Andra Call for Projects
with the support of the
Investments for the Future Programme

CADET

Assisted cavitation for water decontamination

Project supported by Andra under the "Investments for the Future Programme" ("Investissements d'Avenir") - Selected under the Andra Call for Projects "Optimization of post-dismantling radioactive waste management", organized in cooperation with the French National Research Agency (ANR).

Duration: 42 months

Project launch:
01/2016

Total project cost: €1.9 million

Sum covered under the Investments for the Future Programme: €371,000

Type of financial support: Subsidy

Locations: Saint-Cyr-l'Ecole (78), Bagnols-sur-Cèze (30)

Coordinating body:
Jean le Rond d'Alembert Institute (Pierre and Marie Curie University, Saint-Cyr-l'Ecole)

Partners:
- Jean le Rond d'Alembert Institute (Pierre and Marie Curie University, Saint-Cyr-l'Ecole)
- Marcoule Institute for Separation Chemistry

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BACKGROUND

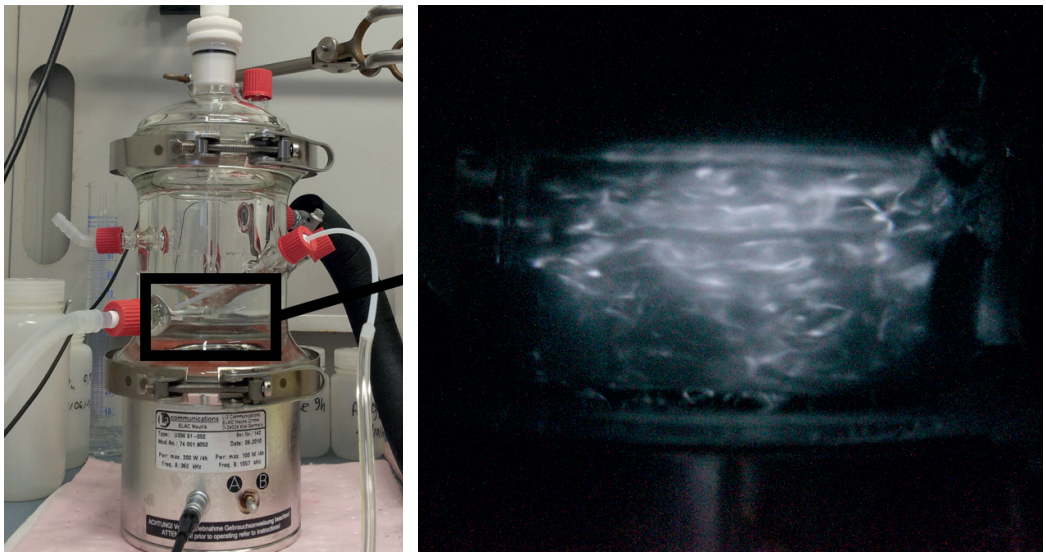
When decommissioning operations are carried out at nuclear facilities, radioactively contaminated surfaces (e.g. tanks and pipes) are cleaned with chemical agents (usually organic complexing molecules) that trap radioactive elements. These chemical agents are then decomposed using other chemical products in order to retrieve the radioactive elements so that they can be disposed of. However, these operations can be complex and increase the volume of the effluents to be managed (secondary waste).

The CADET project (Assisted cavitation for water decontamination), co-developed by the Institute Jean Le Rond d'Alembert (UPMC, Saint-Cyr-l'École) and the Institute for the Separation Chemistry of Marcoule (ICSM, Marcoule), proposes using an innovative process to retrieve radioactive elements without using additional chemical products. It is based on using cavitation phenomena.

OBJECTIVES

The aim of the CADET project is to develop a process for decomposing organic compounds in effluents from nuclear plant decontamination.

The cavitation used in this process is a phenomenon where gas bubbles form in a liquid by changing the pressure. When these "cavitation bubbles" implode, they create extreme pressure, temperature and turbulence conditions (localised creation of a non-equilibrium plasma) that initiate and accelerate chemical reactions around them, and thereby effectively break down the chemical agents used to trap the radioactive elements from cleaning operations.



View of ultrasound-assisted cavitation: Ultrasounds create pressure variation when they pass through the liquid. Gas bubbles form and oscillate before imploding. A plasma is created locally (right-hand photo) and quickly and effectively breaks down chemical agents used to decontaminate nuclear facilities.

d'Alembert Institut Jean le Rond d'Alembert

ANDRA French national radioactive waste management agency

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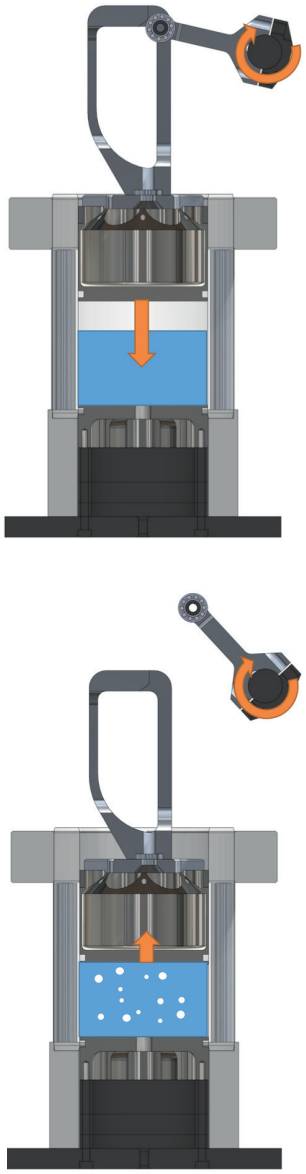
CADET : Assisted cavitation for water decontamination



▶ **Principle of impact-assisted cavitation:** a mechanical arm drives a piston and forcefully releases it to impact the liquid. A shock wave is produced, followed by resonance waves, which creates cavitation bubbles of varying size.

Find the presentation of the CADET project by Lauréanne Parizot, PhD student on the project, made for the "My thesis in 180 seconds competition" (Ma thèse en 180 secondes): **youtube.com/watch?v=xZz_ycXNSzY**

To implement this process, two different types of cavitation have been developed under the CADET project - ultrasound-assisted cavitation and impact cavitation [see photos in the legend]. The first consists in applying a sound wave of regular intensity and frequency. It is easy to control but difficult to apply to treatment for industrial-scale volumes and concentrations. The second generates a more intense wave with highly irregular frequency and intensity, but that is potentially more effective for breaking down chemical agents.

In laboratory conditions, the use of ultrasounds has already shown promising results. However, cavitation via mechanical impact remains an innovation under development, which leaves potential for numerous future optimisations and advances.

PROJECT SEQUENCE

The CADET project is a 42-month fundamental research project involving 2 laboratories - the Reactive Fluids and Turbulence (FRT) laboratory of the Institute Jean Le Rond d'Alembert and the Laboratory of Sonochemistry in Complex Fluids (LSFC) of the Institute for the Separation Chemistry of Marcoule.

The ultimate goal of the project is to better understand the physico-chemical phenomena involved in cavitation and develop an operational pilot process for future industrial application.

EXPECTED RESULTS

Innovation

There is little literature on the mechanical impact cavitation technique, making it an important innovation. A particularly effective process will be obtained from understanding the phenomena at play and the study on the ultrasound-assisted cavitation technique.

Economic impact

Industrial-scale implementation of the process developed under the CADET project will offer the industry a new alternative for treating radioactive effluents that is more cost-effective and environmentally-friendly as it will require less chemicals.

Impact on radioactive waste management

The CADET project offers a new solution for managing nuclear facility decontamination effluents by breaking down the organic compounds found in them, and particularly those used on equipment and pipe surfaces (EDTA, oxalic acid, citric acid, ascorbic acid, etc.). The results obtained from the project must show the technological feasibility of the process.

APPLICATION AND COMMERCIALISATION

The process developed under the CADET project takes into account the requirements of the nuclear sector. However, it could easily be applied to other sectors that use similar chemical agents, and encounter polluted effluent management problems, and would provide them with real benefits (pesticides, organic halogen compounds, pharmaceutical and cosmetic molecules, etc.).