GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2024-2025

Advanced Wastewater Treatment Process Design (I002752)

Course size *(nominal values; actual values may depend on programme)*

Credits 3.0 **Study time 90 h**

Course offerings in academic year 2024-2025

A (semester 1)	English	Gent

Lecturers in academic year 2024-2025

Volcke, Eveline	LA24	lecturer-in-charge

Offered in the following programmes in 2024-2025	crdts	offering
Bachelor of Science in Environmental Technology	3	A
International Master of Science in Sustainable and Innovative Natural Resource Management	3	A
Master of Science in Bioscience Engineering: Environmental Technology	3	A
Master of Science in Chemical Engineering	3	A
Master of Science in Chemical Engineering	3	A
Exchange Programme in Bioscience Engineering: Environmental Technology (master's level)	3	A

Teaching languages

English

Keywords

Wastewater treatment; Reactor design; Mass balances; Suspended sludge installations; Biofilm reactors

Position of the course

This course deals with advanced, quantitative design of wastewater treatment processes, focussing on process engineering aspects (design, operation and control). Both suspended and attached growth processes are considered, in activated sludge installations and biofilm reactors, respectively. Fundamental design principles are derived from mass balances, thus extending design insights beyond the empirical design rules known from previous, more basic courses. Particular attention is paid to the influence of selected parameters and prevailing input conditions on reactor design and operational performance. To this end, detailed computer-assisted design calculations are carried out. Although the application in this course is clearly on wastewater treatment plants, the underlying principles and methods have wider applicability. The schedule of the lectures is fixed in consultation with interested students. Where possible and necessary, lecture recordings will be made available.

Contents

1. Design of active sludge installations

1.1 COD removal

· Influent fractionation

· Design procedure based on steady state mass balances

· Influence of design parameters on (SRT, primary settling, temperature) on reactor design and operation (e.g. sludge production, oxygen consumption, effluent quality)

· WWTP control: SRT vs. TSS control, hydraulic control

· WWTP 'design philosophy'

1.2 Nitrification

· Influent fractionation - fate of influent TKN

· Effluent ammonium concentration – minimum SRT for nitrification
· Design procedure – influencing factors

1.3 N removal
· Design procedure for a MLE system - Optimum a-recycle ratio
· Balanced MLE system
· Effect of influent TKN/COD - MLE sensitivity diagram

2. Design of biofilm reactors
2.1 Introduction: types of attached growth processes and their applications
2.2 Standard examples: moving bed biofilm reactors (MBBR) and aerobic granular sludge reactors
2.3 Physical process design: hydraulic application rate, airflow, oxygen transfer, pressure drop
2.4 Multiple-component conversions:
- fundamentals: rate-limiting substrate, biomass competition for substrate and space, dynamics in time and in space
- application in design for COD and nitrogen removal
2.5 Identification of limiting factors: mass transfer versus biological conversions
2.6 Overall recommendations on process selection

3 Hands-on exercises
The application of advanced design and the study of influencing factors is thoroughly assessed through plenary exercises as well as integrated design exercises in the form of practical PC-room classes.

Initial competences

This course builds on certain learning outcomes from the course units 'Environmental Technology: Water', 'Physics 4: Physical Transport Phenomena' and 'Process Technology' or acquired through alternative courses.

Final competences

1 Possess advanced knowledge and insight in mass-balance-based design of wastewater treatment processes
2 Have a thorough view on influencing factors on process design and operational performance
3 Are capable of process selection, comparing alternative process options for both activated sludge installations and biofilm processes

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Group work, Seminar, Lecture

Study material

Type: Handbook

Name: Biological Wastewater Treatment - Principles, Modelling and Design, edited by Chen G.H., van Loosdrecht M.C.M., Ekama G.A. and Brdjanovic D., 2020, IWA Publishing. Open access doi.org/10.2166/9781789060362
Indicative price: Free or paid by faculty
Optional: yes

Type: Handbook

Name: Biological Wastewater Treatment: Examples and Exercises. Edited by C.M. Lopez-Vazquez, D. Brdjanovic, E.I.P. Volcke, M.C.M van Loosdrecht, D. Wu, and G. Chen, 2023. Open access, doi.org/10.2166/9781789062304
Indicative price: Free or paid by faculty
Optional: yes

Type: Slides

Name: Lecture slides
Indicative price: Free or paid by faculty
Optional: no

References

Biological Wastewater Treatment - Principles, Modelling and Design, edited by Chen G.H., van Loosdrecht M.C.M., Ekama G.A. and Brdjanovic D., 2020, IWA Publishing. Open access doi.org/10.2166/9781789060362
Biological Wastewater Treatment: Examples and Exercises. Edited by C.M. Lopez-Vazquez, D. Brdjanovic, E.I.P. Volcke, M.C.M van Loosdrecht, D. Wu, and G. Chen, 2023. Open access, doi.org/10.2166/9781789062304
Metcalf & Eddy, Inc. George Tchobanoglous, Franklin L Burton, H. David Stensel. Wastewater Engineering : Treatment and Resource recovery. McGraw-Hill, 2014.

Course content-related study coaching

Assessment moments

end-of-term and continuous assessment

Examination methods in case of periodic assessment during the first examination period

Oral assessment, Written assessment with open-ended questions

Examination methods in case of periodic assessment during the second examination period

Oral assessment, Written assessment with open-ended questions

Examination methods in case of permanent assessment

Participation, Peer and/or self assessment, Assignment

Possibilities of retake in case of permanent assessment

examination during the second examination period is possible in modified form

Calculation of the examination mark

Students who eschew period aligned and/or non-period aligned evaluations for this course unit may be failed by the examiner.