Suggested Master of Science project for 1-2 students at the division of Mathematics LTH and Numerical Analysis:

Simulation of a wastewater treatment plant with positivity-preserving numerical methods

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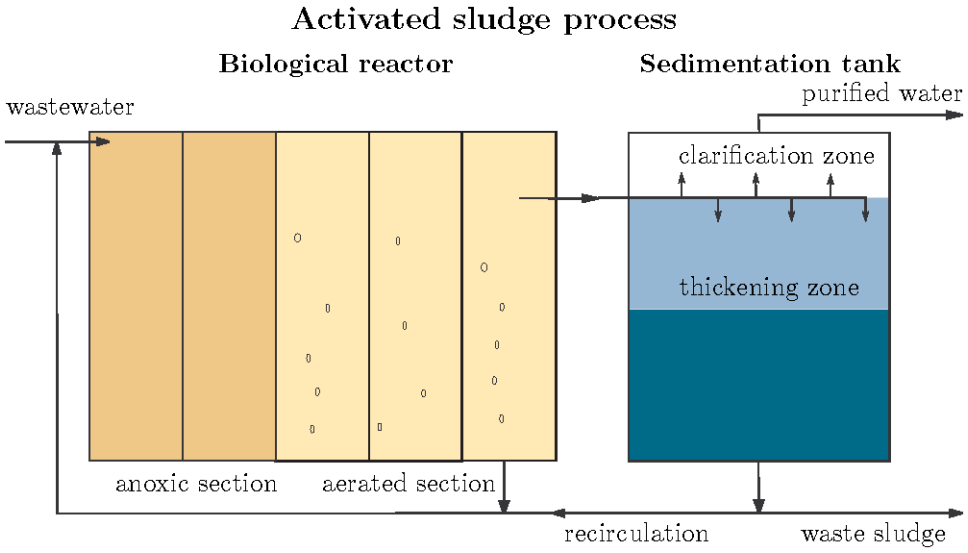
A major challenge for the future is to manage the water cycle more efficiently. This involves many researchers in biology, chemistry, mathematics, control theory, water and environmental science. We analyze, model and simulate the most important part of a sewage treatment plant, namely the active sludge process (see the figure) where bacteria consume nutrients and thereby remove nitrogen and phosphorus from the wastewater. This consists basically of a biological reactor and a sedimentation tank. The mathematical model consists of a system of ordinary and partial differential equations (ODE and PDE).



A problem with the numerical ODE solvers used today for the biologic reactor is that physical variables that should be positive, e.g., concentrations, may be negative. This can lead to completely unreliable simulation results. The tasks in the thesis work is that

- Implement a PDE solver for the sedimentation tank (described in a published article by the supervisor),
- implement the ODE model equations for the biological reactor and couple these with the PDE solvers,
- implement an ODE solver that preserves positivity and compare the efficiency of this in comparison to the standard solvers used today.