Sulfate removal from mine leachate: Development of full-scale bioreactor system (SULFREM)

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Project duration
20220401 - 20251231

SWEDISH MINING INNOVATION

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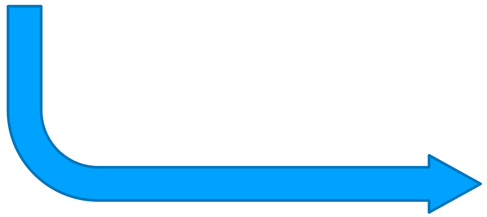
Sulfate in mine water discharge



Rainwater and snowmelt leach out sulfate from waste rock deposits into mine site drainage that eventually flows into surface water recipients

- Decisions from the Swedish environmental court have increasingly required limitations on sulfate (SO_4^{2-}) discharges from mining operations to surface water systems
- While concentrations > 1000 mg/L sulfate are not uncommon in mine drainage, court rulings have restricted discharges to < 150 mg/L (30-day average).
- The development of water treatment methods for reducing sulfate discharges are needed, and have motivated this project.

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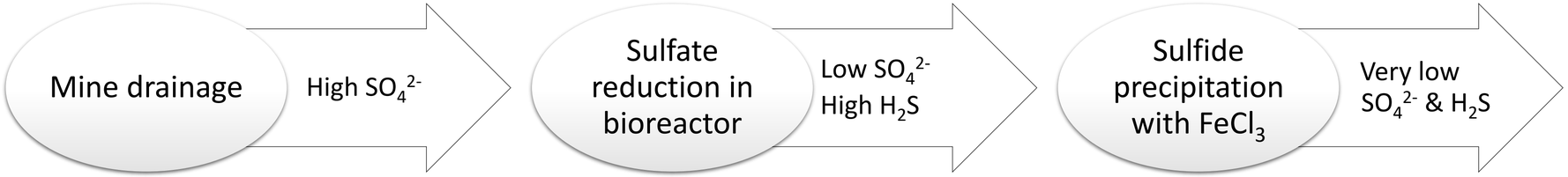
The solution



Dissimilatory sulfate reduction

$$SO_4^{2-} + 2CH_2O \xrightarrow{\text{Sulfate-reducing bacteria}} H_2S + 2HCO_3^-$$

Sulfate + organic matter ⟶ *hydrogen sulfide + bicarbonate*

Anaerobic process to be used as a first step to remove sulfate from mining waters. Lactic acid neutralized to pH 7 used as carbon source.

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Goals of the project

✓ 1. Achieve a >90% reduction in sulfate concentrations in laboratory experiments by refining bioreactor design criteria obtained in previous studies,

In progress 2. Design, construct and operate one bioreactor that achieves >90% sulfate removal

✓ 3. Avoid inadvertent emissions of other compounds in achieving goal 2,

✓ 4. Investigate the feasibility of recovering metals from the bioreactor media,

Postponed 5. Disseminate project results to regulators, end-users, and the public.

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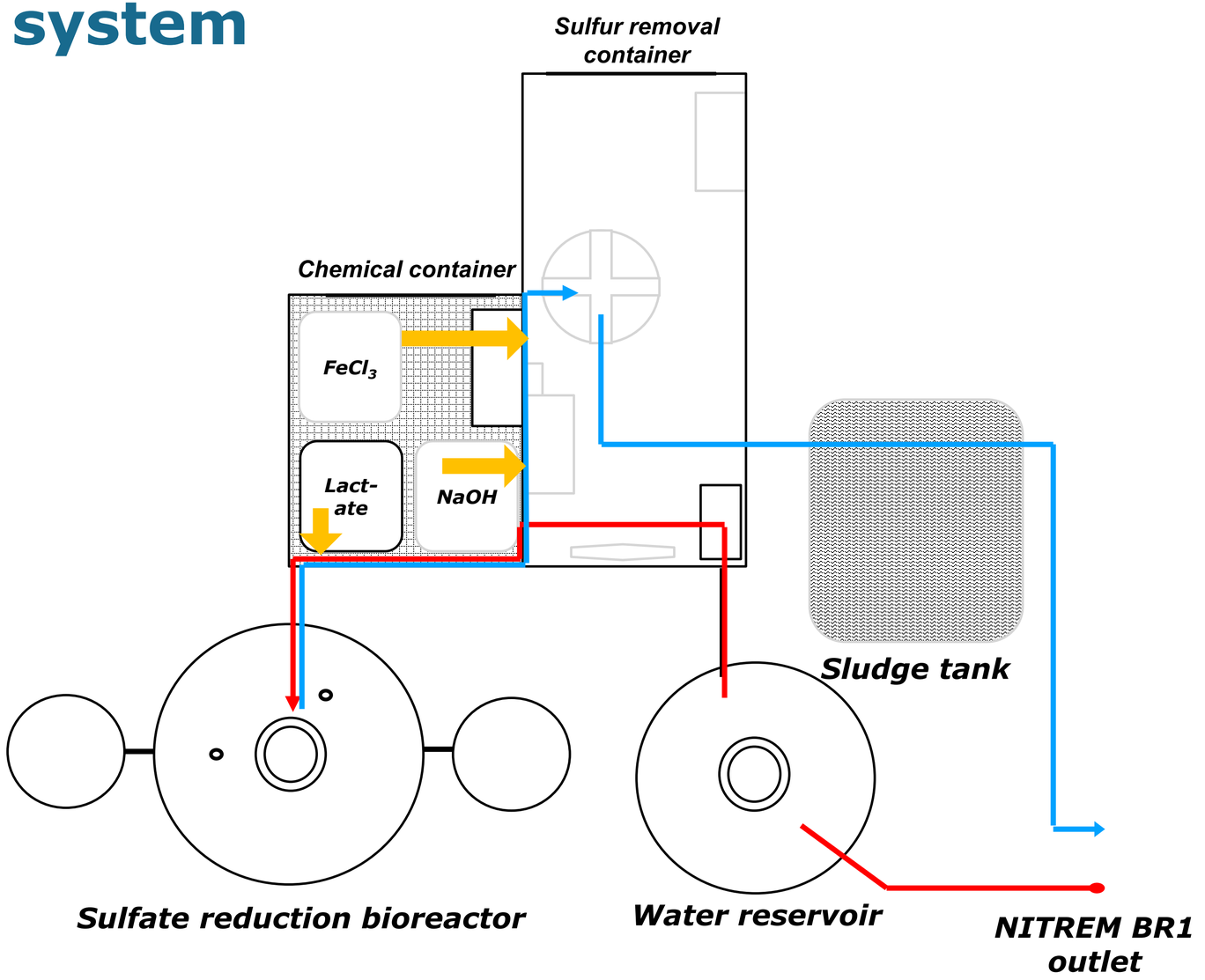
SULFREM bioreactor system

- Water flows in a downward direction through the bioreactor, filled with > 3m woodchips
- Lactate used as external carbon source for sulfate-reducing bacteria
- Ferric chloride and sodium hydroxide added to precipitate H_2S as FeS and elemental sulfur



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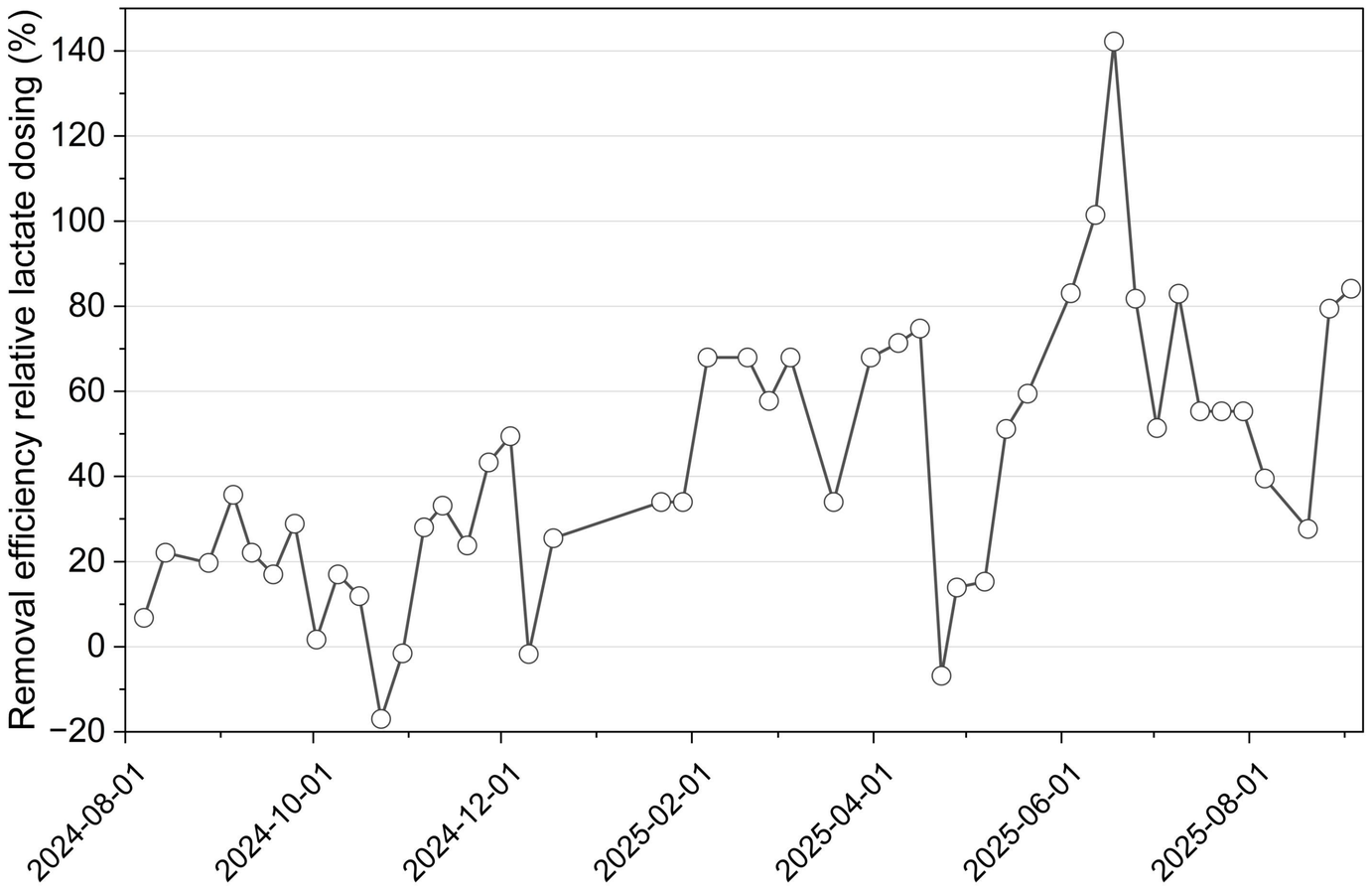
Bioreactor performance



- Sulfate removal has remained at a relatively low level due to:
  1. Limited dosing of lactate
     - Not readily available in large quantities
     - Delays in automatic dosing system for sulfur precipitation required keeping H_2S production at low levels.
  2. Competition for lactate by denitrifying bacteria
- Average sulfate removal efficiency after snowmelt period ca. 60%.

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Next steps

- During remaining project time:
  - Lactate dosing to be increased to acheive greater removal rates
  - New methods for H_2S removal currently being tested

- After end of project
  - Alternative, more available carbon sources to be investigated

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