ZERO BRINE Project Meeting – WP5

June 21th, Athens

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NTUA, UNIPA, TUDELFT, CTM,

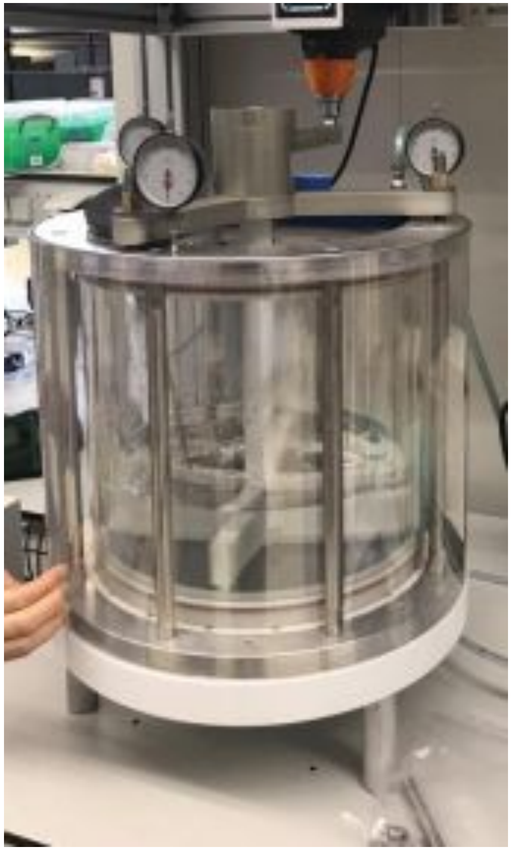
5.1 - Refurbishment and minor design modifications (upgrade) of pilot brine treatment systems

Technology	Current Activities	Planned finalization
MED	- Refurbished and fully installed on the Greek BEC - Ready for upcoming experiments on the UEST Lab	M18
EFC	- Ready for shipping to WP4	M18
Crystallizer	- Lab scale: Multiple Feed – Plug Flow Reactor (MF-PFR), CSTR, CrIEM - Pilot unit: MF-PFR for recovery of Mg & Ca - Ready for shipping to WP2	M18

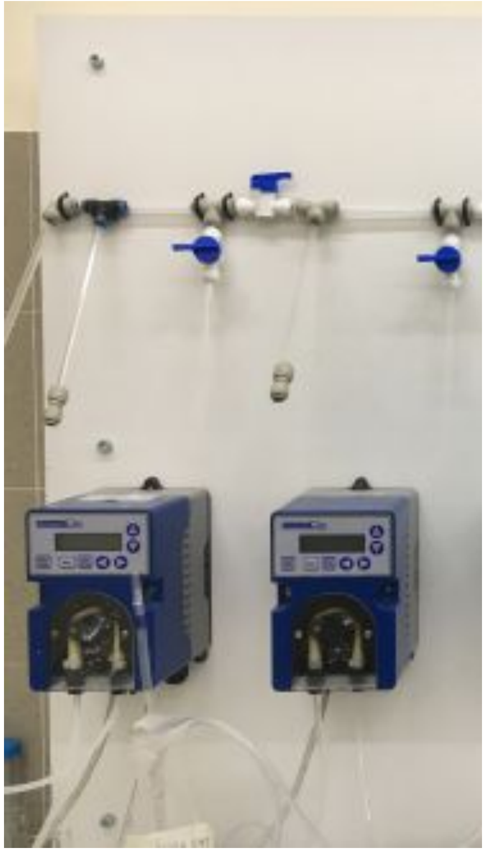
DLR

5.1 - Refurbishment and minor design modifications (upgrade) of pilot brine treatment systems

MED



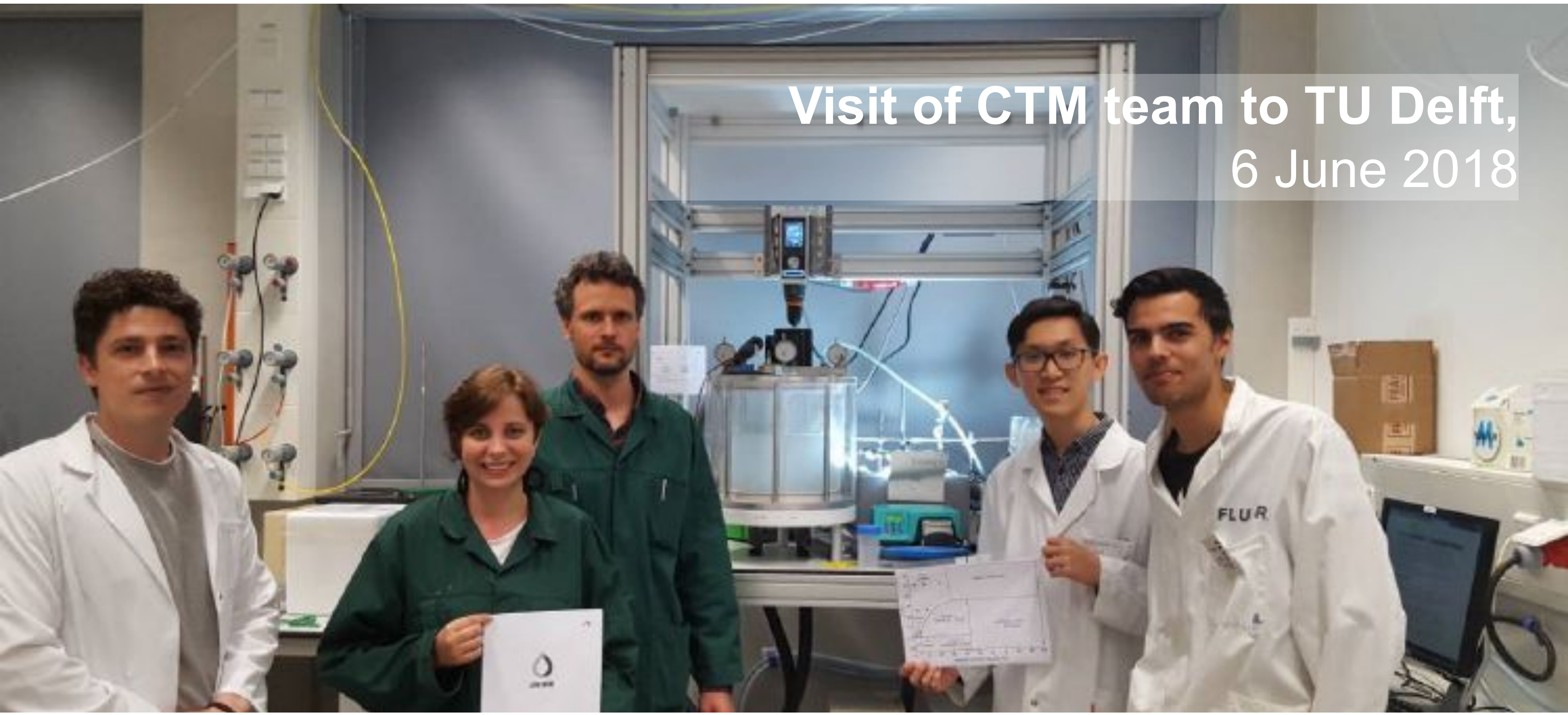
EFC



Crystallizer

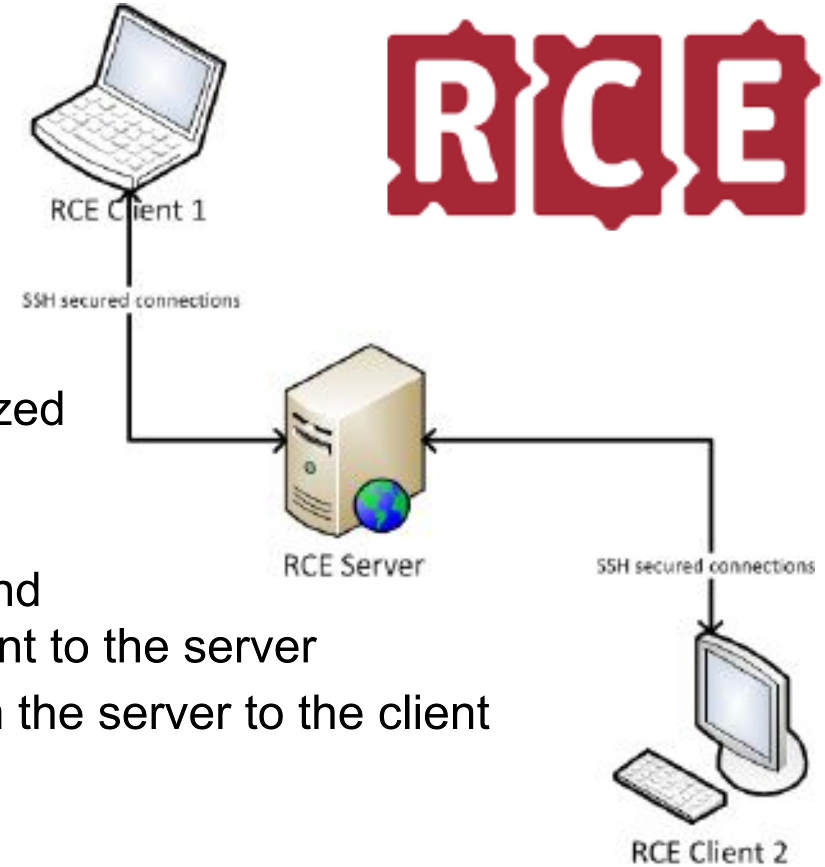
5.2 - BECs

Subtask 5.2.2: Plans for shared use of BEC equipment



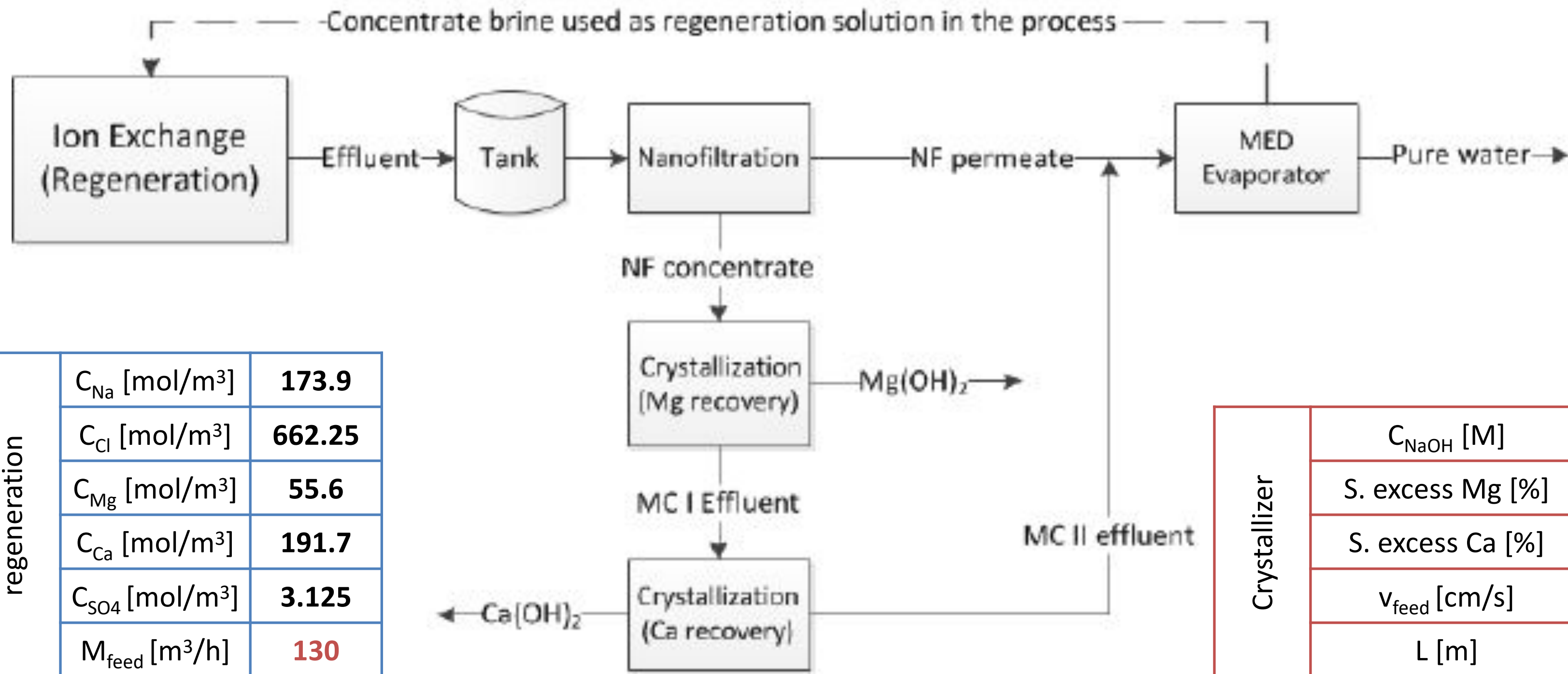
5.3 – Development of technology libraries (software tool) and integration into a common platform

- Java framework by DLR for remote and shared use of models/simulations
- Simulations are defined as workflows which consist of linked modules
- Environment consists of a server and one or more clients
- Simulation code has to be installed on the RCE Server and can be run by all authorized clients
- Configuration of simulations and required input data can be provided by the client and are automatically transferred from the client to the server
- Results are automatically transferred from the server to the client



Model	Responsible	Main Features	Status
MED	DLR/Python	- Forward-feed and parallel-cross feed arrangement - CAPEX (Module Costing Technique) and OPEX estimation	10/17
RO	DLR/Python	- Single stage or permeate staging arrangement - varying P_{feed} and n_{stages} for a required R (cost min)	02/18
NF	DLR/Python	- Batch and plug flow reactor - Economic estimations based on overall mass balances	current
Cryst.	DLR/Python	- Hierarchical model: from membrane to plant scale - CAPEX and OPEX	04/18
MD	DLR/Python	-	pending
IEX	DLR/Python	-	pending
EFC	CTM/Matlab	- Data Driven approach: bench scale monitoring results - Theoretical energy model: stochastic, thermodynamic - Link to energy supply unit (NH_3-H_20 absorption chiller)-EFC	current
ED	CTM/Matlab	- Data Driven approach: bench scale monitoring results - Theoretical energy modelisation: lumped modeling	pending

First treatment chain: EVIDES Site I

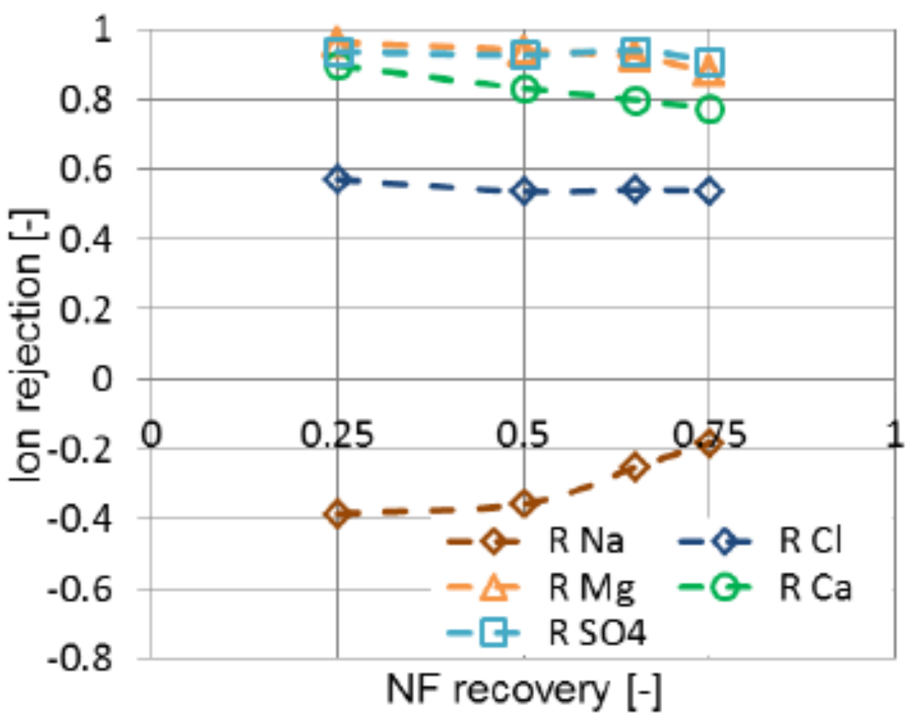


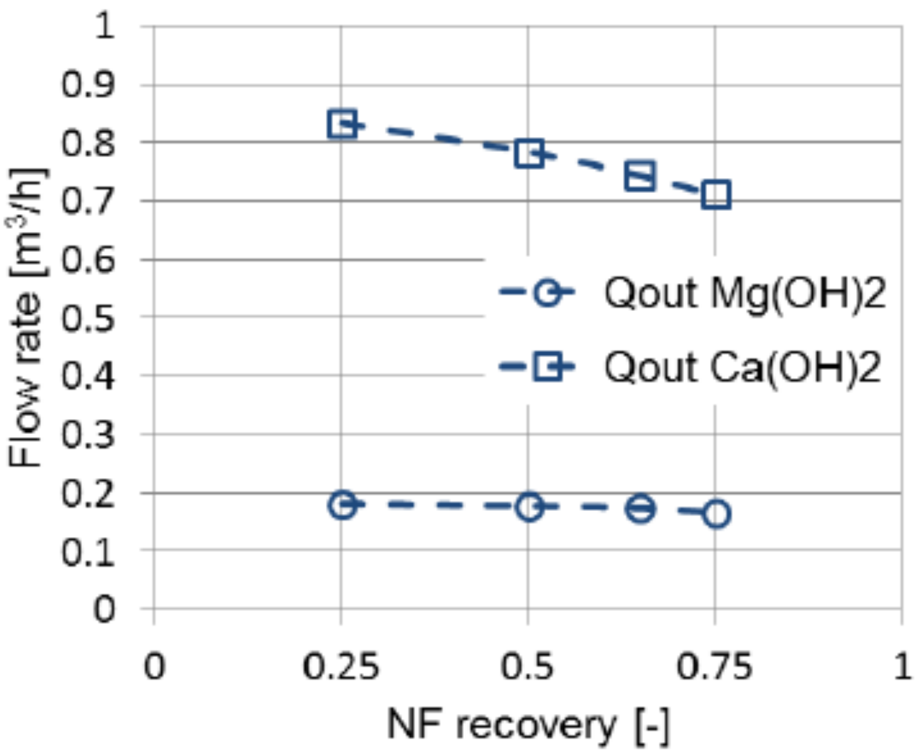
Effluent from the IEX regeneration	C_{Na} [mol/m³]	**173.9**
	C_{Cl} [mol/m³]	**662.25**
	C_{Mg} [mol/m³]	**55.6**
	C_{Ca} [mol/m³]	**191.7**
	C_{SO4} [mol/m³]	**3.125**
	M_{feed} [m³/h]	**130**
NF membrane properties	r_{pore} [nm]	0.45
	δ_m [µm]	3
	ε_{pore} [-]	56.5
	X_d [mol/m³]	**40**

Input data still to be discussed and finalized

Crystallizer	C_{NaOH} [M]	1
	S. excess Mg [%]	10
	S. excess Ca [%]	10
	v_{feed} [cm/s]	4
	L [m]	2.3
MED (plane)	N [-]	13
	P_{steam} [bar]	1
	T_s [°C]	100
	T_N [°C]	38
	Heat cost [$/MWh$_{th}$]	**10**

Nanofiltration recovery variation: preliminary results





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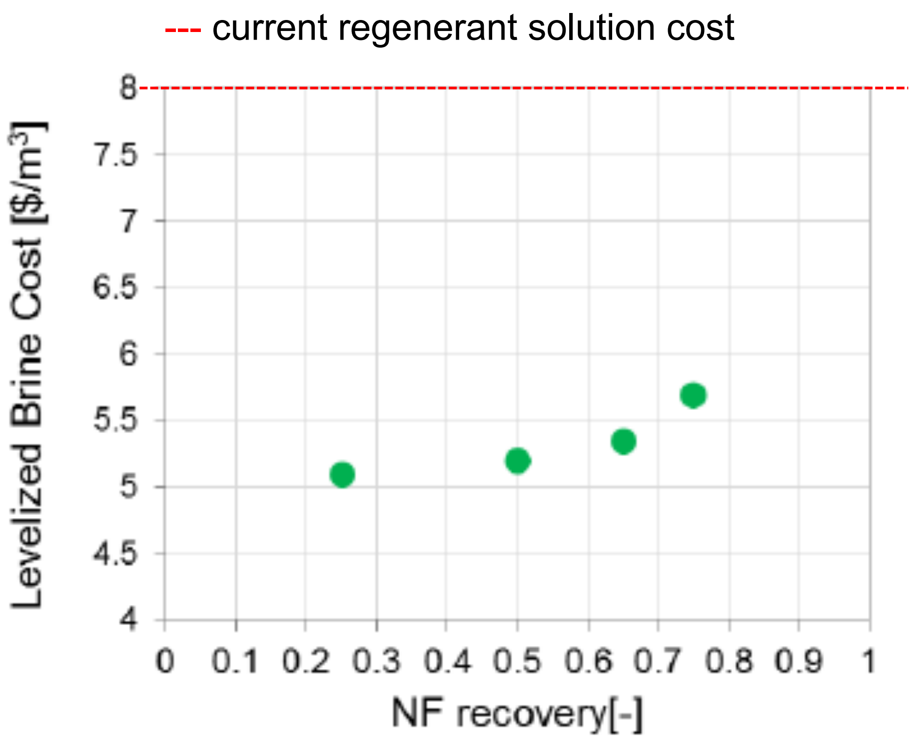
Nanofiltration recovery variation: preliminary results



LBC_{tot} ~ 5 $/m^3 with R=25%

Current cost of regenerant = 8 $/m^3

Dependency on NF membrane properties

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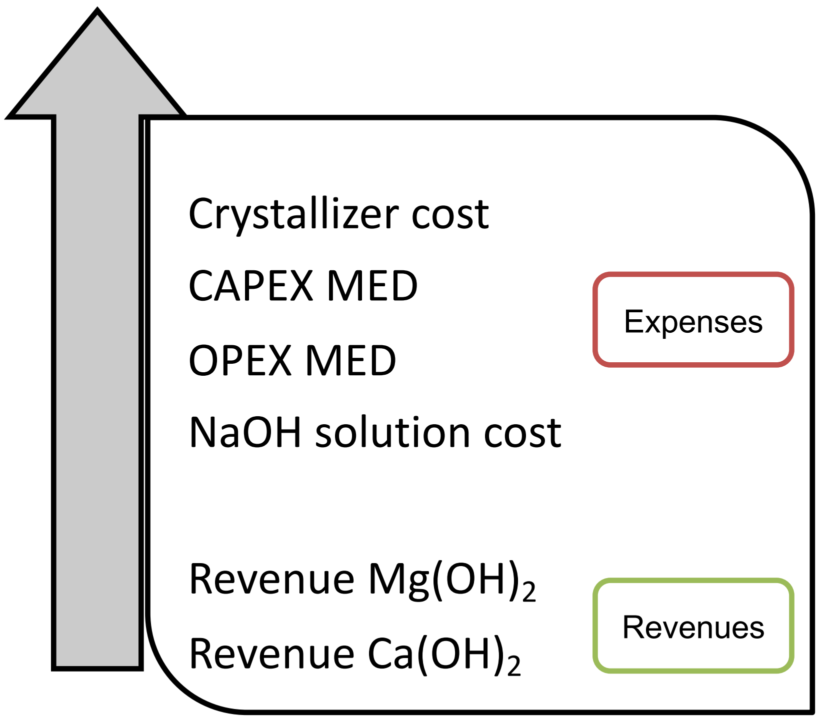
Edge case: chain without NF (preliminary results)

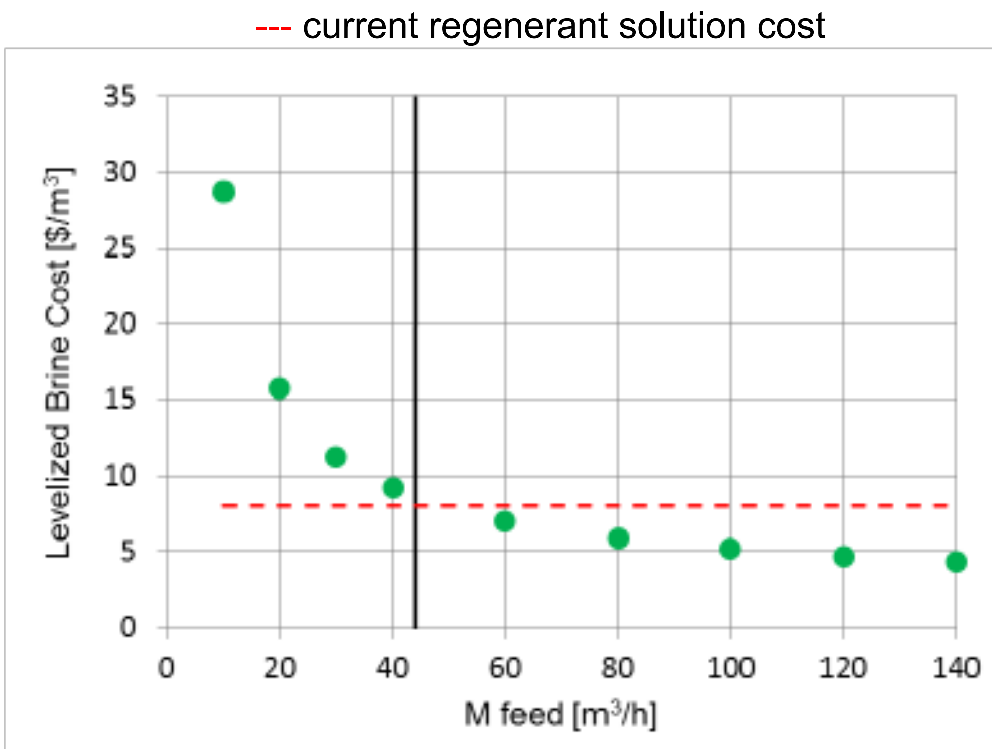
- Presence of NaCl is not problematic in the crystallizer
- Lower concentrations of bivalent ions are favorable in the crystallizer (not too high supersaturation)



LBC_{tot} = 3.9 $/m³ < LBC_{tot} for the full chain with R=25%

DLR

Feed flow rate variation: preliminary results

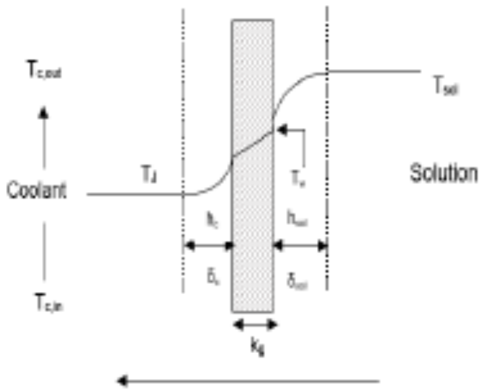


Flow rate produced in the Evides Site I?

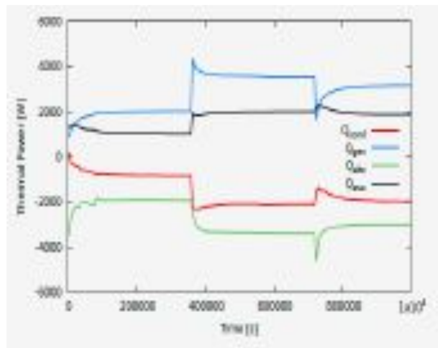
If 1060 m^3/day ~ **45 m^3/h:**

- LBC ~ 8.7 $/$m^3$
- without NF ~ 6 $/$m^3$

Subtask 5.3 – EFC Model



Temperature profile across the subcooled heat exchanger surface. Tj is the average coolant temperature inside the jacket and Tsol is the average temperature of bulk solution in the crystallizer.



Example of a variation of thermal power delivered in function of operational conditions

- ✓ Multiple criteria evaluation and determination of the optimal operating strategy, studying:
  - Energy consumption
  - Operating costs
  - CO_2 eq emissions
  - ....

- ✓ Driving temperature variation (desorber)
- ✓ Sink temperature variation
- ✓ Variable cooling demand
- ✓ Operational constraints: impurity, crystal growth, etc.

DLR