INNOVATIVE FRENCH THERMAL TREATMENT PROCESSES FOR THE MANAGEMENT OF RADIOACTIVE ORGANIC LIQUID WASTE

MILOR Project

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CONTEXT AND POSITIONING OF THE MILOR PROJECT

Issue = Management of Radioactive Organic Liquid Waste (ROLW) not covered by the CENTRACO reference procedure

↳ *Producers :*
- *Nuclear industry (CEA, ORANO, EDF, COMURHEX…)*
- *Small producers (INSERM, Sanofi…)*
- *Orphan sites (e.g. Ganagobie)*

↳ *Specific chemical compositions (high contents of Cl, F, P, S)*

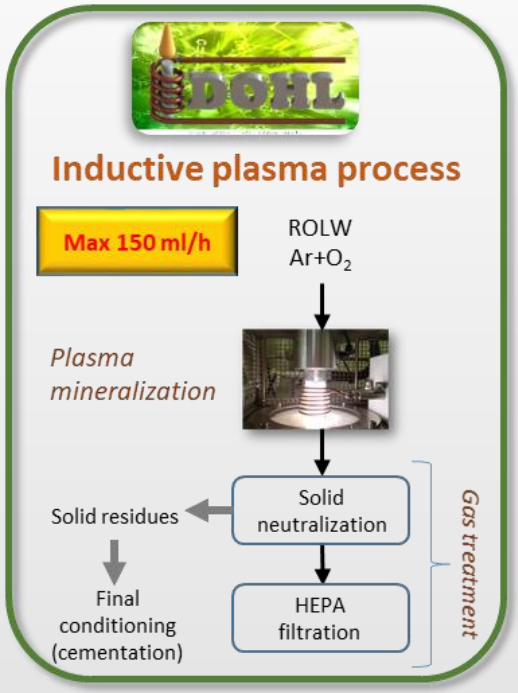
↳ *Oils, fuels, solvents, organic mix, scintillator liquids …*

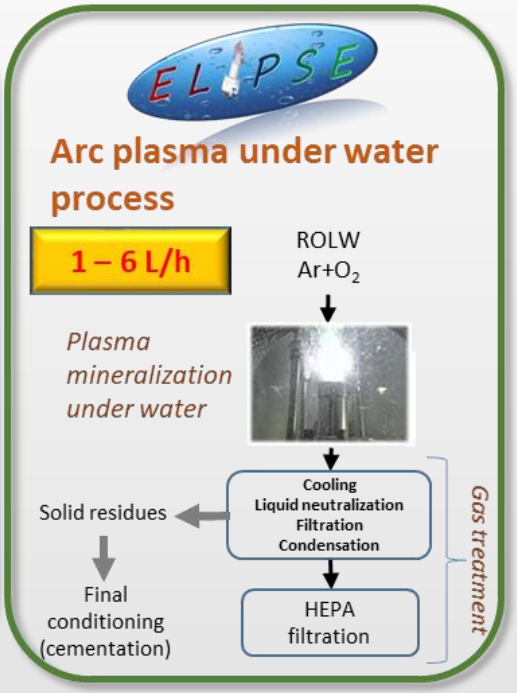
↳ *Specific radiological characteristics*

↳ *Limited volumes (a few hundred m^3)*

Solution proposed = Mineralization using plasma processes

Development of 2 processes for ROLW





MILOR Project

MIneralization of **L**iquid **O**rganic **R**adioactive waste by plasma technology

PROJECT ORGANIZATION

Total project cost: *4.50 M€*
Sum covered under French government program "Programme d'Investissement d'Avenir": *2.25 M€*

Duration: *48 months*

Project launch: *09/2017 → 08/2021 + 6 months*

Partners:

- *CEA – Energy Division (DES Marcoule),*
- *CEA – Fundamental Research Division (DRF Saclay),*
- *Industrial partner: A3i-Inovertis (Donzère) Consultancy & Engineering for innovative processes*
- *ANDRA (French National Radioactive Waste Management Agency)*

Coordinator: CEA - *Energy Division (DES-Marcoule)*

WP		Objectives	Leader
1		Project management	CEA – DES
2		Input data consolidation	CEA – DRF
3		Induction plasma process development and nuclearization	CEA – DES & DRF
4		Arc plasma process under water	CEA – DES
5		Treatment and conditioning of residues	CEA – DES
6		Market survey and valorization	Inovertis
7		Industrial design and technico-economic studies	Inovertis

Partner	Expertise
cea MARCOULE DE2D/SEVT/LPTI	Plasma processes High temperature chemistry Process designer
cea Institut des sciences du vivant Frédéric Joliot DRF/JOLIOT/DMTS/SCBM	ROLW knowledge Scintillator producer Future process operator
cea MARCOULE DE2D/SEAD/LCBC DMRC/SDTC/LPSD	Treatment and conditioning of effluent and solid residues
Groupe INOVERTIS	Engineering Technico-economic prospectives

MAIN RESULTS

Induction plasma process

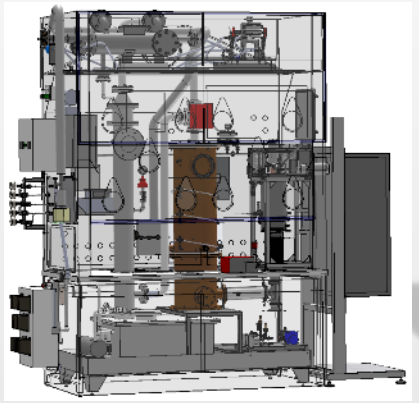
Organo **H**alogenated **L**iquid **D**estruction and **I**ncineration process

- Non active process qualification at CEA-Marcoule (2017-2020)
- Small power plasma (5 kW), flowrates up to **200 ml/h**
- Destruction rate up to 99 %
- Complete neutralization of gaseous chlorine and fluorine
- Nuclearization and commissioning at CEA-Saclay (2021-2023)

Radioactive organic liquid waste at CEA DRF

ROLW	Bq/g ^{3}H	Bq/g ^{14}C
L1, L2, L3	100-5000	1000-10000

	%w		
	L1	L2	L3
H_2O	9,1	7	54
$C_{15,12}H_{22,61}O_{1,37}$	0	54	21
$CHCl_3$	2	4,3	0
CH_2Cl_2	8,2	18,4	0
C_3H_6O	66,1	3,3	4
C_2H_3N	0	7,4	14
CH_3OH	2,3	1,6	7
C_2H_6O	2,5	2,3	0
$C_4H_8O_2$	9,8	0	0
C_3H_7NO	0	1,7	0
$C_2HF_3O_2$	0,3	0,3	0,3

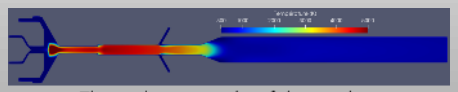


Arc plasma under water process

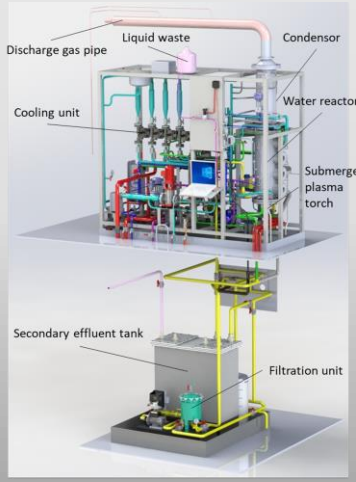
Submerged plasma process for liquid treatment

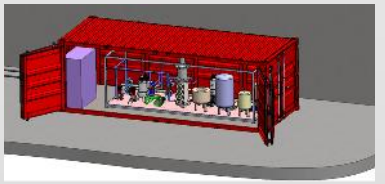
- Process under qualification and development in inactive environment (TRL 5)
- Destruction of liquids in O_2 plasma
- High energy plasma (40 kW)
- Gas treatment replaced by water treatment
- Flowrates from **1 L/h to 6 L/h**
- Destruction rates up to 99.9 %
- Validated performances for
  - TBP (5 → 50%)/dodecane waste mix up to 3 L/h
  - Chloroform waste up to 2 L/h
  - Mix solvents up to 2 L/h
- Thermo & air flow modelling of the nozzle
- Industrial integration and life cycle studies

Arc plasma torch under water



Thermal cartography of the nozzle





Industrial implantation scheme

Remaining work:
- Process qualification with actinides surrogates
- Engineering studies for nuclearization