OPTIMO ATCZ291

Optimization of sustainable sulfuric acid production for (bio)leaching processes in the waste sector

K1 MET
metallurgical competence center

Scientific Partners

BOKU

UNIVERSITAS MASARYKIANA BRUNENSIS

Financially supported by

Interreg
Österreich-Tschechische Republik
Europäischer Fonds für regionale Entwicklung

Expert Meeting, Tulln, 14 December 2022

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metallurgical competence center

Sulfuric acid

- Sulfuric acid is the world's largest bulk chemical, but production high energy requirements
- On the other hand, elemental sulfur occurs in large amounts as a by-product

Aim

- Demonstrate the high potential of extremely acidophilic, sulfur-oxidizing bacteria
- An efficient biogenic sulfuric acid production
- Bioelectrochemical metal recovery

Circular economy

- Use of the produced sulfuric acid for (bio)leaching of secondary raw materials

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Partner

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K1-MET, Linz: Lead partner and experiments with thermophilic bacteria and bioelectrochemical zinc recovery

BOKU, Institute of Environmental Biotechnology, Tulln: experiments with mesophilic bacteria and heap bioleaching

MU, Masaryk University, Brno: Metal analytics, characterization of the microbial communities, kinetic analysis

Project budget:	191 949.09 € (85% funding rate)
Project duration:	01.01.2022 – 31.12.2022 (one year)
Funded by:	European Regional Development Fund (ERDF, INTERREG)

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Selection of suitable bacteria

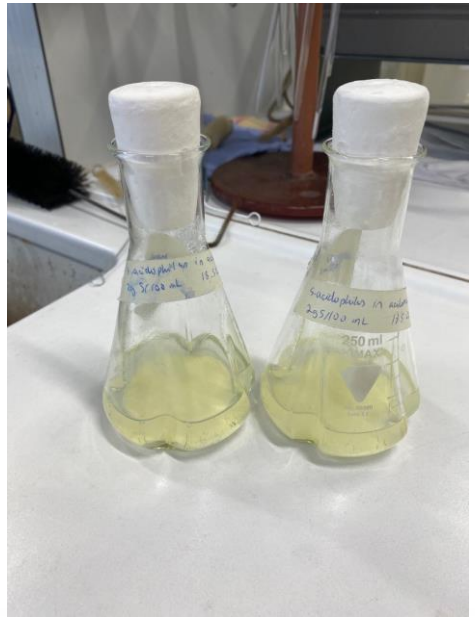
Bioleaching

- **BOKU: mesophilic bacteria: *Acidithiobacillus thiooxidans*, *A. caldus* and environmental sample (lake in Czech Republic)**
- **K1-MET: thermophilic bacteria: *Sulfobacillus acidophilus*, *S. thermosulfidooxidans***

Incubation with elemental sulfur

Screening according:

- **Produced acidity**
- **Sulfur conversion**
- **Optical density**



Incubation with elemental sulfur

Selection of potential waste streams

Biogenic Sulfuric Acid as a leaching agent

Transparent pharmaceutical blisters

White pharmaceutical blisters

Printed circuit boards (PCBs)

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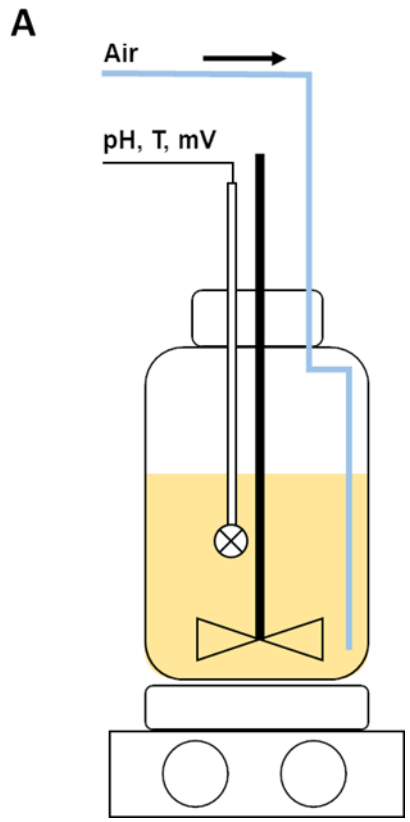
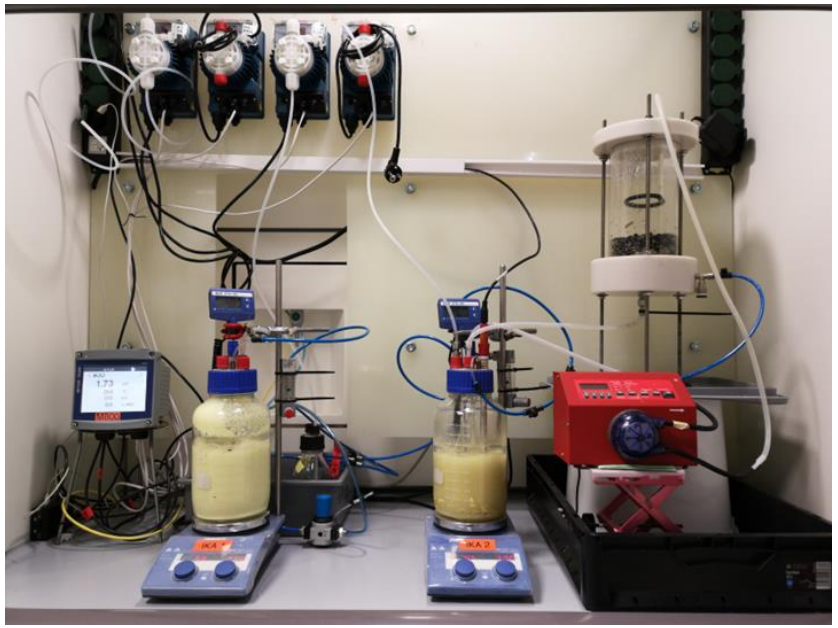
Selection of suitable parameters

Bioleaching at BOKU



(©IFA Tulln)

- **1.5 - 10% (w/v) elemental sulfur**
- **250 rpm**
- **30°C**
- **100 L/h aeration**
- **Minimal Medium (DSM35)**
- **Influence of CO_2 and O_2**


Laboratory Setup at BOKU (©IFA Tulln)

- More about **biogenic sulfur production at BOKU** today…

Biogenic sulfuric acid production and application for metal bioleaching from different waste streams

Dr. Klemens Kremser

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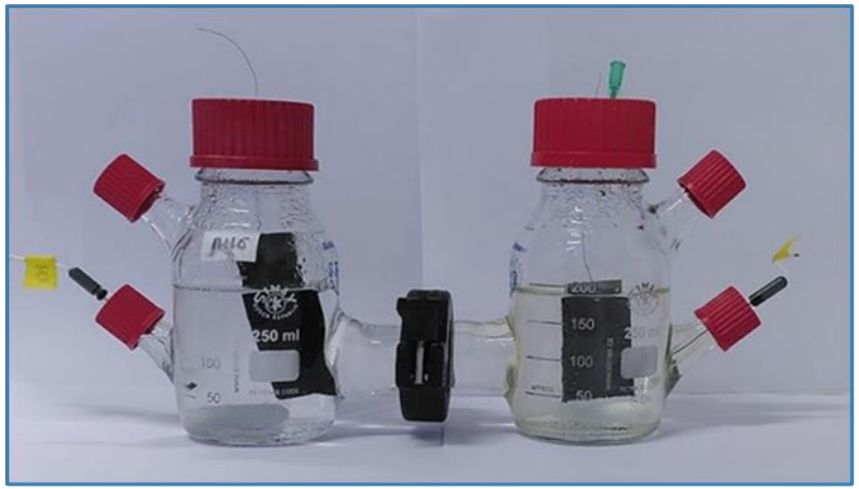
Bioelectrochemical Experiments

Zinc recovery at K1-MET

- **Set up of a microbial electrolysis cell (bioanode and cathode)**
- **Testing Zn recovery from synthetic solution**
  - >90% Zn recovery
  - Impact of cathode material (titanium, graphite)
  - Impact of flushing the cathode solution at Zn recovery
- **Sampling of electroactive biofilm → Analysis of microbial community (MU)**

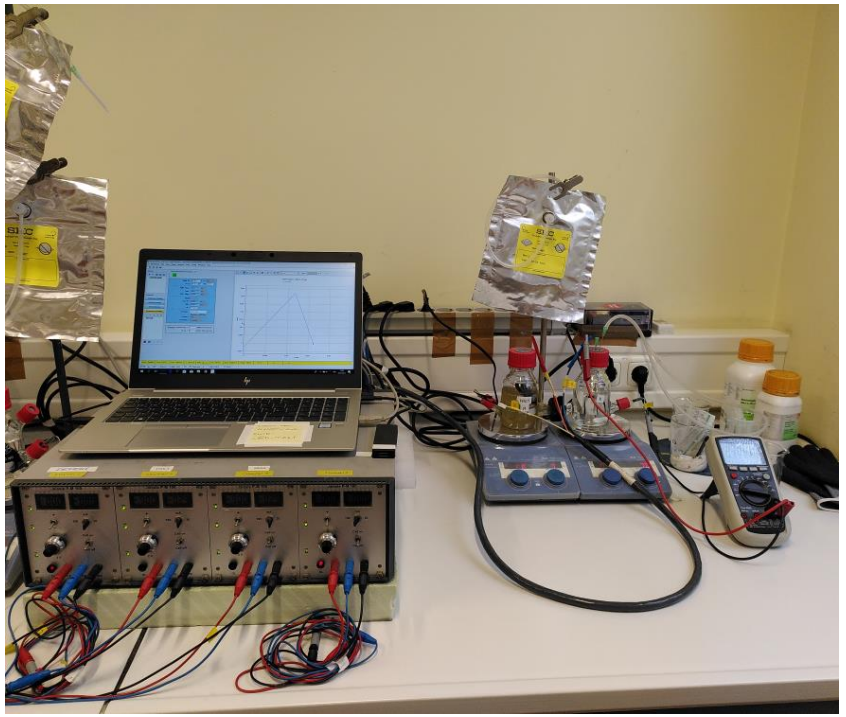


Microbial electrolysis cell

MEC1

Metal recovery from bioleachate - Method

Setup	
Cathode	**220 mL diluted bioleachate** Graphite Aerobic (without catholyte flushing)
Anode	220 mL Cheng medium (pH 7) Pretreated carbon felt electrode Anaerobic
Membrane	Proton exchange membrane (PEM)
Microbes	Mixed culture (inoculum sewage sludge)
Substrate	2x per week, synthetic wastewater (glucose, acetate, peptone, yeast extract)
Temperature	Room temperature (RT)
Monitoring	pH, current flow, anode/cathode potential, COD removal rate, Zn recovery rate
Applied potential	Anode: -100mV vs. Ag/AgCl (3M NaCl)



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Characterization of microbial communities

(Meta)genomic analysis at Masaryk University

- **Methods and Instruments**
  - MiniSeq System (Illumina) next-generation sequencing technology
    >> monitoring all prokaryotes
  - Quantitative PCR (QPCR)
    >> monitoring of the selected species or metabolism markers

https://www.illumina.com/

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Kinetic analysis

Masaryk University

- Study of the limitation of sulfur and iron oxidation by gases such as O_2 and CO_2
- Model bioleaching microorganism *Acidithiobacillus ferrooxidans*
- Impact on mixing and aeration requirements in operational processes

(©MU)

- **More today** ….

The production of biogenic sulfuric acid is limited by the sulfur substrate and potentially by carbon dioxide

Dr. Martin Mandl

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