Summer jobs at ENERSENSE 2020

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 13 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 researcher. If you have any questions about the projects, please contact the responsible person.

Practical information:

- Five weeks of full-time work, with pay rate 22 (student assistant salary system).
- Open to all students, including bachelor and master students from any university.
- 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 enersense.ntnu@gmail.com with the email-subject "summer2020_firstname_lastname" before the **deadline on 08.03.2020 at 23:59.**

List of topics

ESS2001 Lithium-Ion Battery Production for Electrical Vehicles. *(Two positions)*
ESS2002 Thermal Conductivities of Lithium-Ion Batteries.
ESS2003 Fiber Optic Sensors for Measuring Temperature of Lithium-Ion Batteries.
ESS2004 Fiber Optic Sensing in PEM fuel cells.
ESS2005 Mineral Recycling - Membrane Characterization for Electrodialysis *(Two positions)*
ESS2006 Photosynthetic Wastewater Treatment. *(Two positions)*
ESS2007 Use of Birch Wood to Produce Biogas.
ESS2008 Modelling Processes for Liquid Biomethane Production with Aspen HYSYS®.
ESS2009 Sonochemical Synthesis of Nanocatalysts.
ESS2010 The Effect of Power Ultrasound on the Electrochemical Rest Potential.

#ESS2001: Lithium-Ion Battery Production for Electrical Vehicles.
Supervisor: Silje Nornes Bryntesen
Overview: There are **two** summer studentship positions available for the following project: Today, one of the hottest topics within scientific communities are lithium ion batteries (LIBs) for electrical vehicles. New technologies need to be introduced in order to excel in the expected large-scale battery production. The most energy requiring step in battery production is the drying of the electrode.
Goals and tasks: The students will get an experimental and theoretical background in battery manufacturing, drying kinetics and electrochemical properties of the LIB technology. Experiments will focus on synthesis of electrodes, coin cell assembly and electrochemical analysis. Based on the students' preferences, mathematical modeling of electrode drying may also be explored.
After the project, the students will be able to:

- Give a short overview of the Lithium-ion battery manufacturing process
- Give a short overview of material compositions, solvents, and drying methods of electrode drying.
- Understand and explain the drying process and kinetics
- Understand and explain the mathematical model
- Perform experiments at the laboratory.
- Document the work in the thesis/report.

Desired skills and competencies: Skills within renewable energy storage, modelling or thermodynamics are a bonus, but not required.
Any students who has a shared interest in the abovementioned project are most welcome to apply.
Important info: For more details or questions about the summer job, please contact silje.n.bryntesen@ntnu.no.

ESS2002: Thermal Conductivities of Lithium-Ion Batteries
Supervisor: Lena Spitthoff and Robert Bock
Overview: When increasing the size of Lithium-ion batteries, particularly during intense charging, large amounts of heat will be generated. This results in increased temperatures which has an accelerating affect on most degradation mechanisms and can lead to sever safety problems. Therefore, an understanding of the thermal behavior of Li-ion batteries for different operation strategies and the affects of the internal temperature distribution on the performance and safety of the battery are of upmost importance. The determination of thermal conductivity of battery materials allows modelling of internal temperature profiles.
Goals and tasks: The aim of the summer job is to measure thermal conductivities of different battery materials with a thermal conductivity meter. The results will be used to investigate internal temperature profiles using an existing model.
Desired skills and competencies:

- Combination of practical lab skills and Matlab programming experience,
- Ability to work independently with high levels of initiative with some guidance from the supervisor,
- Good problem-solving skills,
- Enjoy working in a research environment with many other researchers.

Important info: For questions about the summer job, contact lena.spitthoff@ntnu.no.

#ESS2003: Fiber Optic Sensors for Measuring Temperature of Lithium-Ion Batteries

Supervisor: Lena Spitthoff, Michael Fried and Ian Muri

Overview When increasing the size of Lithium-ion batteries, particularly during intense charging, large amounts of heat will be generated. This results in increased temperatures which has an accelerating affect on most degradation mechanisms and can lead to sever safety problems. Fiber optic sensor offer the opportunity to measure internal temperature of Lithium-ion batteries due to their extremely small size and being chemically inert to reactive environments.

Goals and tasks: This project will investigate the practical aspects of using fiber optic sensors for temperature measurements in Lithium-ion batteries. The aim of the summer job is the implementation of a fiber optic sensor in a working lithium-ion battery.

The following tasks are part of the summer project:

- Investigate methods of incorporating fiber sensors in different locations of a lithium-ion battery cell, and perform any needed modifications to the cell.
- Characterize sensor performance and perform measurements of an operating battery.

Desired skills and competencies:

- Combination of practical lab skills and Matlab programming experience,
- Ability to work independently with high levels of initiative with some guidance from the supervisor,
- Good problem-solving skills,
- Enjoy working in a research environment with many other researchers.

Important info: For questions about the summer job, contact lena.spitthoff@ntnu.no.

#ESS2004: Fiber Optic Sensing in PEM fuel cells.

Supervisor: Michael Fried, Ian Muri

Goals and tasks: The aim of this summer project is to develop methods for in-situ fiber optic sensing for Proton Exchange Membrane (PEM) fuel cells. This project will investigate the practical aspects of using fiber sensors in fuel cells, as well as to consider which fuel cell parameters can be measured.

The following tasks are part of the summer project:

- Investigate methods of incorporating fiber sensors in different locations of a PEM fuel cell, and perform any needed modifications to the cell.
- Explore the use of alternative sensors such as tapered or etched optical fibers.
- Characterize sensor performance and perform measurements of an operating PEM fuel cell

Desired skills and characteristics:

- Previous lab experience.
- The student can collect and analyze experimental data.
- The student is motivated and can work in an independent manner.

Important info: For questions about the summer job, contact michael.fried@ntnu.no.

#ESS2005: Mineral Recycling - Membrane Characterization for Electrodialysis

Supervisor: Pauline Zimmermann

There are **two** summer studentship positions available for the following project:

Goals and tasks: The aim of this summer project is to measure the ohmic resistance and permselectivity of different ion-exchange membranes for the use in Electrodialysis (ED). ED is an emerging technology that uses an electric potential to separate different minerals in a solution through a membrane. Separation technologies are needed in all kind of industrial applications, for example to recover a certain metal from a mixed solution or to remove impurities from a process stream. Anion and cation exchange membranes determine the performance of the setup to a large extent. Therefore, different membranes are to be tested with regards to their ohmic resistance and permselectivity for ED of sodium chloride.

Two students will be working on the membrane characterization, one mainly on permselectivity measurements and the other one mainly on resistance measurements. The students should be experienced with working in the lab, preferably with electrochemical applications.

The following tasks are part of the summer project:

- preparation of experiments (solutions, membranes…),
- measurement of permselectivity and/or ohmic resistance for different membranes for ED,
- use of potentiostat (cyclic voltammetry, open-circuit potential measurements, EIS),
- use of software (Gamry, Excel, …) to analyze the measurements.

Desired skills and characteristics:

- The student can work in a chemical laboratory (preparing solutions, using measuring instruments, working safely…).
- The student can handle software to conduct and analyze experiments.
- The student can analyze and interpret data obtained from experiments.

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

#ESS2006: Photosynthetic Wastewater Treatment

Supervisor: Jacob J. Lamb

There are **two** summer studentship positions available for the following project:

Overview: The production of fish in recirculating aquaculture systems (RAS) can result in the accumulation of biological compounds containing high amounts of P and N. In order to improve the recirculation of the water used in RAS, these nutrients need to be reduced to avoid becoming toxic to the fish. A promising new French technology developed by the company **Inalve** may have potential for such mediation of N and P by growing microalgae. The Trondheim RAS company **Nofitech** is interested in assessing the **Inalve** technology for wastewater treatment of its RAS.

Goals and tasks: The task will be to use a small test facility for this, and carry out measurements of the degree of purification that can be achieved for this, and how the technology can be optimised for RAS in Norway.

Desired skills and Characteristics: Students must have:

- knowledge of mass-balance analysis, chemistry, process engineering and photosynthetic growth;
- be able to work independently with high levels of initiative with some guidance from their supervisor;

- have good problem-solving skills;
- enjoy working in a research environment with many other researchers; and,
- interesting in a renewable, clean future.

Important info: If you have any further questions, please email Jacob: jacob.j.lamb@ntnu.no.

#ESS2007: Use of birch wood to produce biogas

Supervisor: Seyedbehnam Hashemi and Jacob J. Lamb

Overview: Biogas is a mixture of gases mostly methane and carbon dioxide, which can be considered as alternative fuel. Biogas is produced by the breakdown of organic matters such as agricultural waste, manure, food waste and etc. in the absence of oxygen (i.e. anaerobic digestion (AD)). Recently, the use of birchwood as feed (known as substrate) for AD process has gained much interest due to its abundance. However, the use of birchwood in the AD process requires pre-treatment in order to increase methane content at the final product.

Goals and tasks: We have laboratory that students can test and produce biogas. In this position, we will focus on the methods related to pre-treatment of birchwood. The following tasks can be part of summer project:

- Literature review
- Substrate preparation
- Biogas production
- Laboratory analysis
- Biological modeling

Desired skills and characteristics:

- Students at master and bachelor level within chemical engineering, biological engineering or energy and environmental technology.
- Experience with working in laboratory
- Interested in research and writing reports
- Solution-oriented
- Experience with conducting laboratory tests relative to anaerobic digestion process is considered as positive point

Important info: Preferable for start-up in early June. Candidate should deliver a poster and a report at the end of the five weeks. For more information, you can contact me: seyedbehnam.hashemi@ntnu.no.

#ESS2008: Modelling processes for liquid biomethane production with Aspen HYSYS®

Supervisor: Sayed Ebrahim Hashemi and Donghoi Kim

Goals and tasks: Liquid biomethane (LBM) is an alternative fuel produced from biogas. In addition to liquefaction, LBM production requires gas purification in order to remove carbon dioxide and other minor elements. In this project, absorption-based gas separation (i.e. using amines) will be considered. A process model in Aspen HYSYS® is already available. The main focus of this project is to work on the process and improve its performance. For this position, the following tasks will be considered:

- Literature review to gain relevant knowledge
- Modification of an existing Aspen HYSYS® model

- Comparison of different configurations of the existing process in terms of energy efficiency
- Model fitting for the biomethane liquefaction part

Desired skills and characteristics:

- Students at master or bachelor level within chemical engineering or energy engineering
- Experience with modeling in Aspen HYSYS®
- Being familiar with gas purification and process modeling
- Interested in research and writing reports
- Solution-oriented

Important info: Preferable for start-up in early June. You should deliver a poster and a report at the end of the five weeks. For more information, you can contact me: ebrahim.hashemi@ntnu.no.

#ESS2009: Sonochemical Synthesis of Nanocatalysts

Supervisor: Henrik Erring Hansen

Goals and tasks: The aim of this summer project is to synthesize nanocatalysts for hydrogen evolution and oxygen evolution using ultrasound. By using ultrasound, we can optimize the nanoparticles' catalytic activity so that fuel cells and electrolyzers become cheaper and more efficient. Developing such technologies can therefore help transition our society away from fossil fuels into renewable energy.

As we will investigate nanoparticles, it is required that the student is familiar with nanotechnology and characterization of nanomaterials. A background in nanotechnology, materials science or chemistry is therefore an advantage. The following tasks are part of the summer project:

- Synthesize NiFe-nanoparticles using different ultrasound parameters.
- Characterize the nanoparticles.

Desired skills and characteristics:

- The student has experience with working in a chemistry lab.
- The student has knowledge about nanomaterial synthesis.
- The student is interested in nano science and renewable energy.
- Experience with the NTNU Nanolab is preferred.

Important info: When working with NiFe-nanoparticles, the student is required to follow the HSE-guidelines very carefully.

For questions about the summer job, contact henrik.e.hansen@ntnu.no.

#ESS2010: The Effect of Power Ultrasound on the Electrochemical Rest Potential

Supervisor: Faranak Foroughi

Overview: The use of power ultrasound (20kHz–2MHz) in electrochemistry, also known as sonoelectrochemistry, offers several advantages including: enhanced electrochemical diffusion processes, increased electrochemical rates and yields, increased process efficiencies, suppression of electrode fouling and degassing at the electrode surface, decrease in cell voltages and electrode overpotentials, and improved electrode surface activation. These effects are due to enhanced mass-transport of electroactive species from the bulk solution to the electrode surface caused by acoustic streaming and cavitation.

However, fundamental studies on the effect of ultrasound on the electrochemical rest potential (the potential of an electrode at which the cathodic and anodic reaction rates are equal in the absence of applied potential, Eapp) are scarce.

Goals and tasks: The main goal of this project is to study the effects of power ultrasound on the rest potential of Pt disc electrodes and seeing whether a sono-chemical potential term exists.

Important info: For questions about the summer job, contact faranak.foroughi@ntnu.no.