POND BIOLEACHING MODELLING

Introduction of numerical approaches to support the development of a pond bioleaching unit

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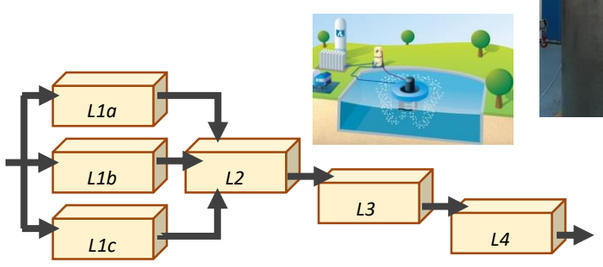
In the frame of the H2020 NEMO project, bioleaching was used to recover metals from mining residues. Complementary numerical approaches were developed to simulate and benchmark several process scenarios for bioleaching pond as well as to support further up-scaling of this concept

Bioleaching pond

PILOT EXPERIMENTS

New bioreactor concept: ponds with floating agitators for pulp suspension and gas-liquid mass transfer



> *Pond bioleaching schema in cascade*

> *1.8 m³ pond bioleaching pilot*

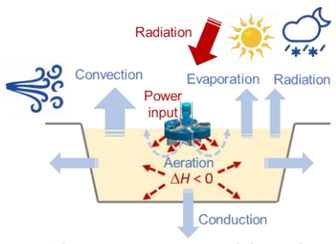
Pilot scale studied on the two study case considered in NEMO project

→ Results used to calibrate and validate: CFD model (Fluent), Mass balance and process simulation (SysCAD) and Heat balance (Matlab)

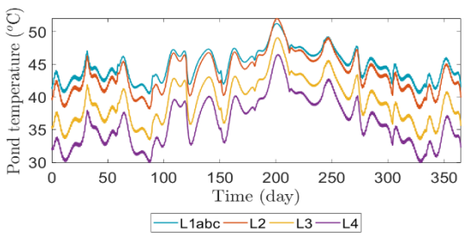
Heat transfer

POND TEMPERATURE

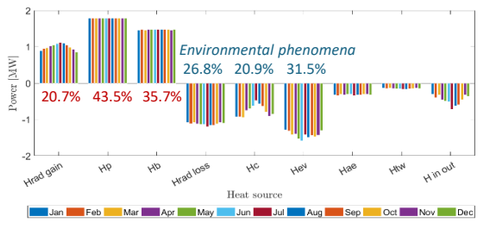
- Heat balance mainly dominated by the reaction enthalpy
- Environmental conditions have little influence
- Temperature maintained in a suitable range (40-50°C) by controlling inlet conditions



> *Phenomena considered*



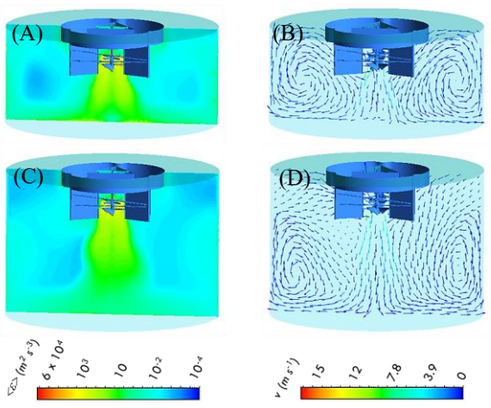
> *Pond temperature over the year*



> *Heat contributions*

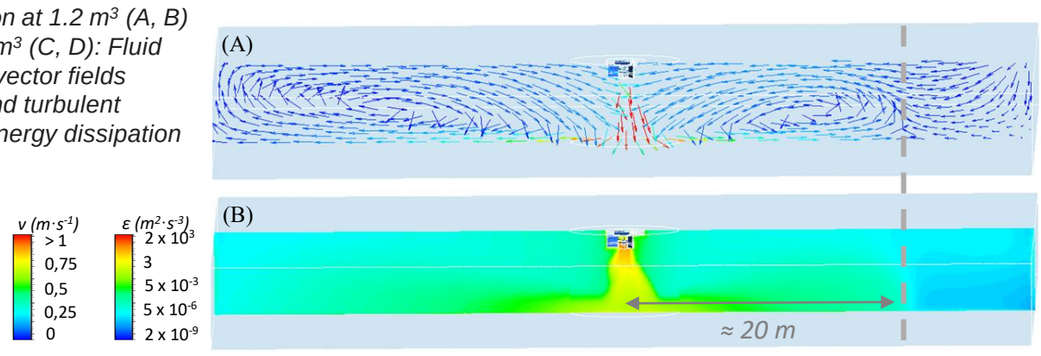
CFD

INFLUENCE VOLUME



> *Pilot reactor CFD simulation at 1.2 m³ (A, B) and 1,8 m³ (C, D): Fluid velocity vector fields (A, C) and turbulent kinetic energy dissipation (B, D)*

- CFD modelling → pilot scale experiments (1.2 and 1.8 m³), no dead zones using the floating agitator (validated experimentally)
- Pond in single phase conditions → agitation influence volume is 20 m long (at 6 m height)



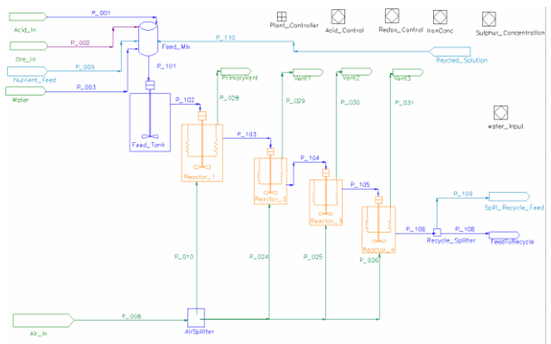
> *Pond CFD simulation: Fluid velocity vector field (A) and turbulent kinetic energy dissipation (B)*

Process simulation

SIMULATION WITH RECYCLING STREAM

- Bioleaching process simulation (SysCAD) using experimental data from 114-L pilot CSTRs in cascade
- PLS composition, reagents consumption and a complete mass balance obtained

> *114-L bioleaching pilot CSTRs*

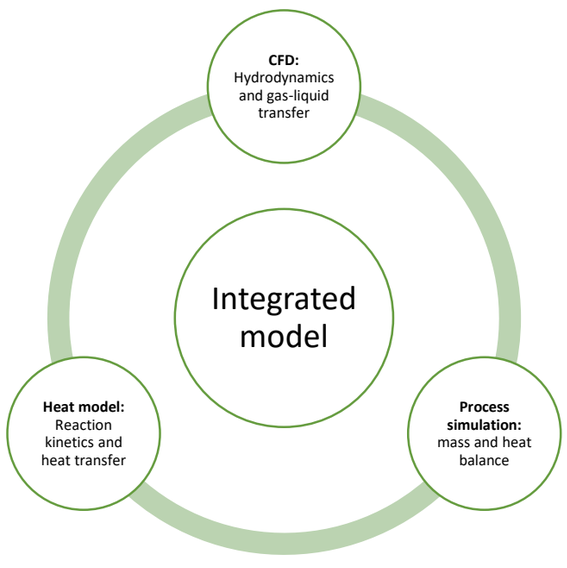


> *Bioleaching process simulation flowsheet*

- Simulation → Recycling stream and further upscaling
- Data for economic and environmental assessment

Perspectives

UPSCALING AND MODEL INTEGRATION



- Additional experimental data to calibrate and validate models
- Integration of the models →
  - Adaptable tool for pond bioleaching feasibility evaluation
  - Easy sizing and assessment of pond bioleaching technology at full industrial scale

Summary

Computational Fluid Dynamics (CFD) was used to model the hydrodynamics of the system and to define the volume of influence of one single agitator, the number of floating agitators and the mechanical power dissipated into the fluid.
A model was then developed and solved using MatLab software to quantify the contribution of the operating and environmental conditions to the heat balance and their influence on the pond temperature. Various scenarios were simulated (equatorial and sub-arctic climates, sulfide concentration, pond geometries…).
Finally, a process simulation was developed using SysCAD to simulate the flowsheet of the process and take into account the recirculation loop that could not be studied experimentally. As the solid was composed of various mineral phases, the use of such model, based on the kinetics obtained experimentally, also enabled to provide data for economic and environmental assessment.

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