ANDRA

French national radioactive waste management agency

Novel treatments to improve radioactive waste disposal : the case of Andra

IGD-TP Exchange Forum n°6

4/11/2015

Andra's positioning ahead of disposal

Andra, French Agency in charge of radioactive waste long-term management

- Independent from radioactive waste producers
- Under the supervision of several Ministries

Strengthen the overall consistency of waste management, from waste production until their disposal

Public endowment received in 2010 within the « Investissements d'Avenir » program to work ahead of disposal

- 75 M€ budget (almost over now)
- Goal: optimize radioactive waste disposal through innovative R&D projects on waste treatment
  - Optimize **waste disposal capacities** by volume reduction
  - Optimize **disposal safety** by processing waste to make them as inert as possible under disposal conditions
  - Optimize **waste take over and distribution between the different disposal facilities** already existing or planned

R&D collaborations between Andra and waste producers on waste processing

- R&D projects led by waste producers
- Andra brings the vision of disposal requirements and constraints

The PIVIC project

IL-LL waste only contaminated with alpha emitters

- Waste mainly arising from Areva facilities: glove boxes used for Mox production (Melox facility) and spent fuel reprocessing plants
- Mixed waste made of c. 30 % organic matter / c. 70 % metal & glass
- Production planned until 2042, c. 3,400 m^3 on the whole

Original conditioning option (compaction) not accepted (2010)

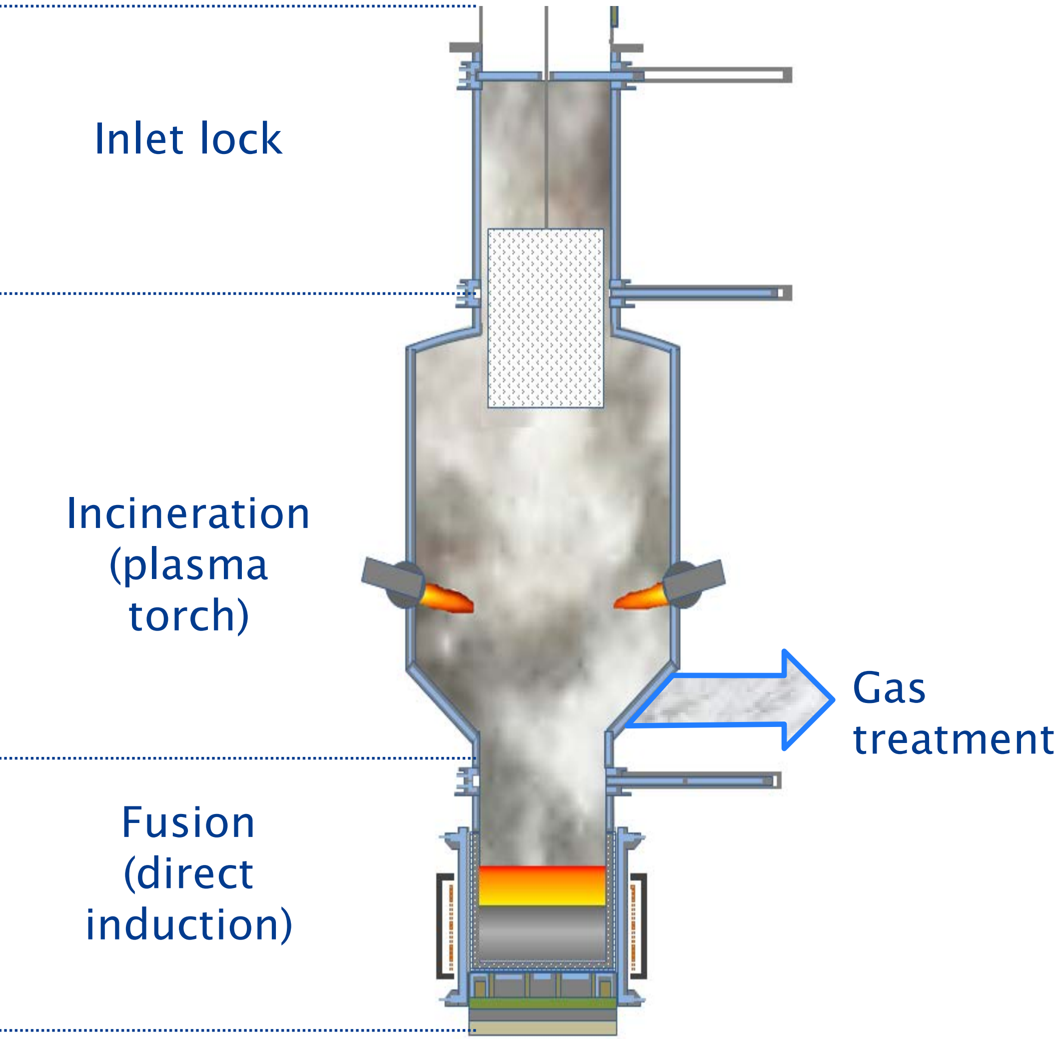
- Organic matter radiolysis and hydrolysis issues under disposal conditions
  - H2 release → *overpressure, explosion issue*
  - Corrosive species release → *waste packages corrosion issue*
  - Complexing species release → *possible increase in some radionuclides mobility in disposal*

An alternative conditioning option is being studied, with the following requirements

- Full destruction of organic matter
- Confinement of radionuclides
- No pre-treatment
- Compactness
- Batch processing system

The « PIVIC » process

PIVIC
PROCÉDÉ D'INCINÉRATION VITRIFICATION IN CAN



Process developed as a combination of pre existing technological elements

- Plasma incineration
- Vitrification of resulting ashes
- Fusion of metallic pieces
- In can process

Production of a biphasic waste

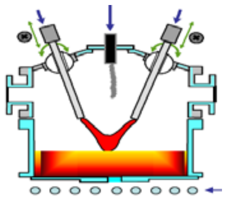
- Metallic fraction below
- Glass fraction above including ashes and actinides

Strong volume reduction

The R&D program

PIVIC
PROCÉDÉ D'INCINÉRATION VITRIFICATION IN CAN

2011



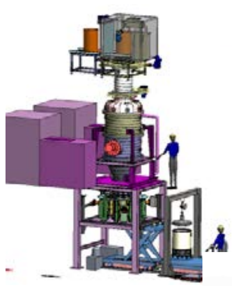
Step 1. Exploratory research

- Fundamental concepts
- Final waste requirements

2018

Step 2. Concepts feasibility

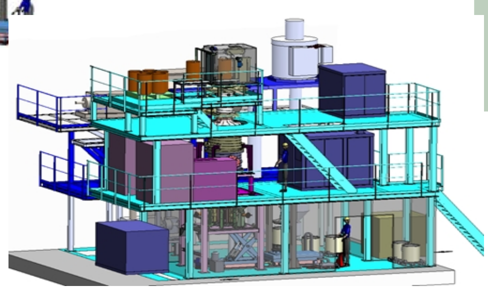
- Feasibility of waste conditioning material
- Feasibility of the process (fusion and incineration)
- Feasibility of gas treatment



2022

Step 3. Integration and development

- Development of the full process scale 1
- Improvement of conditioning material
- Waste package description



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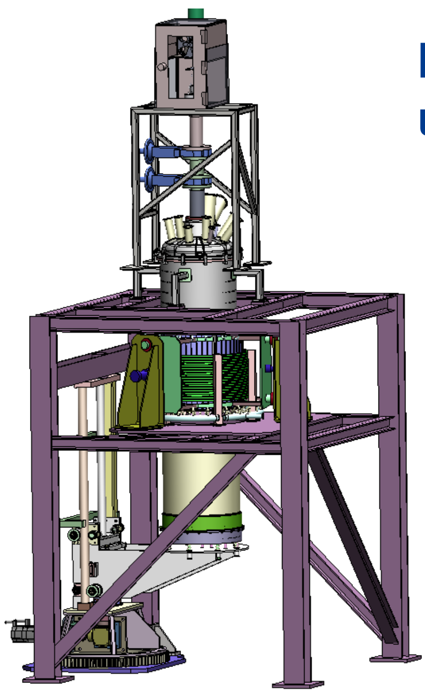
Step 4 . Qualification

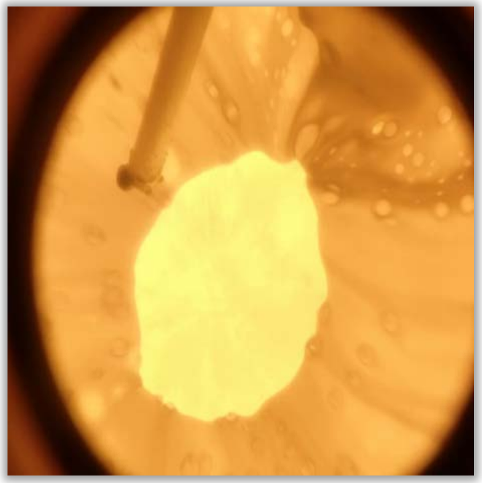
- Final process, to be nuclearized

Current achievements



Fusion pilot already built, tests underway

- Determination of operational parameters
- Study of the fusion of metallic pieces, including Al
- Study of ashes and actinides incorporation into the glass fraction
- Study of the phosphating process to manage metal chlorides
- Study of reactor fouling and actinide accumulation



Characterization of the first cans produced

- Very good separation observed between the metallic and the glass layers
- Actinides simulants almost exclusively located in the glass fraction

Graphite waste treatment

About 23,000 tons of LL-LL graphite waste

- 9 UNGG reactors (graphite moderated, fueled with natural uranium, CO_2 cooled)
- 3 main radionuclides of concern for interim storage and disposal : ^{3}H, ^{14}C, ^{36}Cl

Reference management solution in France: near surface disposal

Graphite decontamination by thermal treatment studies

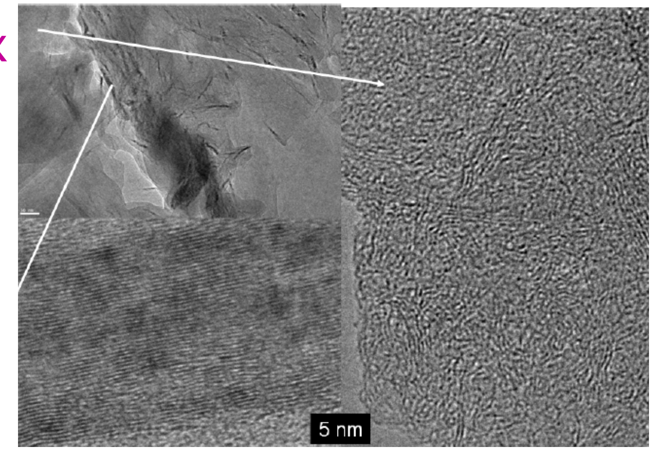
- Good performance for ^{3}H and ^{36}Cl, low decontamination rates in ^{14}C
- Discharges issues, complex management of secondary waste
- Strong lowering of graphite waste radiological inventory make treatment less interesting at this stage

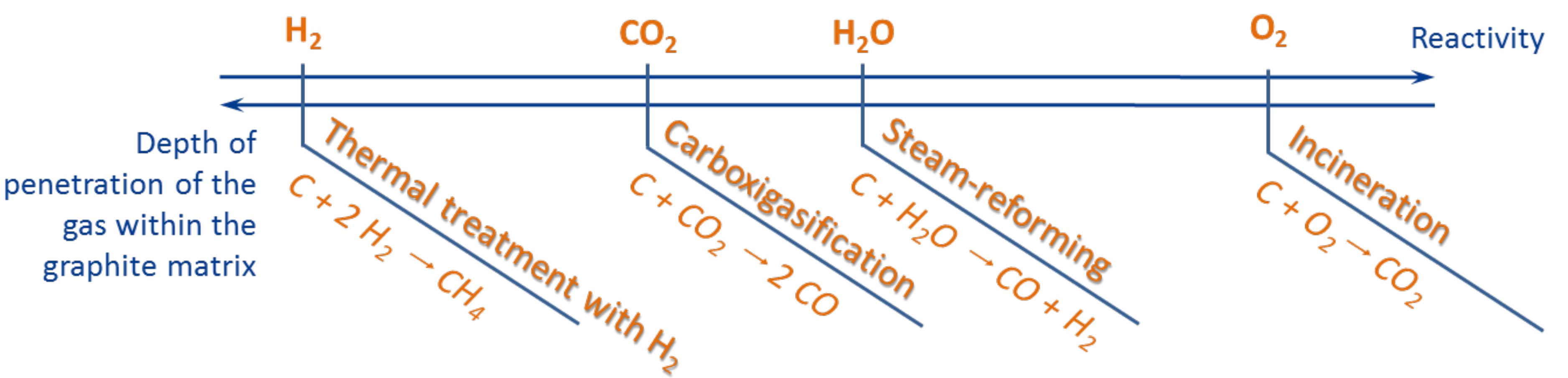
Graphite thermal treament: CO_2 gasification

PhD of Justin Pageot

Basic principle: remove ^{14}C in graphite bulk selectively from ^{12}C

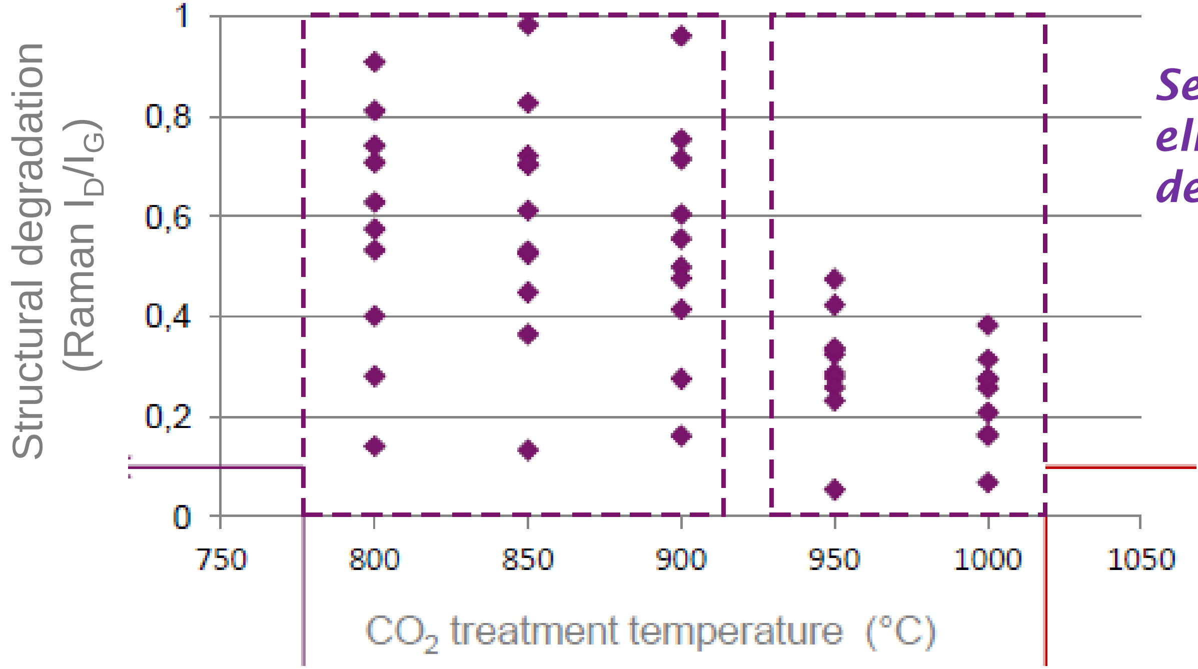
- Structural defects in graphite due to neutron flux are heterogeneous at the nanometer scale
- CO_2 will mainly react with degraded areas (more active sites)
- Assumption: ^{14}C is mainly located in the most degraded areas of graphite matrix





PhD of Justin Pageot

CO_2 selectivity for degraded areas confirmed on i-graphite simulant (milled graphite) above 950 °C

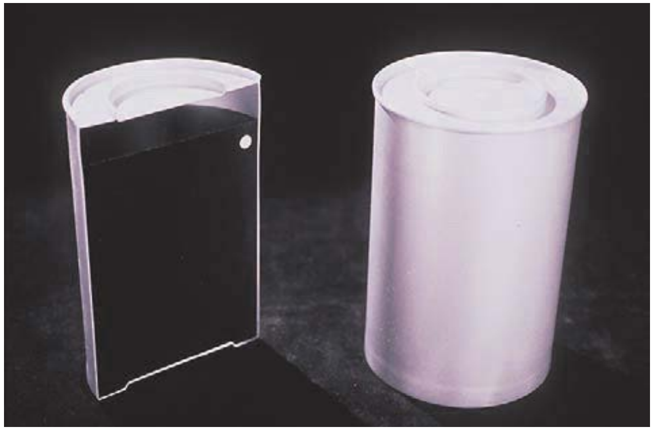


Selective elimination of degraded particles

But moderated removal of ^{14}C on i-graphite

- 26 % of ^{14}C removal for c.6 % weight loss at 950 °C

Research perspectives



About 20 000 m^3 of bitumen waste in France

- c. 7,000 m^3 LLW-LL + c. 13,000 m^3 ILW-LL
- Sludge produced by effluents coprecipitation coming from spent fuel reprocessing
- Homogeneous waste, salts incl. $BaSO_4$, $NaNO_3$

Comprehensive R&D made on French bitumen characterization and behavior under disposal conditions (coll. Areva/CEA/EDF/Andra)

- Fire hazard control (self-heating, fire resistance)
- Better knowledge of bitumen variability composition
- Cracking hazard control (H_2 production, bitumen swelling)

Disposal is the reference solution for French bitumen waste management

Prospective R&D on bitumen treatment may be interesting to maintain alternative management solutions

- Bitumen long-term management options still open in some European countries
- Growing demand of civil society to dispose of non-reactive radioactive waste

Thermal treatment already studied at CEA but strong technological and scientific challenges remain

- Bitumen supply into the process
- Salts decomposition ($BaSO_4$) and redox reactions management
- Gas treatment
- Fissile material management

Launch prospective developments on bitumen treatment ?

- The 2016 Euratom call may be an opportunity