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FLUOREX REPROCESSING SYSTEM FOR THE THERMAL REACTORS CYCLE AND FUTURE THERMAL/FAST REACTORS (COEXISTENCE) CYCLE

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ABSTRACT

A new reprocessing technology, FLUOREX was proposed for thermal reactors cycle and future thermal/fast reactors (coexistence) cycle. The proposed system is a hybrid system that combines fluoride volatility and solvent extraction methods. Spent fuel will be sheared and cladding material will be removed by dry oxidation/reduction method such as AIROX process. Fluorination and purification of most uranium can be easily achieved by fluoride volatility method with compact facility. About 10% residues including plutonium can be treated in well-established PUREX method, which means this facility load will be about 1/10 of the conventional PUREX facility with same capacity. Between fluorination process and PUREX process, there is a pyrohydrolysis process where the fluoride compounds from fluorination process are converted to the oxides. Pure mixture of Pu and U can be obtained by solvent extraction method without separating Pu and U, which is suitable for conventional MOX fuel fabrication. The system can recover pure U and MOX with the decontamination factor of over 10^7 and can drastically reduce the cost and waste generation compared with the conventional one.

Semi engineering scale experiments for the fluorination, pyrohydrolysis, and dissolution of Pu containing materials were carrierd out. From those experimental results, key elemental processes were fundamentally proofed.

KEYWORDS

Reprocessing; PUREX process; Fluoride Volatility Process.

1. INTRODUCTION

Nuclear energy produces electricity now by thermal reactors such as light water reactors (LWRs) and in the future by fast breeder reactors (FBRs) that can enhance much the utilization efficiency of uranium resource. Unfortunately realization of FBRs will be postponed, so we should consider in the near future economical and transparent LWR fuel cycle system which can recycle uranium and MOX and can also store plutonium for a while considering recent difficult conditions for MOX utilization in LWRs. The authors have been developing flexible LWR fuel processing technology applicable to any kinds of LWR and FBR cycle scenarios(Amano., *et al.*, 2001).

Requirements for the future nuclear fuel cycle system may become different depending on the phase from LWR era to FBR recycle age as shown in **Table 1**. In the first phase nuclear power generation is dominantly made by LWRs and the second is the co-utilization period of both LWRs and FBRs, the third in which the independent FBR fuel cycle will be established. In the first phase, the role of fuel reprocessing is mainly in LWR fuel cycle in which Pu is reprocessed to produce MOX fuel for Pu-thermal utilization and U is separated for re-enrichment or storage. In this phase high decontamination factor (DF) may be required for both U and Pu products. From the late of the first phase to the early second phase, the fuel production for the initial fuel loading to FBRs will be added to the role of fuel reprocessing and high DF may not be need for MOX any more. However, the DF of U should be still high even in this period since excess U will be produced over the utilization in MOX fuel production due to the difference in the Pu contents of the fuels for LWRs and FBRs. From late second phase to third phase, fuel reprocessing will be performed to recycle FBR fuels. The low DF fuels may be adequately used in FBRs and thus simplified fuel reprocessing system will be adopted in this era.

Table 1. Requirements for the future nuclear fuel cycle system

Item	(I) LWR period	(II) Transition period	FBR period
Feature of spent fuel	Content of U>95% U enrichment > about 1%	Same as left	Driver: U about 70% Pu about 30% Blanket: U>90%
Usage of Recovered U and MOX	U: Re-enrichment or storage MOX: Fuell pellet	U: Same as left MOx: Pellet or vibration packing	Pellet or vibration packing
Required DF for reprocessing	U: High DF MOx: HighDF	U: High DF MOx: low DF	U: Low or High DF MOx: low DF