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SACSESS

Collaborative Project

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SACSESS
Safety of actinide separation processes

Project Presentation

Authors: B. Duplantier (LGI), S. Bourg (CEA)

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Summary

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Name	Organisation	Comments
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Governing board members	SACSESS	

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SACSESS

In line with the Strategic Research Agenda of SNE-TP, the SACSESS collaborative project will provide a structured framework to enhance the fuel cycle safety associated to P&T. In addition, safety studies will be performed for each selected process to identify weak points to be studied further. These data will be integrated to optimise flowsheets and process operation conditions.

1. Nature and scope of the project

Nuclear power plays a key role in limiting the EU's emissions of greenhouse gases, and makes an important contribution to improving the European Union's independence, security and diversity of energy supply. However, its social acceptance is inextricably linked to enhanced safety management and to a safe management of long-lived radioactive waste contributing to resource efficiency and cost-effectiveness of this energy and ensuring a robust and socially acceptable system of protection of man and the environment against the effects of ionising radiation.
Amongst the different strategies studied to manage safely the long-lived radioactive waste, partitioning and transmutation allows a reduction of the amount, the radiotoxicity and the thermal power of these wastes, leading to an optimal use of the geological repository sites.
SACSESS is a FP7 Collaborative project gathering 26 Partners. It aims at optimising separation processes previously selected within the FP7 ACSEPT project by focusing on all the safety issues related to the industrial implementation of a chemical process.

2. Activities

In aqueous reprocessing, SACSESS will work at optimising the chemical systems selected within ACSEPT. 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.

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.

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.

In pyrochemistry, SACSESS will focus on the recovery of minor actinides from metallic fuels and inert matrix transmutation targets. Within ACSEPT and former European projects, two processes were identified and further developed at the lab scale (the electrorefining process on aluminium and the liquid-liquid reductive extraction process in molten fluoride/liquid aluminium). Specific salt treatment for recycling and waste conditioning were also proposed.
However, at this stage, some safety issues have to be addressed. The first ones are those related to the use of molten salts and liquid metals at high temperature. The physico-chemical behaviour that impacts the chemical safety (solubility, volatility, influence of oxygen ingress, heat capacity, viscosity, etc) both in chloride and in fluoride will be studied. Online monitoring development will be continued.

In addition, parameters that can impact the safety will be identified and studied. This includes risks of accumulation of an element in liquid or solid phase, of precipitation, of formation of volatile species… Molten salt modelling will also be developed, first to help to calculate physico-chemical parameters and reduce the number of necessary complex experiments and second, to develop the modelling of pyrochemical processes in the longer term.
The conditioning of the used molten salts (chloride and fluoride) and/or or other process chemicals (metals…) into waste streams suitable for a safe storage/repository will also be considered, including the impact of matrix material.

With the above studies, being driven by safety considerations, a specific domain will be dedicated to global safety and integration whereby safety case studies will be performed on each process concept to identify the weak points in order to give feedback and reorient the experimental program. Integration studies will gather all the results to deliver optimized process flowsheets.
With the help of TSOs and with feedback from safety analyses, specific methodologies will be developed and applied to these processes in order to identify safety issues and then to optimise these processes. In addition, all the results will be integrated to optimise the flowsheets, to perform system studies and will ensure the link with other projects and initiatives to ensure the relevance of the SACSESS research program.

3. Expected results

Safety is a key issue for nuclear waste management, not only for the final disposal repository design, but also all along the process that leads to the fabrication of this ultimate waste form, including the safety of the separation processes when implemented through a fuel cycle strategy.

Presently, the European nuclear reactor fleet leads to the annual production of 1800-2000 t/y of spent fuel, containing approximately 20 t of Plutonium, 2,8 t of minor actinides (MA, namely Np, Am, Cm) and 2,5 t of long-lived fission products (LLFPs). These MA and LLFPs stocks need to be managed in an appropriate way. The spent fuel reprocessing followed by the geological disposal or the direct geological disposal are today the envisaged solutions depending on national fuel cycle options and waste management policies. Required time scale for the geological disposal exceeds the time of our accumulated technological knowledge and this raises problems of public acceptance. P&T has been pointed out in numerous studies and more recently in the frame of the Generation IV initiative as the strategy that can relax the constraints on the geological disposal, and reduce the monitoring period to technological and manageable time scales, whatever in the case of nuclear industry development or phase-out of nuclear. If scientific and technical solutions are now available, their safety has to be assessed to allow their development at a higher scale.

SACSESS will contribute to address these key issues at a high level and will help Europe to hold a top level position in this domain.

Moreover, beyond sharing national experience, it is essential for Europe actively to participate in longer term international efforts to prepare the future in order to perpetuate competences in the field of actinide sciences, chemical separation and fuel fabrication processes in order to be able to ensure the safety of the chemical processes developed.

With its extensive and encompassing research program, SACSESS will have industrial impact by assessing the chemical safety of advanced processes and by developing methods for carrying safety case reviews of these processes, it will provide tools to be used by the industrial to answer regulatory bodies and safety authorities on sound technical and scientific basis.

4. Societal impact

In the continuation of ACSEPT, SACSESS aims to reduce the amount and the radiotoxicity of high-level nuclear waste by designing chemical processes that aim to recycle all actinides within fast-neutron reactors or transmuting transuranics in dedicated burners with a focus on the safety of these processes. This will benefit Europe by easing the nuclear waste management problem and by increasing public acceptance of nuclear energy. The advances will be useful both to countries committed to using nuclear energy and those planning to phase it out.

SACSESS will propose safe optimized advanced closed-fuel-cycle options that incorporate actinide reprocessing to European policy makers, utilities and technology providers. The demonstration of a feasible recycling strategy under safe conditions should have a positive impact on public opinion, and in turn on government decision makers. It will also help to prevent the diffusion of hazardous radionuclides into the biosphere in the far future, paving the way for nuclear sustainability.

Project information

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EC project officer:
Michel HUGON
European Commission
Research DG - Energy - Unit J2 Fission
CDMA 1/52
B-1049 Brussels
Email: michel.hugon@ec.europa.eu

Coordinator:
Stéphane BOURG
CEA/DEN/MAR/DRCP, Bat 400
CEA Marcoule, BP 17171
30207 Bagnols sur Cèze
France
Tel: +33 4 66 79 77 02
Email: stephane.bourg@cea.fr

Partners:

Partner number	Partner full name	Short name	Country
1	COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES	CEA	France
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