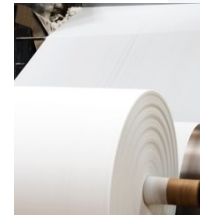
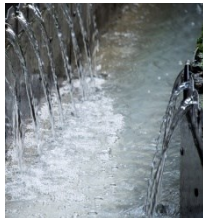


Nuclear Waste Management: Solidification of Liquefied Ion Exchange Resin Geopolymercamp 2026

Matthias Weiß / Wöllner

Jutta Maaßen / Framatome



09.07.2026

Framatome Waste Management and Decommissioning

SUPPORTING CUSTOMERS TO ACHIEVE THEIR PROJECT GOALS

Technologies for Waste Management and Decommissioning (Engineering, Procurement, Installation supervision, commissioning, operational support) to achieve long term safe and environmental sound solutions for the management of radioactive materials worldwide

Strong capabilities for test facilities at Erlangen and Karlstein, both GERMANY

Technologies for the treatment of solid, liquid and gaseous radioactive waste, physical and chemical pre-treatment methods as well as retrieval and management of legacy waste



More than 40 years

Safe, environmentally sound

Fulfilment of waste acceptance
criteria for long term storage or
disposal

Background

Ion Exchange Resins are used for state-of-the-art waste water treatment in Nuclear Power Plants

Solidification of the waste for final disposal is associated with a number of difficulties:

- *Swelling and shrinking of the beads,*
- *Limited organic content accepted in repositories,*
- *Gas production via radiolysis,*
- *Interaction with matrix,*
- *Difficult sampling due to inhomogeneity*

The goal is to solve these difficulties while optimizing the proportion of waste embedded in the matrix, for financial, space and environmental reasons



Reinventing Spent Resin Disposal, reducing conditioned waste volume by up to 20 times via resin destruction, as well as producing virtually organic-free residues for safe, sustainable disposal.

**INNOVATION
AWARDS** **WINNER**
by **wne**
PRIMO

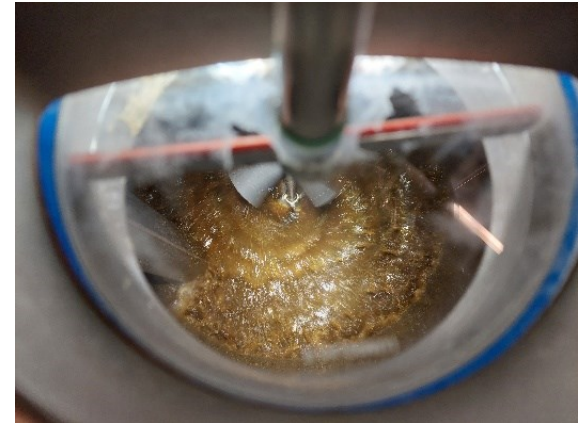
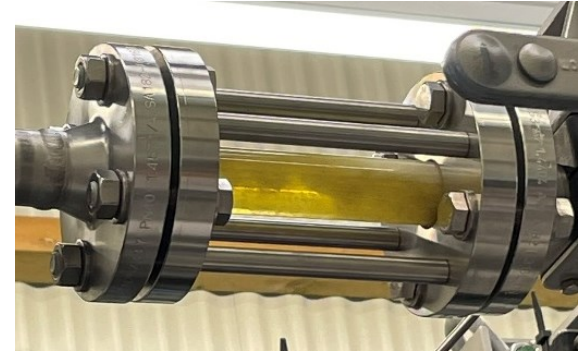
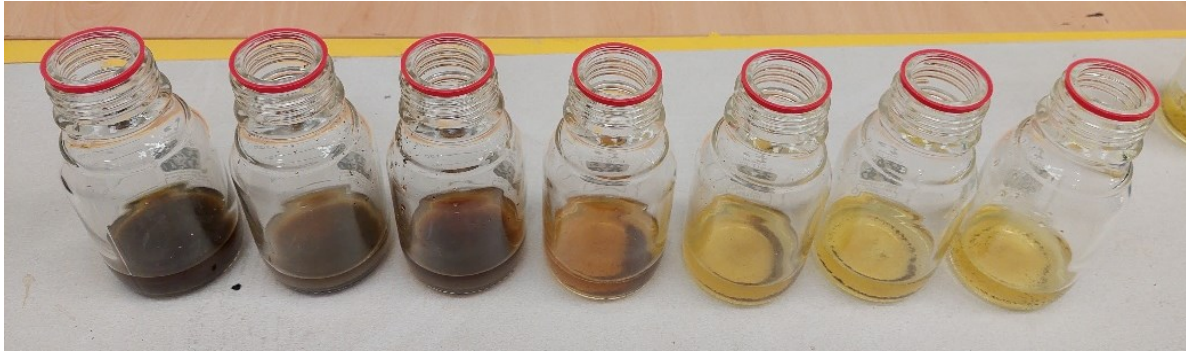
Pilot plant “**Waste ERASER**” Framatome GmbH, Karlstein (Germany)



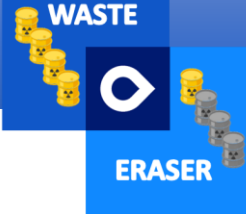
framatome

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Results from the Liquefaction Tests



CUT STORAGE COSTS BY 75%



State of the art: Volume of directly cemented spent IER, common recipe



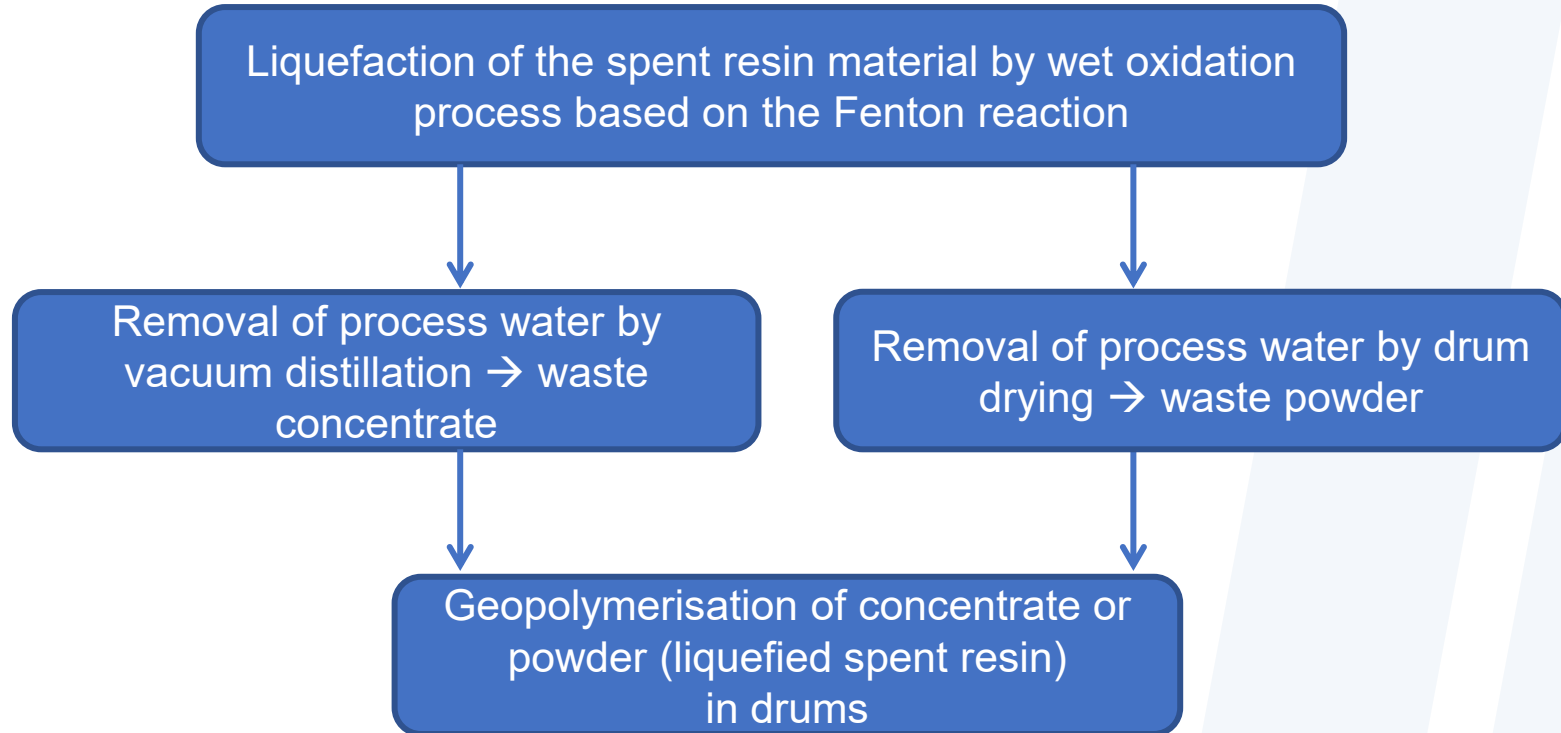
**400.000 € pro
m³ IER**



The Framatome / Wöllner Collaboration

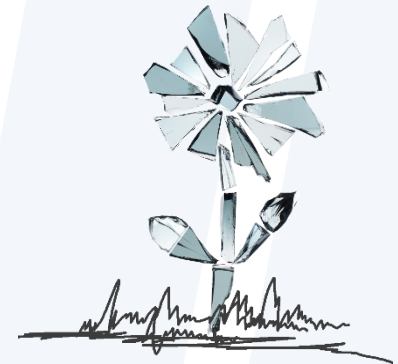
- The goal is to replace the cementation with a geopolymerization while further optimizing the proportion of waste embedded in the matrix, for financial, space as well environmental reasons
- Wöllner is developing for Framatome a Geopolymer recipe to solidify liquefied Ion Exchange Resin

Process Background

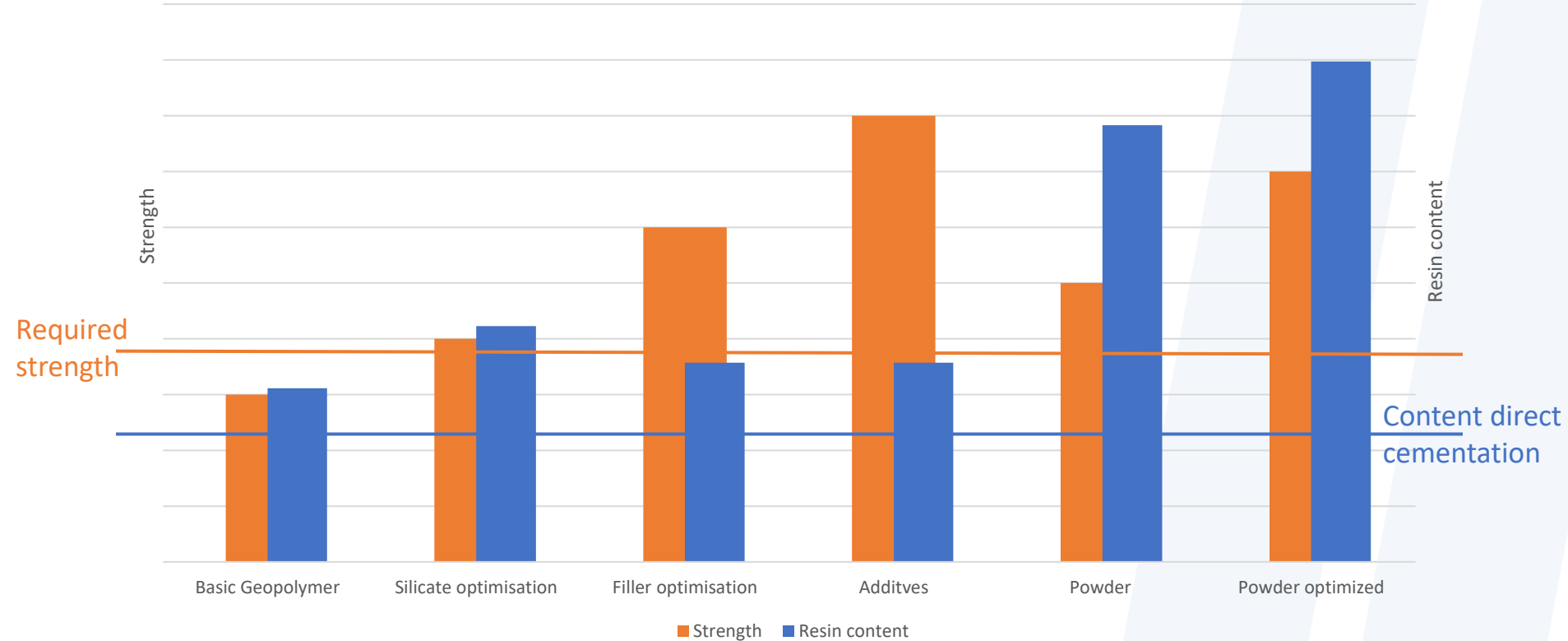


Recipe Development Approach

- Testing the liquefied ion exchange resin
 - General properties
 - Reaction with Silicates
- Basic trials with Geopolymers
- Mixing procedure variation
- Silicate optimization
- Introducing fillers to reduce leaching and increasing the strength
- Introducing additives from Wöllner to reduce leaching and increasing the strength



Current Development Progress

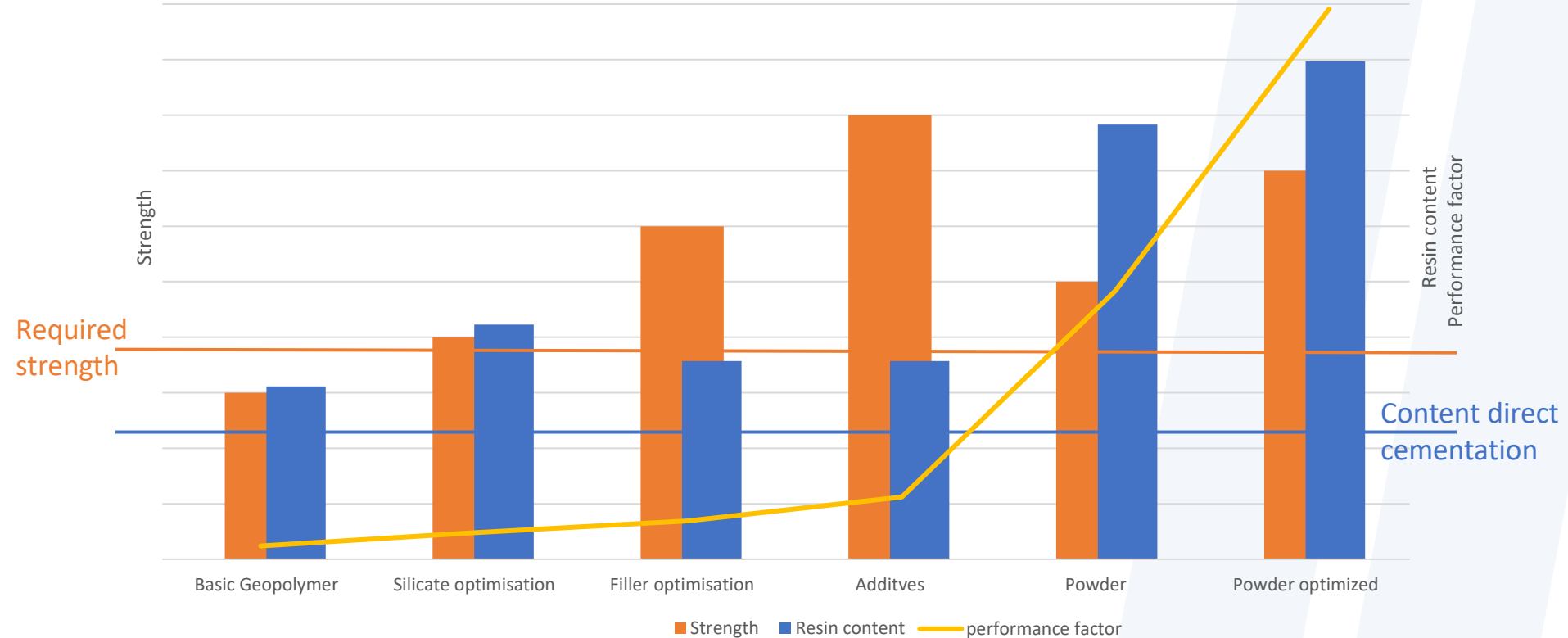


Multi Factor Evaluation

$$\textit{performance factor} = \textit{resin content}^2 * \textit{strength}^2$$

- Squaring prevents a high value in one domain from masking a critical deficit in the other by exponentially penalizing low content while disproportionately rewarding peak strength

Current Development Progress: Performance Factor



Comparison Solidification

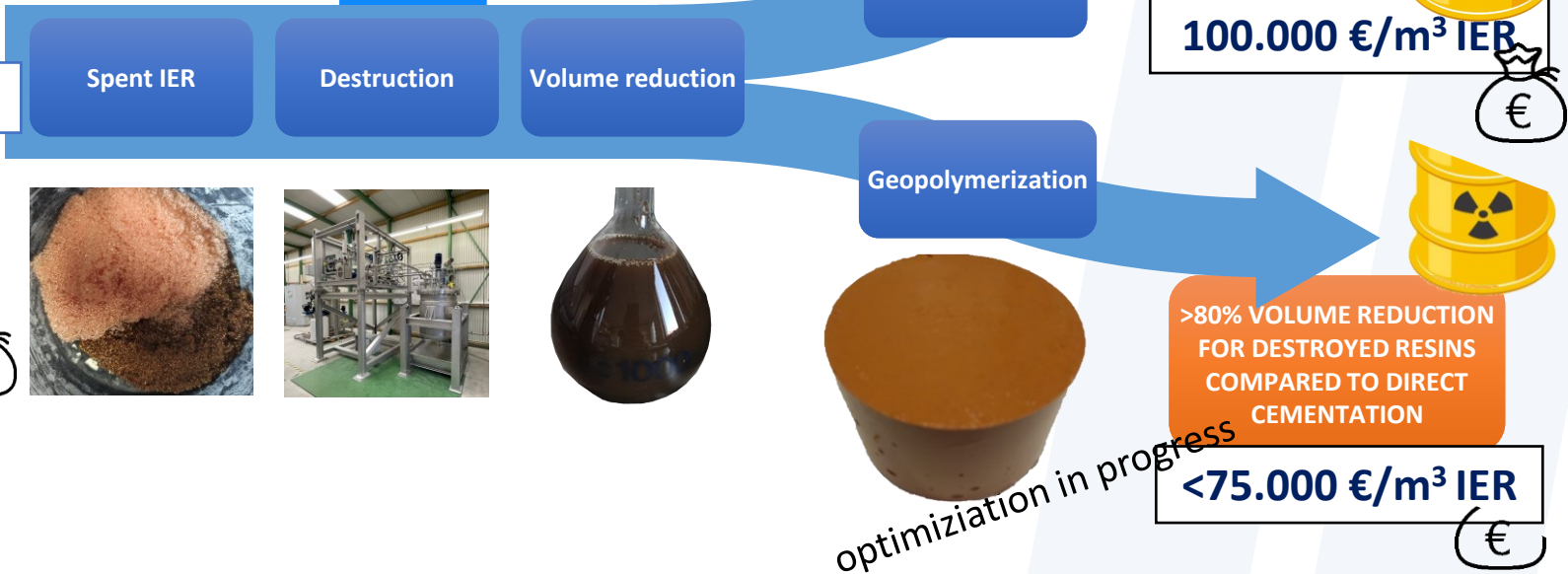
Direct vs. after Chemical Treatment

Criterion	Direct solidification	solidification after liquefaction	
		Cementation	Geopolymerization
Waste volume increase by conditioning	Factor of 3-4	No increase Factor of 1	Slightly decrease Factor of 0,75
Swelling of resin beads	Possible	Resin beads do not exist	
Organic content in final waste package	Approximately 15 wt.%	Approximately 2 wt.%, can be reduced to 0.01 wt.%	
Waste characterization	Difficult due to inhomogeneity	Easy due to sampling of a homogenous solution	
Respect of radioactivity limits of waste package	In general no issue due to underloading	Easy due to concentration step	
Long-term pressure stability	Low due to swelling and gas generation by decomposition	Excellent due to no swelling and no generation of gas by further decomposition	

CUT STORAGE COSTS BY >80%

woellner
framatome

State of the art:
Volume of directly
cemented spent IER,
common recipe



400.000 €/m³ IER



Cementation

75% VOLUME REDUCTION
FOR DESTROYED RESINS
COMPARED TO DIRECT
CEMENTATION

100.000 €/m³ IER



Geopolymerization

>80% VOLUME REDUCTION
FOR DESTROYED RESINS
COMPARED TO DIRECT
CEMENTATION

<75.000 €/m³ IER



woellner
chemical solutions

22 000 Ltr.

woellner

Lösungen die ankommen...