**Available internship positions for ERASMUS+ students**

**Academic year 2023-2024**

The Biochemical Process Engineering research group at Luleå University of Technology (Sweden) consists of >20 people working with biomass pretreatment, carbon dioxide capture and utilization, anaerobic biotechnologies and bioelectrochemistry for bioremediation. Within the research group researcher in bioelectrochemistry team are studying the design and use of enzymes and electroactive microorganisms for bioremediation, production of fuels, chemicals and materials. Their expertise ranges from microbial physiology, fermentation, electrochemistry, process technology to modelling of bioprocesses. During the past year, we have hosted many international students engaging with diverse and interesting projects related to biotechnology (<https://www.ltu.se/research/subjects/Biochemical-Process-Engineering/Utbytesstudenter?l=en>).

We are currently offering various internship projects for ERASMUS+ students as listed below. Preferred duration for the internship is 3-6 months. The internship can start either the winter or spring semester.

**Contact:**

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For applications and deadlines, please consult with the ERASMUS+ office within your university.

***Project 1: Electricity generation using bacteria and sulfide containing wastewaters in Microbial fuel cell***

Description:

Sulfide in wastewaters and in gaseous emissions are harmful to human health and also to the environment. It is necessary to treat sulfide before discharging to environment. In this project, we are developing a bioelectrochemical system to oxidize the sulfide and at the same time recover the electricity using the microbial fuel cell (MFC). In MFC, a consortium of electroactive bacteria is used as catalyst to oxidize the sulfide and the electrons generated in the reaction are transported to the electrode (anode) which can be harvested as electricity by integrating an oxygen reducing cathode.

Activities:

1. Setup of two compartment reactors
2. Growing bacteria on the electrode
3. Sampling and analysis of liquids for sulfide and chemical oxygen demand measurements
4. Measurement/ monitoring of electric current/ voltage and Reporting

***Project 2: Electricity generation from the mixing of acid mine water and alkaline solutions by using cation and anion-exchange membranes***

Description:

Acid mine drainage (AMD) is highly acidity (pH 2–4) effluent from mining sites which contains high level of sulfate and heavy metals such as Fe, As, Mn, Al, Cu, Zn, Pb, and Cd. If left untreated, AMD can have a severe effect on ground and surface water, causing an ecosystem damage with a potentially risk impacting human health. Research on bioelectrochemical approach of AMD treatment combining the recovery of valuable metals have been undergoing in our lab. For this process, first, neutralization of AMD is required by adding bases like lime and caustic soda. We are proposing to carry out this neutralization process by using ion exchange membranes, so that the transport of ions across the membranes during the mixing of acid mine drainage water and alkali solution will generate electricity. In this project we are fabricating and testing the multi- flow compartment reactor (see photos) which contains several pairs of alternately placed cation and anion exchange membranes. It is aimed to generate measurable potential difference across the anode and cathode electrodes located at the two ends of the reactor. The feasibility of stable electricity generation, voltage maximization and usable electricity production will be studied by changing the number of acid-base compartments in the reactor.

Activities:

1. Fabrication and setup of leakage free reactor using polycarbonate plates and frames.
2. Setup and operation of the reactor
3. The profile of pH and voltage at different flow rates and concentrations of acid mine drainage and alkali solution will be continuously measured and monitored.
4. Measurement of current and voltages
5. Sampling and analysis and Reporting

***Project 3: Treatment of acid mine waters using sulfate reducing bacteria (SRB) and electricity***

Description: Bacteria can treat the acids mine drainage (AMD) by converting the sulfuric acids to solids particles of sulfides. Bacteria needs energy and carbon source for their metabolism. Several carbon sources such as acetate, glucose and hydrogen gas are used for the microbial growth. The addition of large amount of substrate for the biological treatment of AMD can be impractical. Instead of chemical addition, electricity can be provided as energy source in bioelectrochemical systems. In this project. we are investigating various SRB for their capability to treat the sulfuric acid/sulfate with the use of electricity as energy. SRB will be grown at the cathode side of bioelectrochemcal reactor where the bacteria can use electrons from electricity to chemically reduce the sulfate to sulfide. Once sulfide is produced, it also removes heavy metal ions as precipitates.

Activities:

1. Setup and operation of the bioelectric reactor
2. Measurement of current and voltage
3. Sampling and analysis of water samples for the determination of sulfate, organic acids and monomers concentrations
4. Reporting

***Project 4: Cultivation of various sulfate-reducing bacteria for the degradation of plastics and their monomers in electricity-driven reactor.***

This project involves anaerobic culturing of various sulfate reducing bacteria (SRB) pure strains purchased from microbes’ collection center (DSMZ). These SRB will be used for the biodegradation of plastics and monomers eg. ethylene glycol and also the sulfate from the wastewater is removed. Small electric voltage is provided via two electrodes in the single chamber bioreactor. The growth and reduction of sulfate in the AMD will be measured along with the changes in the plastic monomers concentrations in the liquid.

Activities:

1. Serial anaerobic cultivation of sulfate reducing bacteria: inoculation, sampling and analysis and reporting
2. Growing strong SRB culture from natural sources with sequential culture: inoculation, sampling and analysis, reporting
3. Bioelectrochemical reactors setup and operation: setup, startup, sampling and analysis, Reporting

***Project 5: Growing electroactive bacteria to produce fatty acids and alcohols from CO2 and acetate in microbial electrosynthesis.***

Description:

This project involves anaerobic culturing of pure strains of various CO2 fixing anaerobic bacteria (homoacetogens) with H2 gas as energy source. These bacteria produce acetate from CO2 and H2 at neutral pH. But when subjected to acidic pH and highly reduced condition, the acetic acid can be converted to ethanol and further on with the combination of carbon chains of acetate and ethanol, it produces medium chain organic acids by microbial chain elongation process. These bacteria will be adapted to grow under acidic condition with acetate (2 Carbon) and ethanol (2 carbon) as substrate and the production of medium chain acids such as butyrate (4 Carbon) and caproate (6 carbon) will be monitored. For chain elongation, bacteria need high reductive energy conditions. This high energy condition can be created by provided electricity input in microbial electrosynthesis reactor (shown in photo). The adapted bacteria will be used in MES reactor to obtain high-rate production of medium chain acids. In this project, we are investigating various bacteria for their capability to use electricity as energy source for high-rate production of medium chain acids in MES. Small electric voltage is provided via two electrodes in the MES reactor. The growth and production of acids and alcohols will be measured and monitored continuously.

Activities:

1. Anaerobic cultivation of several CO2 fixing bacteria: inoculation, sampling and hplc analysis, Reporting
2. Adaptation of bacteria in Acetate and Ethanol as substrate for medium chain acids production: sampling and hplc analysis, Reporting
3. MES reactors setup and operation: setup, startup, sampling and hplc analysis, reporting

Other projects may be also available during the academic year 2023-2024. Please contact us for further information.

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