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Palladium behavior in the presence of irradiated diluent in the PUREX process

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Abstract

AREVA La Hague plants UP3 and UP2-800 started operations to reprocess spent nuclear fuel in 1990 and 1994 respectively. Aging equipment in these plants is a cause for concern as it could lead to process dysfunctions or production rate decrease. A few years ago, several columns had to be replaced in UP3-T4 plutonium purification facility because of clogging. Analyses revealed that TPH degradation products could be responsible for precipitating palladium compounds. 1 M NaOH solutions proved to be efficient to dissolve most of the precipitate. Therefore, several columns in both UP3 and UP2-800 are from now on washed periodically with 1 M NaOH solutions to avoid further clogging and to dissolve current precipitates.

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1. Introduction

Most reprocessing operations today use the well-proven hydrometallurgical PUREX (Plutonium Uranium Reduction Extraction) process. Following the dissolution of the irradiated nuclear fuel in concentrated nitric acid,

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uranium and plutonium are separated from fission products and minor actinides using solvent extraction – the extractant being 30% tri-*n*-butylphosphate (TBP) diluted into hydrogenated tetrapropylene (TPH). Plutonium and uranium are then separated from one another and further purified in dedicated purification cycles. Plutonium purification cycle involves oxidation/degassing steps to oxidize Pu(III) into Pu(IV) so that it can be separated from impurities using again solvent extraction (Fig. 1).

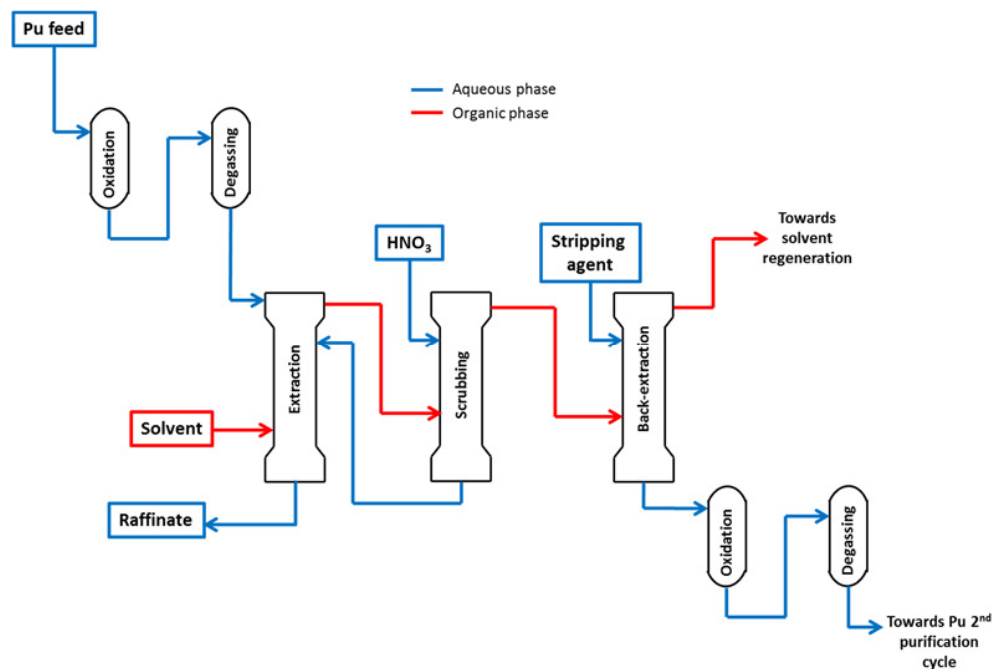


Fig. 1. Plutonium first purification cycle – PUREX process.

France has a long history of reprocessing irradiated nuclear fuel. The first reprocessing plant was UP1 (Usine de Plutonium 1), operated between 1958 and 1997 on Marcoule nuclear site. At La Hague facility, reprocessing of oxide fuels began in 1976 in UP2-400 plant. In 1990, UP3 plant started operations and in 1994 a third plant sharing facilities with UP2-400 was started up and called UP2-800. After UP2-400 was officially closed in 2004, only UP3 and UP2-800 plants are industrially operated now by AREVA NC.

After more than 20 years of operations, aging equipment in both these plants is a cause for concern as it could lead to process dysfunctions or production rate decrease. As a matter of fact, in 2012, several columns in UP3-T4 plutonium purification cycle showed some significant dysfunctions and had to be replaced consequently. After their replacement, inspection of the damaged equipment revealed the presence of precipitate inside the columns (Fig. 2).



Fig. 2. Precipitate found in T4 degassing column.

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