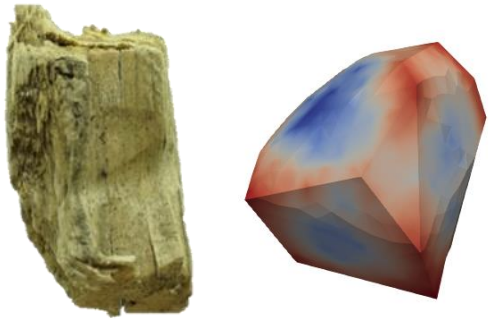
Vacancy:

Masterthesis

Implementation and validation of a model for thermal conversion of biomass particles in DEM

Topics: *thermal conversion, pyrolysis, C++, CFD/DEM, Intra-particle transport*
Thermal conversion (specifically pyrolysis) of biomass is an important process in many technical applications like combustion/gasification or simply a mean to produce certain products (biochar, biogas, tar) for later use. One of the most common occurrences of biomass is in the form of chipped wooden particles (cm-range) and therefore, it is of interest to observe the thermal conversion of these particles in detail. To achieve this, one can use numerical simulations and calculate heat/mass transfer inside as well as through the surface of a single, thermally thick particle.
The main task of this thesis is to implement a model that describes the thermal conversion of a single biomass particle. The implementation has to be conducted within the frame of an already existing in-house DEM-Code (written in C++). Within a particle, transport equations for heat and mass have to be solved and appropriate boundary conditions have to be applied. There already exists a plethora of models in the literature (e.g. Mehrabian et al.), which can be used as reference. However, a challenge may lie in the fact that many models developed use a 1D particle discretization, which are then not readily adoptable for arbitrarily shaped particles. One of the goals of this work is to implement a model that can be used on tetrahedral, body-conformal particle meshes and therefore, for any particle shape. This could possibly be achieved by extending a 1D model to 3D but other solutions (found through literature research) are also imaginable. As it is intended to use the model in DEM-simulations with a large amount of particles, computational efficiency also has to be considered during implementation.
After the implementation, the model has to be validated against experimental data to check if it delivers physically correct results. This can then be done by using experimental data from literature for simple particle shapes like spheres or cylinder. The modelling approach, equations utilized and assumptions/constraints of the model have to be documented in a clear and conscious way. This obviously applies to the results as well.



left: real woodchip, right: surface temperature of a DEM woodchip

Qualifications: The student should have an interest in physical/chemical conversion processes of solid particles and should have knowledge of basic heat/mass transfer mechanisms. Thus, previous attendance in corresponding in lectures is appreciated. Knowledge of numerical mathematics (transport-equations, solvers) and an interest for programming, especially C++, is required. Independence and reliability are a matter of course. The thesis can be written in English or German.

Bochum, 08.08.2024

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