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SACSESS

Safety of ACtinide Separation proceSSes

Collaborative Project

SACSESS
Safety of actinide separation processes

Co-funded by the European Commission under the
Euratom Research and Training Programme on Nuclear Energy
within the Seventh Framework Programme

Contract Number: 323282
Start date: 01/03/2013 Duration: 36 Months

www.sacsess.eu

Action Sheet No. 2014-001
under the
Technical Exchange and Cooperation Arrangement
Between
The Department of Energy of the United States of America
and
The European Atomic Energy Community
As Represented by the Commission of the European Communities
in the Field of Nuclear-Related Technology Research and Development

SACSESS project – Contract Number: 323282
Safety of ACtinide Separation proceSSes
EC Scientific Officer: R.Garbil

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Summary

This document is an action sheet under the Technical Exchange and Cooperation Arrangement between the Department of Energy of the United States of America and the European Atomic Energy Community as Represented by the Commission of the European Communities in the Field of Nuclear-Related Technology Research and Development done at Brussels 6 March 2003.

Approval

Rev.	Date	First author	Activity leader	Project Coordinator
0	20/11/2014	S. Bourg, CEA	S. Bourg, CEA (MGT)	S. Bourg, CEA

Distribution list

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The Department of Energy of the United States of America (DOE)

and

The Commissiariat à l'Energie Atomique et aux Energies Alternatives (CEA) as Principal Co-ordinator of the SACSESS project of the European Atomic Energy Community (Euratom),
Hereinafter referred to collectively as the "Parties":

Preamble

NOTING the Technical Exchange and Cooperation Arrangement between the Department of Energy of the United States of America and the European Atomic Energy Community as Represented by the Commission of the European Communities in the Field of Nuclear-Related Technology Research and Development" done at Brussels on 6 March 2003 (hereinafter "the Technical Arrangement");

DESIRING to foster collaboration between DOE's Fuel Cycle Research and Development Material Recovery and Waste Forms Development Campaign at DOE National Laboratories (hereinafter "the DOE Project"), on the one hand, and Euratom's Safety of ACtinide Separation proceSSes (SACSESS) Collaborative Project, of which the Commissariat à l'énergie atomique et aux énergies alternatives (CEA) is the technical coordinator, on the other hand;

ACTING pursuant to Article 4(4) of the Technical Arrangement;

NOTING Euratom's Seventh Framework Programme for nuclear research and training activities (Council Decision 2006/970/Euratom of 18 December 2006), adopting a specific program (Euratom) for Research and Training on Nuclear Energy (Council Decision 2006/976/Euratom of 18 December 2006) and concerning the Rules for the participation of undertakings, research centres and universities in actions under the FP7 and for the dissemination of research results (regulation (EC) No 1906/2006 of the European Parliament and of the Council of 18 December 2006); and

NOTING further that the DOE-sponsored DOE Project and the Euratom-sponsored project SACSESS represent areas of cooperation under Annex A of the Technical Arrangement,

Hereby agree as follows:

Section 1
Purpose

1. The purpose of this Action Sheet is to provide a framework for cooperation between participants in the DOE Project (including a consoriutm of DOE national laboratories) and the participants in SACSESS.

2. This Action Sheet is subject to and governed by the Technical Arrangement.

Section 2
Scientific and Technical Scope of the Co-Operation

1. The areas of planned scientific co-operation under this Project Sheet are described in Annex 1 which is attached to and constitutes an integral part of this Action Sheet.

2. DOE's technical coordinator to manage the cooperation conducted under this Action Sheet is Dr. Terry Todd, National Technical Director for Separations and Waste Forms, Idaho National Laboratory. Euratom's technical coordinator is Stéphane Bourg CEA, Coordinator of the SACSESS Project.

Section 3
General Provisions

1. Cooperation under this Action Sheet may commence upon signature, and continue so long as the Technical Arrangement remains in force.
2. This Action Sheet may be amended at any time in writing by the Parties' mutual agreement.
3. This Action Sheet may be terminated at any time in writing by the Parties' mutual agreement. Alternatively, a Party that wishes to terminate its participation in this Action Sheet shall provide at least sixty days advance notice in writing to the other Party.
4. All documents relating to the cooperation undertaken pursuant to this Action Sheet, including, notices and meetings, shall be in the English language.

DONE in duplicate.

FOR THE DEPARTMENT OF ENERGY
OF THE UNITED STATES OF AMERICA:

Date: 3/16/2015
Place: Washington, DC

FOR THE COMMISSARIAT A L'ENERGIE
ATOMIQUE ET AUX ENERGIES
ALTERNATIVES:

C. Behar

Date: 30/03/2015
Place: Saclay

COMMISSARIAT À L'ÉNERGIE ATOMIQUE
DIRECTION DE L'ÉNERGIE NUCLÉAIRE
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Annex 1

SACSESS aims to address the safety issues related to the implementation of actinide separation processes, previously developed within the FP7 ACSEPT Project, both in aqueous and pyro reprocessing, with a focus on minor actinide recovery.

Within ACSEPT, several aqueous partitioning processes were selected and developed up to scientific feasibility, through hot-tests. These processes involved new extracting or complexing organic molecules and new diluents. To be developed further, these processes require now a comprehensive study of the multiform safety issues that any chemical process requires under operation conditions or mal-operation. This implies a better understanding of the chemical systems involved and the need to enhance the future process operation at the industrial level.

For each chemical system, parameters involved in safety case analysis will be studied, such as radiolytic solvent stability, solvent clean-up, management of the secondary wastes, physico-chemical solvent stability, loading capacity, and kinetics. The behaviour of the extractants, complexants, diluents all together (solvent stability) will be studied in process conditions, but also out of these operation ranges (mal-operation), in order to identify the weak points and find solutions to assess the safety of the processes. The work will be organised by chemical systems selected for each tested process options, including, when accurate, the alternative system. Furthermore, a list of transversal key issues has been established. For each system, this will allow us to define the studies needed to be able to optimise the processes and assess their safety.

In the field of process operation, the simulation of these systems will be developed from the chemistry to the process, allowing a better and safer management of the plant in the longer term. This includes multiscale modelling, radiolysis modelling and process modelling. In addition, new online monitoring techniques will be developed, allowing a fine tuning of the plant operation parameters. In parallel, an alternative process to those already developed will be studied, allowing the partitioning of americium alone, reducing the hazards related to the handling of curium in fuel for enhanced safety. As far as possible, the most promising systems already identified will be adapted to meet the requirements of such a process and optimised. If needed, specific extractant molecules will be developed and the separation efficiency will be studied. Solubility issues, kinetics, and loading capacities will be studied to assess the safety of this new process. All the new generated data will be integrated thanks to flowsheeting and system studies to allow a feedback to the R&D programme and an assessment of the global safety of the designed processes.

The DOE Project aims to develop advanced fuel cycle separation and waste management technologies that improve current fuel cycle performance and enable a sustainable fuel cycle, with minimal processing, waste generation, and potential for material diversion. Both aqueous and pyrochemical technologies are being investigated for application in future fuel cycles.

Over the past 4 years, the DOE Project has focused on developing advanced methods to separate americium or americium and curium from solutions resulting from UREX or COEX type processes. This effort, called the Sigma Team for Minor Actinide Separations, is a multi-laboratory, multi-discipline approach and is investigating separation technologies based on selective complexation of minor actinides and lanthanides and/or higher oxidation states of americium.

The DOE Project has also developed new capabilities to study solvent degradation by radiolysis and hydrolysis, using a solvent test loop coupled to a gamma irradiator, numerous methods to study alpha and gamma radiolysis and methods to study the kinetics of radiation induced free-radicals. Additional capabilities have been developed to support understanding of the fundamental aspects of separation technologies, to elucidate better understanding and provide fundamental data in support of predictive modeling capabilities. Such techniques include isothermal calorimetry, isopiestic chambers to study solution non-ideality, and stopped-flow kinetic measurements. All of the above techniques are applicable to any solvent extraction technology and support the development of process understanding that will be needed for process development, demonstration, and safe operation.

Technical Cooperation

The areas of the technical cooperation in the safety of partitioning processes are

1. Radiolytic Stability
2. Americium Chemistry
3. Kinetics
4. Modelling
5. Training and Education

1. Joint Experiments on Radiolytic Stability

Radiolytic studies are an essential effort in SACSESS. However, SACSESS does not have access to all the experimental facilities required for a thorough study. Especially, a loop for continuous recycling/irradiation operation is to be set up. Furthermore, a detailed understanding of radiolytic degradation requires performing pulse radiation experiments. While SACSESS has only limited experience in this topic, DOE has experts on hand who also have access to a powerful infrastructure.

- Access to irradiation loop at DOE's Idaho National Laboratory (INL) to perform one or two experiments with SACSESS systems
- Access to pulse radiation facilities at Notre Dame Radiation Center and Brookhaven National Laboratory to study promising SACSESS systems

SACSESS has the ability to perform spiked counter-current tests in small-scale centrifuges at Jülich. These tests have been performed to validate calculated flow-sheets and to set the stage for hot tests. Spiked tests can be performed comparatively easily.

- A spiked separation test with DOE system(s) can be performed at Jülich.

2. Americium Chemistry

Two different approaches for separating americium from curium are pursued:

- One DOE concept is to oxidise americium to higher oxidation states to facilitate its separation from trivalent curium. Another approach is based on selective complexation of minor actinides.
- Processes under study in SACSESS are based on the push-pull effect,combining the (small) reverse separation factors of some extracting and complexing agents to separate trivalent americium and curium.

For information, a joint workshop on americium chemistry was organised as part of the SACSESS meeting in September 2013 at Reading University.

3. Kinetics

There are many experimental approaches for studying kinetics in solvent extraction systems. Most simply, these are shaking tube experiments. More quantitative results are achieved using more elaborate techniques such as stirred cells, single drop, or membrane techniques.

These approaches have different advantages and limitations; these should be discussed. Also, a discussion of how much kinetics should go into flow-sheet calculations could be useful. Finally, it is important to bridge the gap between kinetics measured in the above devices and the devices used in process tests, such as centrifugal contactors.

Addressing these topics, a joint workshop on kinetics should be organised as part of the SACSESS meeting in April 2015 in Warsaw, as a side meeting to the SACSESS International Workshop.

4. Modelling

The main aspects to be taken into account for a comprehensive modelling of a solvent extraction process are: equilibrium, kinetics, and phase behaviour (third phase formation). While a good activity-based (SIT, Pitzer or the like) description of the aqueous phase is possible, this is not the case for the organic phase. Also, the behaviour of species at the interface is important for kinetics and for third phase formation issues.

A joint workshop on modelling of solvent extraction systems should be organised in September 2015 (as part of the SACSESS meeting, just before or after Global 2015, at NNL) or in February 2016 (as a part of the SACSESS final meeting).

5. Training and Education

- Access for students to DOE facility or Laboratory as observers: very feasible (1-2 months previous notice)
- 2 SACSESS winter-schools (fuel cycle): seats for U.S. students; grants depend on the sponsors; Invitations of U.S. lecturers.
- SACSESS International workshop (22-24 April 2015): US contribution (both experts and young researchers) are very welcome
- Student exchange: from SACSESS, a student from a laboratory can go up to two months to another lab. An idea would be to select students to exchange with the U.S. labs.