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RERTR ACTIVITIES IN ARGENTINA

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ABSTRACT

The Atomic Energy Commission of Argentina has been involved in the Reduced Enrichment for Research and Test Reactors Program since 1978. The most relevant milestones of the program, regarding fuel R&D activities, were the development and manufacturing at industrial scale of U_3O_8 dispersed fuel assemblies and the conversion of the RA-3 reactor core to LEU fuel.

More recently, the activities were focused in the development of high density U_3Si_2 fuel with a density of 4.8 gU/cm^3 and the improvement of the manufacturing process of U_3Si_2 powder.

Currently one of the main objectives is to develop and qualify the technology for the production of high-density LEU fuel elements using U-Mo alloy. Several alternative ways to obtain U-Mo powder are under development with the aim of evaluating plant scale production and costs.

To boost this program the main research reactor of Argentina, the RA3, will be upgraded to 10 MW early in 2001 and the hot cells at the Ezeiza Atomic Center are fully operational after important investments.

Significant progresses were also carried out in the development of LEU targets for the production of Mo^{99}. Experimental work has demonstrated the feasibility of the manufacturing and radiochemical processing of miniplate targets prepared with dispersed U-Al_x, maintaining the geometry and the alkaline processing of the HEU targets used so far.

1 Introduction

The National Atomic Energy Commission of Argentina (CNEA) started its involvement in the Reduced Enrichment for Research and Test Reactors Program more than twenty years ago. Since then important achievements were obtained and many activities are in progress, some of them under the framework of the cooperation with the USA Department of Energy and the Argonne National Laboratory.

This paper reminds the milestones of the program and describes an overview of the current RERTR activities pointing specially at the ongoing R&D and qualification programs on the new U-xMo fuel and the LEU target material for Mo^{99} production.

2 Milestones

The most relevant achievements of CNEA under the RERTR framework, regarding fuel R&D activities, were probably the development and manufacturing at industrial scale of U_3O_8 dispersed fuel assemblies and the RA-3 research reactor core conversion to LEU fuel.

The experience obtained through the studies performed in the reactor and fuel areas allowed the Argentine nuclear system to establish bilateral works with another developing countries and also to develop a significant commercial activity.

As important as the above mentioned experience was the development of UF_6 conversion to U_3O_8 which is an alternative option to guarantee a stable supply of the fissile material.

3 High Density Fuels Programs and Facilities

The development and qualification of the technology associated with the fabrication and utilization of high-density MTR fuels and its implementation in Argentine research and radioisotope production reactors is allowing CNEA to fulfil satisfactorily the new requirements of international customers.

When the development and manufacturing at industrial scale of U_3O_8 fuels was completed the activities were focused in the development of high density U_3Si_2 fuel with a density of 4.8 gU/cm^3 and the improvement of the manufacturing process to obtain the U_3Si_2 powder.

During the last years and according with the international trend in this field, CNEA started with the development of a new type of fuels bearing very high density fuel materials (U-xMo).

3.1 U_3Si_2

The program to qualify the technology and the facilities developed by CNEA for the production of silicide fuels includes the following stages:

- Development and improvements of the process to obtain the uranium silicide fissile material
- Fabrication and irradiation of miniplates
- Manufacturing of full size fuel plates
- Full scale fuel irradiation

The completion of the first three stages of this program was reported in previous RERTR Meetings (1) and RRFM Topical Meetings (2). The irradiation stage is taking place in the Argentine RA3 reactor. At the present there is no evidence of any undesirable behavior or fuel failures related with the new type of fuel material. The fabrication of a silicide fuel element with thinner plates started recently and the fuel assembly will be ready for irradiation early in 2001.

3.2 U-xMo

Nowadays one of the main objectives is to develop and qualify the technology for the production of high-density LEU fuel elements using U-xMo alloy.

The first activity within this program is the adjustment of fuel plates manufacturing using natural U-8Mo powder supplied by KAERI and prepared by the centrifugal atomization process. The set up of U-Mo fuel plate fabrication is expected to be consolidated by the end of 2000.

The next step will be the fabrication and irradiation of full-sized fuel elements. To fulfil this objective fuel plates will be fabricated using LEU U-8Mo also from KAERI. At the present it is planned to build three full-sized fuel elements for irradiation in the RA-3 reactor. The target burnup will be 50-70 % and the irradiation of the first of these fuel elements is expected to start during 2001.

Another important activity related with the U-xMo program is the development of alternative U-Mo fabrication routes. Several options are under consideration with the aim of evaluating plant scale production and costs. Some of these alternatives require a first instance research work and some are proposed improvements of well-known processes. Mechanical alloying, spark erosion, wheel grinding and cyclonic centrifugal atomization (CCA) are included in these developments. Hydriding and dehydriding technique is also included. The initial results and considerations about this process are reported in (3). Figure 1 shows a typical picture of U-Mo particles obtained with this method. The activities related with the alternative routes will include full testing and irradiation with U-Mo powder coming from different routes and finally the development of powder specifications. The main characteristics under analysis are the shape and size distribution of the U-Mo particles and the content of impurities.

The program requires also the development of U-Mo fuel qualification criteria and licensing requirements. In the same way are to be considered the different items that need to be addressed in the Safety Report.

3.3 Facilities for the High Density MTR Fuel Program

3.3.1 Fuel Fabrication Plant

As was previously reported (1), the fabrication facilities were improved and upgraded in the past years with the aim of setting up the equipment necessary for silicide material fabrication. The main improvement involved the ventilation system of the fuel fabrication glove boxes to ensure a protective, low oxygen atmosphere for silicide fuel manipulation. The induction furnace for silicide material preparation is fully operational. The new equipment for particle size adjusting and for quality control inspection of silicide fuel plates and fuel assemblies is fully available and has been used for silicide fuel fabrication during this year.

3.3.1 RA-3 Research Reactor

As was reported elsewhere the RA-3 reactor is a pool type, refrigerated and moderated with light water. Cooling is provided by down-going forced convection. The present nominal power is 5 MW which is reached with an equilibrium configuration of 25 fuel assemblies. Early in 2001 the reactor power will be upgraded to 10 MW. This fact will boost considerably the qualification program of high density fuels. The feasibility of U-Mo 9 gU/cm^3 fuels irradiation in this reactor under the future operating conditions has already been analyzed and demonstrated (4).

3.3.2 Hot Cells

The hot cells are located in the Ezeiza Atomic Center, near Buenos Aires City. Two lines of cells for gamma active materials and gas-tight boxes for alpha-gamma active fuel materials are already available (See Figure 2). Four working stations are fully operational in the alpha-gamma line. A complete metallographic microscope is also available in an annex cell.

The hot cells have already been used for the non-destructive examinations of P-04, the first silicide fuel element manufactured in Argentina. An special device was developed for dismantling the fuel assemblies. Figure 3 shows this device in which fuel plates may be separated for inspection without producing any waste.

3.4 Improvement of Fuel Behavior Codes

As part of a collaboration agreement between ANL and CNEA, held by the Implementation Arrangement for Technical Exchange and Cooperation in the Area of Peaceful Uses of Atomic Energy, a new enhanced, visual version of DART code was developed (5). DART is a successful mechanistic model based code, developed by J. Rest, for the performance calculation and assessment of aluminum dispersion fuel. The present version, available for silicide and U-Mo fuels, adds to the classical accuracy of DART models for fuel performance prediction, a faster execution due to a new, time saving calculation routine, able to be run on a PC, a friendly visual input interface and a plotting facility.

4 LEU Targets for Mo^{99} Programs

Significant progresses were also obtained in the development of LEU targets for the production of Mo^{99}. As is already known, the general objective of this part of the RERTR program is the replacement of the HEU targets using LEU 20% U^{235}.

Experimental work has demonstrated the feasibility of the manufacturing and subsequent radiochemical processing of miniplate targets prepared with dispersed U-Alx, maintaining the geometry and alkaline processing of the HEU targets used so far.

4.1 Miniplates

To replace the HEU targets, miniplates with uranium aluminide disperse in Al and with a density of 3 gU/cm^3 were developed. Miniplates were manufactured using the standard process for plate manufacturing: Melting U and Al to obtain UAl_2, milling, mixing and pressing to obtain the compact and framing and hot and cold rolling to fabricate the miniplates.

The feasibility of the replacement of HEU was demonstrated without changing the geometry of the target and using the same radiochemical treatment to obtain the Mo^{99}. The characteristics of the miniplates fabrication and the Mo^{99} recovery process are reported in (6) and (7).

4.2 Foils

The development of LEU Metal Foil Targets for the production of Mo^{99} is being performed also under the framework of the cooperation between ANL and CNEA. Activities included in this work are the development and fabrication of LEU foil test targets, irradiation and examination of test targets, design and fabrication of targets for industrial irradiation, development of a dissolving process, construction and testing of a dissolver system, development of Mo-recovery and purification process for LEU. The demonstration of the entire process is foreseen and also the final economic assessment of the conversion to LEU. The program is expected to be completed by the end of 2002.

5 Shipping RA-3 Spent Fuel to USA

As part of the program for the shipping of RA-3 spent fuel to USA, the inspection of 207 HEU MTR spent fuel assemblies was performed at the storage site at the Ezeiza Atomic Center. The inspection, carried out during October 1999, was performed by CNEA and Westinghouse Savannah River Company with support of DOE-Savannah River Operations Office.

The objective of the inspection was the characterization of the fuel condition to check acceptance criteria for transportation compliance, structural integrity and deformations. The condition of the fuel assemblies was found satisfactory for handling, shipment and storage in the Savannah River Site. A detailed description of inspection works is reported in (8).

6 Conclusions

As a result of the active involvement of CNEA in the RERTR program, a remarkable progress in different fields may be reported for the 1999-2000 period. The facilities to complete the qualification of high density MTR fuels are fully operational and equipped to perform all needed tasks. CNEA is carrying out a very active U-Mo development project that will include full scale fuel irradiation starting in 2001. Another activities like the replacement of HEU targets using LEU 20% U^{235}, Mo^{99} production from LEU Metal Foil targets and the shipping of the RA-3 Spent Fuel to USA within the acceptance program are well advanced.

7 References

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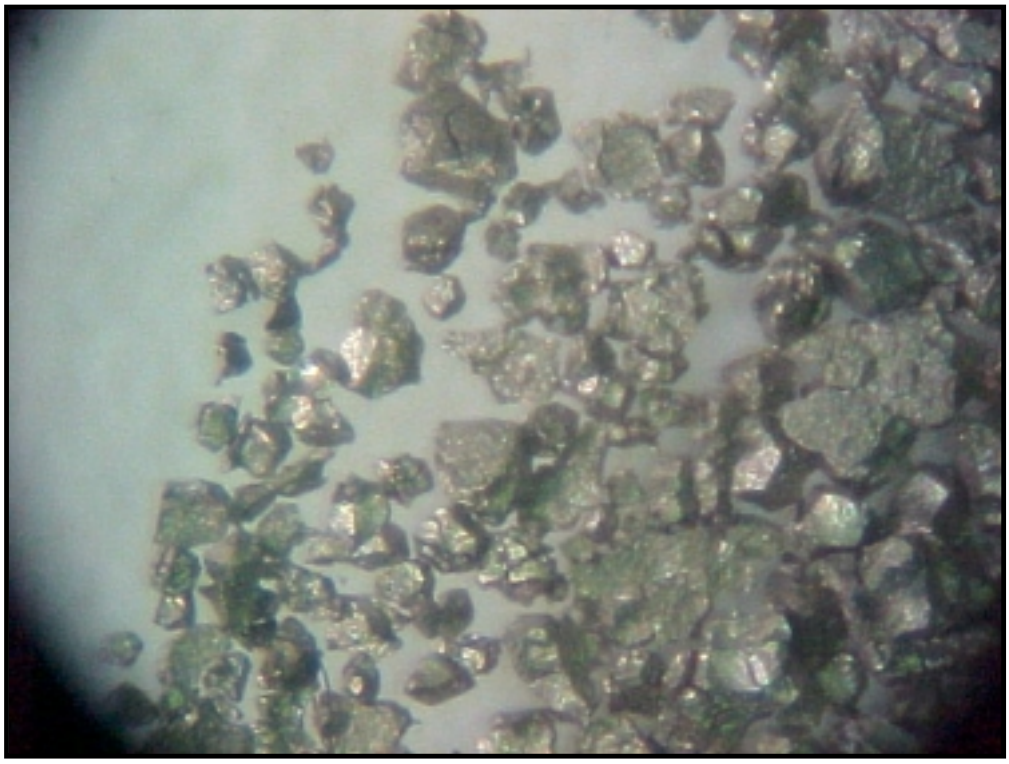

Figure 1: Typical picture of U-Mo particles obtained with the hydriding and dehydriding method.

Figure 2: General view of the hot cells at Ezeiza Atomic Center.

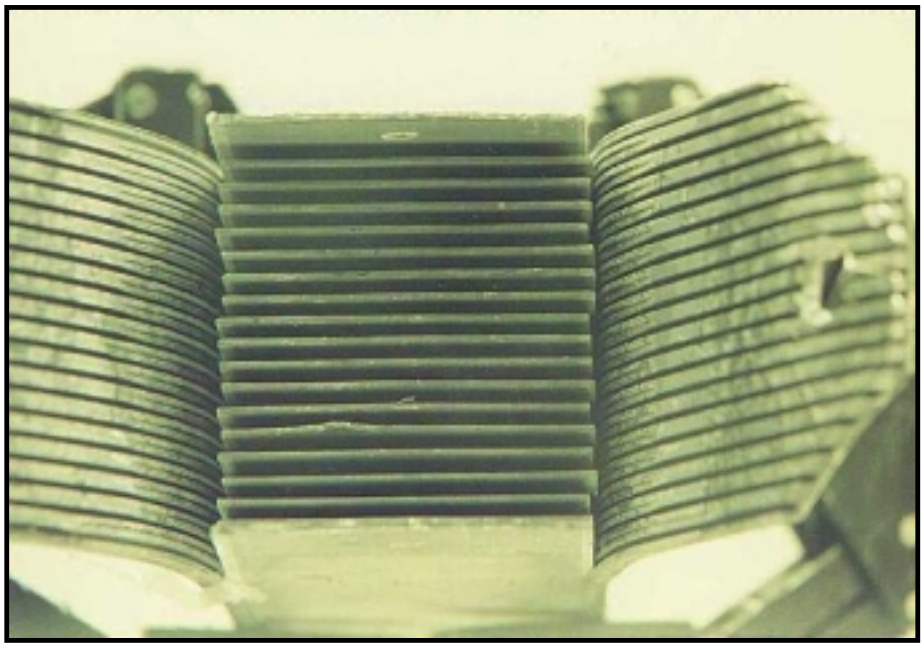

Figure 3: Dismantling the fuel assembly in an special device where fuel plates may be separated for inspection.