Mathematics and Computer Science Seminary
Djilali Liabès University - Sidi Bel Abbès - Saturday, 07/11/2026

From the Chemostat to ADM1: Models, Simulation and Control in Environmental Biotechnology



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Abstract

Mathematical models of bioprocesses are essential tools for understanding, predicting and controlling wastewater treatment systems, whose goal is increasingly the reuse of treated water. This presentation follows the modeling path from the chemostat, a two-equation system with Monod or Haldane kinetics whose equilibria, stability and bifurcations are well understood, to activated sludge models (ASM1, ASM2d, ASM3), membrane bioreactors coupling biology and fouling, and the anaerobic digestion model ADM1, with more than thirty state variables. Faced with this complexity, we discuss open mathematical questions: equilibria and stability analysis, model reduction through time-scale separation, parameter identification and identifiability from noisy data, state estimation, and control strategies to increase permeate production while reducing energy consumption. Simulation results from the Bioprocess team are used to illustrate each point.

Mathematics Subject Classification : 34D20, 37N25, 92D25, 93B11, 93B30, 93C10.
Keywords and phrases: Chemostat, wastewater treatment, ASM1, ADM1, membrane bioreactor, model reduction, parameter identification, control.

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