LUND UNIVERSITY | LTH FACULTY OF ENGINEERING

Suggested master degree work within the LTH Profile Area Aerosols 2023

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

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. Starting in January 2024. 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 and more aware of bad air quality consequences. It is therefore of great interest to investigate potential technologies to reduce the load of the pollutants inside the cars i.e., in 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 be then complemented with on road tests for particulate pollution.

External partner: Volvo Cars R & D: Climate Department & Materials Engineering Center, Gothenburg

More info: https://www.design.lth.se/english/article/aerosol-technology-in-cabin-air-quality-volvo/

Reproducible Laboratory Simulation of Biomass Combustion and Wildfire Emissions

Contact person: Joakim Pagels

Project description: Biomass combustion (residential heating, wildfires etc.) is a dominating aerosol source globally, with strongly varying properties dependent on combustion conditions and fuels. In this thesis project you will evaluate a cone calorimeter set-up where small fuel samples are combusted under various controlled and repeatable conditions. Particle size distributions as well as chemical composition will be evaluated. The project is mainly experimental and will include evaluation of a rich experimental dataset.

Aerosol Emission from Sustainable Aviation

Contact person: Joakim Pagels

Project description: Introduction of Sustainable Aviation Fuels (SAF) is expected to be the major pathway for the aviation industry to reach climate targets and net neutrality by 2050. Aviation aerosol emissions leads to adverse health impact and poorly constrained climate forcing, including high altitude effects. It is not known how a transition to SAF changes this. *In this thesis project* you will: Carry out a literature review on *health* & *climate* impacts of Aerosol Emissions from SAF, design an aerosol sampling and dilution set-up and carry out first experimental tests at the jet engine laboratory at Ljungbyhed airport (TFHS). The research project was recently funded by FORMAS and will be connected to the Competence Centre CESTAP at LTH with a large number of societal and industrial partners.

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 particulate reactive oxygen species (ROS)

Contact person: Vilhelm Malmborg

Project description: As part of the European Green Deal, this project focuses on the European Commission's directive regarding ambient air quality, emphasizing oxidative potential (OP) as a key metric. Anthropogenic sources, especially non-exhaust traffic and biomass combustion emissions, contribute to ambient oxidative potential. Your task involves assessing OP and particulate reactive oxygen species (ROS) in brake, tire, and road wear samples generated under controlled laboratory conditions. Your project, integrated into ongoing research funded by Swedish Research Councils VR and Formas, includes chemistry-related tasks and experimental work on PM generation.

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 toxicity of the particles. Assessment of ROS can provide such a new metric and provides an 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 (minute resolution) which is a huge advantage in comparison to off-line methods. The thesis work will include lab experiments to assess the performance of the instrument and tests on sources of particles (e.g., secondary organic aerosols, e-cigarettes, cooking, candles).

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

Contact person: Christina Isaxon

Project description: 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.

Department of Physics

Artificial Intelligence/Machine Learning 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 Artificial Intelligence/Machine Learning 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.

Speeding up nephelometry a factor thousand to depth resolve lung particle deposition

Contact person: Mikkel Brydegaard and Jakob Löndahl

Project description: The project is based on downscaling Scheimpflug lidar to count and measure individual aerosol particles in inhaled and exhaled air as a function of phase in the breath cycle.

Elevated tropospheric ozone and secondary organic aerosols episodes in Europe

Contact persons: Pontus Roldin and Ågot Watne (IVL)

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 from incomplete combustion processes, poses a major 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 nano- pollutants 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 involves constructing an Optical Tweezer Raman Microscopy system. The student is expected to have 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 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.

Department of Mechanical Engineering Sciences

Degree Project in Machine Elements, MMEM01, 30 credits

Brake wear emissions from trucks and trailers

Contact persons: Joakim Gripemark (Haldex) and Jens Wahlström

Project description: Haldex is a global disc brake manufacturer for heavy vehicles. These manufacturers must consider/develop solutions for the upcoming Euro 7 standard of emissions. In a friction brake there will always be wear particles. The Euro 7 standard will set the bar at a max of 7 mg of PM10 per kilometer per vehicle until 2035. In 2035, the limit is reduced to 3 mg/km/vehicle. The related framework for heavy vehicles above 3.5 tons is under development. Haldex is looking for one or two students to investigate and propose different roads forward to lower brake wear emissions. Lab, software and computer resources will be provided by Haldex at site in Landskrona.

External Partner*:* Haldex (Landskrona)

Particle emissions from train brakes

Contact person: Yezhe Lyu

Project description: Particle concentration in underground subway stations is significantly higher than in the urban environment above ground. Subway particles, with a large portion originating from train brakes, are more genotoxic than street particles. This experimental project will use specialized instruments to replicate train brake conditions, aiming to examine particle emissions across various braking scenarios. Online and offline particle samplers will be employed to assess the emitted particles. The gained insights will contribute to a deeper understanding of the health and environmental impacts of train particle emissions.