropwise, applying water cooling. After the aluminium had been dissolved (hydrogen bubbling ceased), 5 ml of 10M HNO\textsubscript{3} was added to the flask. After half an hour the clear pale-yellow solution was made up to 25 ml with water. The mass of this solution was 26.9592 g and the fuel concentration was 11.2392 mg/g solution. From this stock solution uranium and aluminium were determined.

**Determination of uranium**

From among a number of methods for the determination of uranium the one described by Davies and Gray\textsuperscript{7} and modified by Mareška\textsuperscript{8} was used. The end-point of titration, however, was detected potentiometri-