PhD course: Mathematical Modelling in Wastewater Treatment Processes and other Applications

10 credits

Period:

Jan.–May, 2017 (Jan 17 & 31; Feb. 14 & 28; Mar. 14 & 28; April 11 & 25; May 9 & 23).
Time: 9:00-12:00, Room: R1-343 (12 chairs).

Entry Requirements

Basic course/knowledge in environmental processes, single variable calculus, and basic skill in programming.

Learning Outcomes

Students who pass the course should be able to:

- Explain the basic concepts involved in modelling some of the fundamental biological processes.
- Represent the activated sludge process from basic to more complex model structure.
- Use and develop optimization tools to improve the performance of biological processes.

Content (preliminary version)

#	**Topic**	**Description**
1	The specific growth rate	Basic assumptions, derivation.
2	The kinetic function	Description of the most common kinetics functions, with and without substrate inhibition.
3	Microbial growth in a CSTR	Basic equations, steady-state points and wash-out condition, the case of different flow rates.
4	The plug-flow reactor	Basic equations, PFR as infinite CSTRs in series.
7	The settler	Ideal settler, Takacs model, Bürger-Diehl settler model, the approximate expression for the BD-settler model.
5	The activated sludge process (ASP)	Sludge age, ASP with ideal settler, ASP with PFR.
6	Activated Sludge Model no. 1 (ASM1)	Process rates, Güjer matrix, general assumptions, general description of ASM2 and ASM3
8	Photo-bioreactors	The basic (Droop) model, the irradiance models, other models.
9	Biochemical Methane Potential	Basic models, derivation of parameters.
10	Optimization problems	General idea, application in different problems: optimum volumes in bioreactors and ASP, optimization of photo-bioreactors, fitting curves to find optimum parameters.
11	Similarities in math modelling between different domains and applications	Guest lecture given by Prof. Erik Dahlquist.

The content in the previous table will be presented as one (and sometimes two) topics per lecture, with one lecture every 2 weeks, with 3 hours (including a coffee break) per lecture. Skype connection will (hopefully) be available for those who cannot attend the lectures at MDH.

If you are interested, please write me an email including your name / department / University / position. Dates and place of the lectures will be sent by email some days before the first lecture.

Instruction

Lectures, problem solving sessions (both with and without computer) and homework assignments.

Assessment

2 written exams, 2 homework assignments and 1 power-point presentation.

Reading list (preliminary content)

- Olsson, G. and Newell, B., Wastewater Treatment Systems - Modelling, diagnosis and control, IWA Publishing, 1999.
- Leslie Grady Jr, C.P., Biological Wastewater Treatment, Marcel Dekker Inc., NY, 1999.
- Henze, M., Gujer, W., Mino, T., van Loosdrecht, M.C.M., Activated Sludge Models ASM1, ASm2, ASM2d and ASM3, IWA Scientific and Technical Report No. 9, IWA Publishing London, UK, 2000.
- Zambrano, J., Carlsson, B. and Diehl, S., 2015, Optimal steady-state design of zone volumes of bioreactors with Monod growth kinetics, Biochemical Engineering Journal 100, 59-66.
- Diehl, S., Zambrano, J. and Carlsson, B., 2016, Steady-state analysis of activated sludge processes with a settler model including sludge compression, Water Research 88, 104-116.
- Johnson, A., 2013, Teaching the principle of biological optimization, Journal of Biological Engineering 7:6.

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