Summer jobs at ENERSENSE 2023

This summer we are offering the chance to be involved in one of our exciting research projects within ENERSENSE. The ENERSENSE research group focuses on energy storage, energy efficiency, and sensor technology in an interdisciplinary way. There are 8-10 summer positions available, and the different topics of these are listed and described below. All projects are under the supervision of our Ph.D. candidates, postdocs and researchers. If you have any questions about the projects, please contact the responsible person. We especially encourage students that might be interested to continue with a master project, to apply.

Practical information:

- Five weeks of full-time work, with pay rate 22 (student assistant salary system).
- Start-up in early June with some flexibility towards the student's availability.
- Specific requirements are listed under the positions.
- Delivery of a poster is required at the end of 5 weeks.

How to apply?

If you are interested in one or more of the summer jobs, please send in your motivation letter, CV (including relevant skills and competencies), and a grades-overview. In case you want to apply for multiple positions, send your top three preferred projects.

Please send this information to markus.s.wahl@ntnu.no with the email-subject "ENERSENSE summer internship" before the deadline on 31.03.2023 at 23:59.

List of topics

ESS2301 Electrochemical flow-cells for LiB recycling
ESS2302 Metal production with electrodialysis
ESS2303 Increase of specific energy for thicker electrodes
ESS2304 Capacity fade and analyzing battery degradation in lithium-ion batteries using PyBamm
ESS2305 Development of a surrogate model for P2D lithium-ion battery simulation
ESS2306 Lithium-ion batteries: live monitoring of lithium-ion concentration using fiber-optic sensors
ESS2307 Investigation of multi-floor lithium-ion giga-factories for potential declines in cost and environmental impacts

ESS2301 Electrochemical Flow-Cells for LiB Recycling

Supervisor: Simon B. B. Solberg

Overview:

Li-ion batteries for energy storage are more relevant than ever. At ENERSENSE we are investigating the usage of electrochemical flow-cells to recycle the valuable metals in spent batteries. This is achieved by acid leaching of the battery components and increasing the concentration of the valuable metal ions in the flow-cell system. We want to explore different factors experimentally, such as current voltage relationships and electrochemical impedance.

Goals and tasks:

Test the up-concentrating process of Li_2SO_4 in a membrane flow-cell, and measure the resistance of components of the flow-cell using EIS. This task is largely practical laboratory work.

Desired skills and Characteristics:

- Basic knowledge and understanding of electrochemistry;
- be able to work independently with high levels of initiative with guidance from their supervisor;
- have good problem-solving skills;
- enjoy working in a systematic manner in a research environment with many other researchers.

Important Information:

If you have any further questions, please contact: simon.b.b.solberg@ntnu.no

ESS2302 Sustainable Metal Production with Electrodialysis

Supervisor: Pauline Zimmermann

Overview: Due to readily available hydropower and a great amount of raw material in the ground, Norway has a leading position in the world's metal production. However, raw materials become depleted and the focus on sustainable use of resources is ever increasing. Norway's metal industry is facing the challenge of implementing circular economy in their process cycle. Electrodialysis is a promising technology for metal recycling from aqueous streams. It is a separation process based on ion-selective membranes that uses an electric potential to drive the separation. This practically oriented summer job focusses on laboratory studies on an electrodialysis setup with real industrial solutions from electrowinning of zinc, provided by Boliden Odda. The goal is to find out if electrodialysis is feasible to be used as solution purification method in Norway's metal industry to increase circular economy. The experimental method has already been established with model solutions. In this summer job, you will test the electrodialysis performance with the real industrial solution, therefore, bridging the gap between research and application.

Goal: Investigate whether electrodialysis is feasible as solution purification method in Norway's metal industry to increase circular economy. The experimental method has already been established with model solutions. In this summer job, you will test the electrodialysis performance with the real industrial solution, therefore, bridging the gap between research and application.

Desired skills and competencies:

- Experience with independent lab work.
- Basic understanding of (electro)chemistry and transport phenomena.

Important info: For questions about the summer job,
contact pauline.zimmermann@ntnu.no.

ESS2303 Increase of Specific Energy for thicker electrodes

Supervisor: Ejikeme Raphael Ezeigwe

Overview: Thick electrode architectural design offers an approach of improving the electrochemical performance of LIBs without altering its electrode chemistry. It involves the optimization of parameters to provide an improved mass-transportation efficiency within the electrodes and consequently electrochemical performance in lithium-ion batteries. The approach of increment in electroactive material loading while decreasing the passive electrode components has achieved a higher energy density goal for lithium-ion batteries.

Goal: In this summer job, you would fabricate electrodes of different thickness and assemble battery cells in two different configurations (two electrode and three electrode) then the electrochemical properties of the assembled cells would be tested.

Desired skills and competencies

- Experience with independent lab work
- Basic understanding of electrochemistry

For questions about the summer job, kindly contact ejikeme.r.ezeigwe@ntnu.no

ESS2304 Modeling Capacity Fade and Analyzing Battery Degradation in Lithium-ion Batteries using PyBaMM

Supervisor: Mahshid Nejati Amiri

The goal of this project is to develop a Lithium-ion battery model based on the PyBaMM model that can simulate capacity fade and investigate how different battery parameters affect battery degradation. The model will be based on a physics-based approach, using parameters such as electrolyte concentration, particle size distribution, and solid-state diffusion coefficients. The model will also include factors that contribute to capacity fade, such as solid electrolyte interface (SEI) formation, lithium plating and loss of active material.

Main tasks of the project are:

- Developing a PyBaMM model that can capture battery degradation and capacity fade.
- Sensitivity analysis to identify the most influential parameters including battery properties.
- Investigating the possibility of parameter estimation based on experimental data of Lithium iron phosphate (LFP) battery available in the literature.
- Documenting the methodology and results of the project and presenting them to the team.

Requirements:

- Basic knowledge of lithium-ion batteries and their operation
- Basic knowledge of Python programming language

Important info: For questions about the summer job,
contact: mahshid.n.amiri@ntnu.no

ESS2305 Development of a Surrogate Model for P2D Lithium-ion Battery Simulation

Supervisor: Mahshid Nejati Amiri

The objective of this project is to develop a machine learning algorithm to create a surrogate model for the pseudo two-dimensional (P2D) battery model. The algorithm will use synthetic data generated from simulations to train the model and map the properties such as thickness, porosity and particle radius to battery behavior. The goal is to enhance the accuracy and speed of the simulations by using the surrogate model, and to potentially identify new insights into the underlying physics of battery behavior. The student will participate in developing a suitable machine learning algorithm, such as a neural network, to train the model and evaluate its performance using metrics such as R-squared, mean absolute error, and root mean squared error.

Main tasks:

- Developing and testing various machine learning algorithms to create a surrogate model that can accurately map the input parameters to the corresponding battery behavior.
- Evaluating the accuracy of the surrogate model by comparing its predictions to the original P2D model for a range of input parameter combinations.
- Investigating the potential benefits of using the surrogate model, such as speeding up simulations or identifying new insights into battery behavior.
- Documenting the methodology and results of the project and presenting them to the team.

Requirements:

- Basic understanding of lithium-ion battery operation and modeling
- Basic experience with Python programming
- Basic knowledge of machine learning

Important info: For questions about the summer job,
contact: mahshid.n.amiri@ntnu.no

ES2306 Lithium-ion batteries: live monitoring of lithium-ion concentration using fiber-optic sensors

Supervisor: Markus Solberg Wahl

Overview: The limited lifetime of electrochemical energy storage solutions (batteries, fuel cells) is one of the main factors currently holding back the necessary transition into a more sustainable society. Understanding the ageing mechanisms of batteries is therefore important. What changes inside these systems that weakens performance over time? A micro-sensor placed on the tip of an optical fiber may give the answer.

Goals and tasks: This project will work with fiber-optic sensing, aimed at measuring the chemical environment inside batteries and fuel cells. This will include:

- Lab work (optical/chemical)
- An understanding of optical systems
- An understanding of light-matter interactions
- An understanding of chemical reaction kinetics

Desired skills and competencies:

- Experience within optics/chemistry/electrochemistry always good, but everyone interested is encouraged to apply.
- Experience with plotting and analysis in Matlab/Python
- Ability to work independently with some guidance from the supervisor,
- Enjoy working in a research environment with many other researchers.

Important info: For questions about the summer job, contact markus.s.wahl@ntnu.no

Investigation of multi-floor lithium-ion giga-factories for potential declines in cost and environmental impacts

Supervisor: Sina Orangi

Overview: Transitioning to multi-floor factories can potentially result in significant cost savings due to the more efficient use of space. By building up instead of out, factories can increase their production capacity without having to acquire additional land or build new facilities. This can also result in reduced operational costs, such as utilities and maintenance.

Multi-floor factories can also help to reduce the environmental impacts associated with manufacturing. By consolidating production onto a smaller footprint, factories can reduce their energy consumption and carbon emissions, as well as the amount of waste generated. Additionally, multi-floor factories can be designed with sustainable materials and technologies, reducing their environmental footprint.

Another potential benefit of multi-floor factories is the ability to centralize production and reduce transportation costs. By consolidating manufacturing onto a single site, companies can reduce the need to transport raw materials and finished products between multiple locations, resulting in lower transportation costs and reduced emissions from transportation.

Finally, transitioning to multi-floor factories can create more sustainable and livable urban environments. By building vertically, factories can help to reduce urban sprawl and preserve green spaces, while also providing job opportunities in more densely populated areas. This can lead to a more efficient and sustainable use of urban space, with benefits for both the environment and local communities.

Goals and tasks: This project will investigate how a multi-floor Lithium-ion giga factory plant will potentially bring cost and environmental savings compared to a conventional one

Desired skills and competencies:

- Knowledge of Lithium-ion giga factories' structure,
- Knowledge of architecture and design,
- Knowledge of life cycle environmental analysis,
- Previous experience in cost analysis.

Important info: For questions about the summer job, contact sina.orangi@ntnu.no