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Safety aspects of fabrication of Americium-Plutonium Oxide pellets in a glovebox



SAFETY ASPECTS OF FABRICATION OF AMERICIUM-PLUTONIUM OXIDE PELLETS IN A GLOVEBOX


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INTRODUCTION

Oxide fuels for Generation IV systems and BMF (Boron Matrix Fuel) may contain high concentrations up to 50% of plutonium and minor actinides. High concentrations of plutonium in oxide fuels strongly limit the solubility in nitric acid. However, the effect of the Minor Actinides content (specifically Am) on the dissolution capability is still unknown. For this effect forms a crucial aspect in the design of a reprocessing. Row-act for oxide fuels for Generation IV systems, as well as for BMF. The objective of the research is to study the basic dissolution properties of oxide fuels with a high concentration of minor actinides. This enables establishing a relationship between Am content and dissolution capability, addressing open issues concerning the maximum achievable Minor Actinide content in fuels and targets for transmutation purposes.

Within this research, fresh Am-Pu oxide fuel pellets had to be prepared by powder metallurgy method. NRG operates an actinide laboratory equipped with gloveboxes and analytical apparatus for actinide (U, Pu) research. In case of Am-241, the pellet fabrication by powder metallurgy (done by hand) is quite challenging in terms of radiation protection, as Am-241 is an alpha and gamma emitter. The standard glove box does not give sufficient protection against gamma radiation.



EXPERIMENT

EQUIPMENT


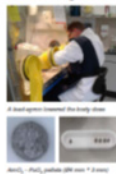
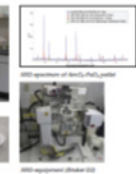
The glove box is developed by Kwest Engineering BV in the Netherlands. It is made from stainless steel, with two FRMA 12 mm windows. The additional shielding is provided by addition of lead-glass with lead - equivalent of 5.2.5mm PLYTON.

A special coating (Teflon, Swaston) was applied inside the glovebox on the floor and on the walls to make the cleaning and decontamination after fabrication campaign easier.

The glovebox is equipped with Plexen Lead free shielding gloves for protection against low gamma radiation.

FABRICATION AND CHARACTERIZATION

The fabrication of the pellets has been done by powder metallurgy method. The fuel pellets with 20 wt% on 50 wt% AmO₂ in PuO₂ have been characterized by density measurements (immersion method) and the chemical composition was checked by X-Ray absorption (ED, Bruker - custom made, placed in a dedicated glovebox).

A lead light barrier for the body dose.

AmO₂ - PuO₂ pellets (20 wt% Am)

AmO₂ equipment (20 wt% Am)

DOSE

DOSE CALCULATIONS

We did several dose calculations after measuring the contact and distance dose of the stock amount AmO₂ (2.8 g). The pellets fabrication starts with 0.75 and 0.45 g AmO₂.

Calculations in regular glovebox	Dose calculations		Regular glovebox		New construction	
	AmO ₂ (2.8g)	AmO ₂ (0.75g)	AmO ₂ (0.75g)	AmO ₂ (0.45g)	AmO ₂ (0.75g)	AmO ₂ (0.45g)
contact dose	800	27	27	15	15	15
10 cm distance	10	0.3	0.3	0.15	0.15	0.15
100 cm distance	0.1	0.003	0.003	0.0015	0.0015	0.0015

* measured dose


REGISTERED DOSE

Body: The fabrication has been done by two technicians. The body dose has been registered by beta/gamma detectors to record the body dose obtained by beta and gamma radiation. An electronic dosimeter with an alarm function was used to measure gamma radiation and to warn workers if the dose rate would be above 20 µSv/h. The body dose per worker stayed below 20 µSv.

Finger: Finger dosimeters, type ring, have been used to register the finger dose. These dosimeters register both beta and gamma radiation dose. Finger doses of 1.6 and 1.8 mSv, respectively, have been reported for the technicians.

Both doses are well below the calculated and limit doses. This demonstrates that with the correct preparations and protective equipment, it is possible to handle and process limited amounts of AmO₂ in a glovebox in a safe and secure way.




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