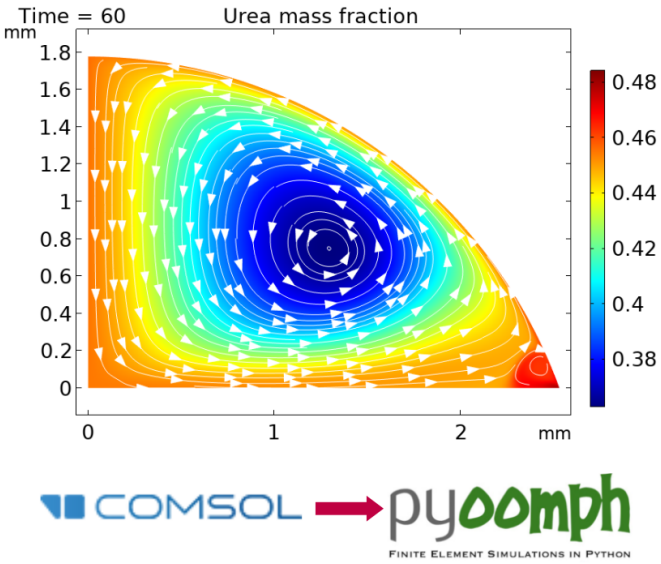
Numerical investigation of evaporation of UWS drop using pyoomph

TECHNISCHE UNIVERSITÄT DARMSTADT

Master thesis
From now on
22. April 2026

Motivation

Numerical simulations are required in a cost-effective prediction, analysis and optimization of complex systems. Urea water solution (UWS) is widely used in Selective Catalytic Reduction (SCR) systems to reduce harmful nitrogen oxide (NO_x) emissions from diesel engines. One of the most common undesired effect in using UWS is the formation of liquid films or drops on the walls due to incomplete evaporation. In these films and drops, water evaporates and urea concentration increases and eventually crystallizes in solid deposits. The investigation of UWS evaporation is fundamental to understand the process of deposit formation, and it can be extended to many other applications, such as inkjet printing and pharmaceutical production processes. Recently, the numerical investigation has been developed in the framework of COMSOL Multiphysics®, providing information regarding the processes of evaporation and deposit formation.



Evaporation of a UWS drop in COMSOL® Multiphysics - urea distribution in solution

Tasks

In the master thesis project, a new numerical framework will be used to conduct the simulations. *Pyoomph* is a open source environment developed in the University of Twente by C. Diddens and D. Rocha. It uses the object-oriented interface of *oomph* developed in the University of Manchester in a python environment.

The following work packages will be included:

1. Familiarization with the topic of UWS evaporation and formation of deposits.
2. Familiarization with the numerical strategies to model the UWS evaporation in the context of the pyoomph framework.
3. Creation of the numerical model in pyoomph from existing models.
4. Executions of simulations and evaluation of the results in comparison to older simulations.
5. Written report and presentation of the results.

Requirements

- knowledge of Python and c++
- Familiarity with numerical simulations, CFD and FEM
- Interests in numerical modeling of thermodynamic problems

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Appointment

From now on