LUND UNIVERSITY

LTH
FACULTY OF ENGINEERING

Suggested master degree work within the LTH Profile Area Aerosols 2024

Department of Design Sciences

Degree Project in Aerosol Technology, MAMM05, 30 credits

Nasal Drug Delivery – Particle Deposition in the Nasal Cavity for Pharmaceutical Development

Contact person: Hugo Öhrneman

Project description: There are currently few nasal inhalation devices which rely on the active inhalation of pharmaceuticals and the mechanics of how drug particles of different sizes deposit in the nasal cavity are not fully understood. The goal of this project is to use a metal cast of the nasal cavity to investigate how particles of sizes between 2 – 50 µm deposit in the nose to determine how drug formulations can be optimized to reach the desired part of the respiratory tract when inhaled. Experiments will be performed in the aerosol laboratory at LTH and at the pharmaceutical company Iconovo. Work will include building a test setup as well as testing live drug formulation at Iconovo and comparing the results to standard methods used in the industry.

External partner: Iconovo

Exhaled aerosol sampler for respiratory infection diagnostics

Contact person: Malin Alsved

Project description: During the covid-19 pandemic, billions of oral and nasal swabs were used to detect covid infections; however, noses became sore, and it was overall an unpleasant procedure. So what if we just had to breathe into a mouthpiece, more or less like an alcohol test? During the pandemic, we detected infectious virus in the exhaled aerosol from persons with covid-19 but with an advanced instrument setup. The goal of this project is to develop a small point-of-care sampler for collection of exhaled respiratory aerosol, which can be used for infection diagnostics of bacterial, fungal and viral pneumonia, and we hope to use the device in research projects studying people with respiratory infections.

Microphysics of exhaled droplets

Contact person: Malin Alsved

Project description: Aerosols droplets are formed in our respiratory systems when we breathe and speak, and upon exhalation the water evaporates, leaving a dry solid particle. A large proportion of viruses in these aerosol droplets are inactivated during the drying process, but those that are still infectious in the dry particle often remain infectious for a long time. This project is focused on understanding the microphysics of these complex droplets that contain salts, proteins, lipids, and potentially microorganisms, using microscopy and spectroscopic methods. Thus, it will be a cross-disciplinary project including both laboratory work and theory, with a high degree of freedom and creativity.

Fire-fighter exposure and fire emissions monitoring using a low-cost sensor network

Contact person: Vilhelm Malmborg

Project description: In this project, you will address the potential risk of work-related exposure to air pollutants at the Revinge training ground, estimated to cause around 1500 premature deaths annually (Swedish Work Environment Authority, 2019). Daily fire drills at the site simulate scenarios resulting in smoke and air pollutant emissions. Your task is to develop, test, and validate a low-cost sensor network for continuous air quality monitoring. You will evaluate parameters based on previous data and install the network for real-time monitoring over a period of up to 6 months. Collaborating with occupational health personnel, you will assess the network's usability and identify measures to reduce exposure.

Evaluating the toxicity of non-exhaust traffic pollutants by analysis of oxidative potential (OP) and reactive oxygen species (ROS)

Contact person: Vilhelm Malmborg

Project description: This project emphasizes oxidative potential (OP) and reactive oxygen species (ROS) as key metrics to estimate health impacts of ambient air pollution. Anthropogenic sources, especially non-exhaust traffic and biomass combustion emissions, contribute to ambient OP. Your tasks involve assessing OP and ROS in brake, tire, and road wear emissions generated under controlled laboratory conditions. Your project, integrated into ongoing research funded by Swedish Research Councils VR, includes chemistry-related tasks, experimental work on PM generation and detailed particle characterization.

Fire emissions reduction from training objects at a firefighter training school (MSB Revinge)

Contact person: Vilhelm Malmborg
Project description: MSB Revinge hosts and develops firefighting training objects. Certain exercises result in unwanted smoke emissions, which can have long-term negative effects on health and the environment. You will study techniques for mitigating hazardous gas and particle (aerosol) emissions. In the project you will perform experimental studies on an existing training object at MSB Revinge. This setup has been installed with a scrubbing technique to mitigate the emissions. Equipment for quantifying smoke properties and the reduction potential is supplied from the LTH Aerosol Laboratory (IKDC). In summary, your project will investigate, theoretically and experimentally, cost-effective smoke mitigation techniques in a commercial fire-fighter training setup. Location: IKDC, Lund; MSB Revinge, Lund with co-supervisor Lasse Nelsson (MSB).

Low-cost biomass stoves targeted at low-income countries – what are their emissions?

Contact person**:** Christina Isaxon
Project description: Of the 1.1 million deaths in Africa annually due to air pollution, approximately 64 % is caused by Indoor cooking with solid biofuels. Much research and innovation are done to develop less polluting ways of cooking (i.e. more advanced stoves) targeted towards low-income countries, but these stoves are normally too expensive to be a realistic choice for most households. We aim to study two newly developed stoves (one using wood pellets and one using wood sticks) that are sold for only 20-50 USD, and which the producer claims “does not produce any harmful smoke”. This is a laboratory-based project in which the pollution emitted from these stoves shall be measured and characterized in detail, using authentic fuel from Sub-Saharan Africa, and compared to more traditional cooking methods such as open fire or clay stove.

In-cabin air quality

Contact person: Aneta Wierzbicka
Project description: Two students needed for a project with Volvo comparing cabin air purifying systems for particle and gas filtration performance. Studies have identified road traffic as a dominant source of ultrafine particles. The use of various means of transportation can account for a significant proportion of daily particulate exposure. Customers are becoming more aware of bad air quality consequences. It is therefore of great interest to investigate potential technologies to reduce the load of pollutants inside the cars, i.e., in the passenger compartment. The practical thesis work will be carried out at the Sustainability Centre at Volvo R&D in Gothenburg. Three different cabin air purifying systems will be compared when it comes to particle and gas filtration performance. Rig measurements will then be complemented with on road tests for particulate pollution.
External partner*:* Volvo Cars R & D: Climate Department & Materials Engineering Center, Gothenburg

Toxicity screening of particles in real time – laboratory evaluation of novel instrument

Contact person: Aneta Wierzbicka
Project description: Reactive oxygen species (ROS) are a group of free radicals which can be either present on the surface of particles or generated through chemical reactions between particles and cells. Exposure to particle induced ROS is believed to be the main toxicity mechanism responsible for the adverse health effects associated with inhalation of airborne particles. Current legislation uses particle mass concentration as a metric, but there is a need for a more health-relevant metric that captures the potential toxicity of the particles. Assessment of ROS has the potential of becoming such a new metric and provides an interesting alternative for pre-screening of particle toxicity. In the Aerosol Laboratory we have built an instrument which can assess ROS on particles in real time (time resolution in minutes) which is a huge advantage in comparison to off-line methods. The

thesis work will include laboratory experiments to assess the performance of the newly built instrument and tests on different sources of particles (e.g., secondary organic aerosols, particles from electronic cigarettes, cooking, candles).

Transport Emissions – Brake Wear Particle

Contact persons: Joakim Pagels, Yezhe Lyu
Project description: In the near future non-exhaust emissions will be the main source of aerosol emissions from the transport sector. EU just formulated the world´s first emission legislation value for Brake Wear Particle (BWP) emissions. This spurs a strong demand for *new experts* on the formation, characterisation, mitigation and health impacts of BWP as well as to develop low emission brake systems. This fall an extensive experimental campaign will be carried out at LTH, using the pin-on-disc method to investigate BWP in large detail with a unique combination of expertise in aerosol technology, tribology and toxicology. You are welcome to contribute to the campaign as part of an MSc thesis. You may bring and develop new competences in for example material characterisation and advanced aerosol data analysis. Another opportunity could be to design, validate and test a new set-up to measure the BWP electrical charge distribution using the Tandem DMA technique. Knowledge of the BWP charge distribution may be used to design effective mitigation techniques to strongly reduce BWP emissions.
Partners: Mechanical Engineering Sciences, LTH, Tampere University, Finland. Industrial partners may also be involved.

Emission Analysis of a Potential Zero Emission Propulsion System for the Shipping Sector

Contact person: Joakim Pagels
Project description: Conventional shipping propulsion systems based on internal combustion engines (ICE) are in addition to greenhouse gases, associated with substantial aerosol and gas emissions (PM,

NOx, SO2, UFP etc) with large adverse health impacts and societal costs. Within the Horizon EU project NAUTILUS a novel technique is developed for modular replacements of ICE with Solid Oxide Fuel Cells (SOFC). The goal is to reduce PM, NOx and SO2 by 99% compared to baseline using ICE. However, he SOFC system does not fully convert all fuel (fuel is in a first stage natural gas) to CO2 and water. To avoid pollutant emissions, a post combustor system is used. You will contribute to for the first time experimentally quantify the emissions from the SOFC-postcombustor system at a demonstrator unit at DLR in Stuttgart. You will be responsible for extensive emission data analysis and to determine the emission reduction potential of the technology. You will also (theoretically) assess the potential for emission reduction by using novel low-carbon fuels in the SOFC system (e.g. Green Ammonia and Methanol).
External partners: German Space Centre DLR, Stuttgart, SolydEra, MAN and shipping industrial partners

Department of Physics

Elevated tropospheric ozone and secondary organic aerosols episodes in Europe

Contact persons: Pontus Roldin, Ågot Watne
Project description: The interaction between nitrogen monoxide (NO) and volatile organic compounds (VOCs) emitted from the biosphere and anthropogenic sources impact both the air quality and climate on Earth. Sunlight, NO and VOCs facilitate the production of tropospheric ozone (O_3), highly oxygenated organic molecules (HOM) and secondary organic aerosols (SOA). In the proposed project you will use the chemistry transport model ADCHEM together with existing atmospheric field observations from a O_3/VOC/SOA European Monitoring and Evaluation Programme (EMEP) campaign in summer 2022 to investigate the factors governing high tropospheric

ozone and SOA episodes in Europe. The project requires some programming both for the atmospheric modelling task and for the analysis of the model and experimental results.
External partner*:* IVL Swedish environmental research institute

Constructing an Optical Tweezer Raman Microscopy system for applications in studying single nano pollutants

Contact person: Kim Cuong Le
Project description: Nano pollutants have gained increasing attention for their potential environmental and health impacts. Among them, black carbon, originating from incomplete combustion processes, poses a significant threat. These ultrafine particles not only contribute to climate change by absorbing sunlight, but also contaminate the air, water, and soil, with detrimental effects on both ecosystems and human health. Raman spectroscopy (RS) is a powerful technique widely employed for structural characterization. However, it typically necessitates thick samples to obtain discernible Raman signals while mitigating interference from substrates. This poses a challenge, particularly for environmental pollutants with low concentrations. Our aim is to facilitate the study of individual nanopollutants by advancing the use of Optical Tweezer Surface Enhanced Raman Spectroscopy. Optical tweezers enable the manipulation of single particles, while SERS shows promise due to its substantial enhancement of inelastic light scattering by molecules, with factors of up to 10^8 or greater.
Requirement: The master's thesis work will encompass the initial phase of the project, which involves constructing an Optical Tweezer Raman Microscopy system. The student is expected to possess a foundational understanding of lasers, optics, and programming. A strong willingness to delve into topics of personal choice and interest is essential.

Designing and constructing a spectrometer for remote sensing pollutants

Contact person: Kim Cuong Le

Project description: Nano-pollutants such as black carbon, plastics, and pollen grains can exacerbate allergies and respiratory conditions due to their inhalable size. Understanding and mitigating the impacts of these nano pollutants is crucial for safeguarding both environmental quality and public health. Our target is to develop hyperspectral lidar for remote sensing pollutants at elevated distances. In this project, the master student will design, construct, and apply the spectrometer to detect these pollutants in the atmosphere.

Requirement: The student is expected to possess a foundational understanding of lasers, optics, and programming. A strong willingness to delve into topics of personal choice and interest is essential. Because of the innovation and complication of the project, a half-pace is preferred so the student can work during two semesters.

AI/ML for improved climate simulations

Contact person: Johan Friberg

Project description: The stratospheric aerosol cools the climate and destroys ozone, creating holes in the ozone layer. Difficulties in quantifying the stratospheric aerosol load leads to uncertainties in our projections of future climate and the fate of the ozone layer. You will use AI/ML for feature classification in satellite data (from NASA), to retrieve clean signals of stratospheric aerosol. The final feature classification method will be used to produce a dataset that can be implemented in climate models to retrieve improved simulations of the future climate and ozone.

Engineering aerosols – Investigating the production of CuZn nanoparticles

Contact person: Linnéa Jönsson
Project description: *Spark ablation* is a method that can produce nanoparticles in the aerosol phase, thereby reducing the need for additional processing steps to clean the particles like in the case of chemical production. This project will involve the use of spark ablation to create CuZn (brass) nanoparticles and analyzing their properties by investigating their size distribution, shape, and composition. The work will be done in close collaboration with me, Linnéa, and the engineering nano-aerosol group at Solid State Physics, led by Prof. Maria E. Messing and Prof. Knut Deppert.

Department of Mechanical Engineering Sciences

A novel test method to generate road and tire particles

Contact person: Jens Wahlström
Project description: The purpose of the project is to further develop a laboratory test method to be able to experimentally study the influence of existing and future road surfaces on the generation and characteristics of airborne wear particles. The work will be in collaboration with researchers in road technology and aerosol sciences.