ENV-500

Solid waste engineering

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Cursus	Sem.	Type
Energy Management and Sustainability	MA1, MA3	Opt.
Energy Science and Technology	MA1	Opt.
Energy minor	H	Opt.
Environmental Sciences and Engineering	MA1, MA3	Opt.

Language of teaching	English
Credits	4
Session	Winter
Semester	Fall
Exam	During the semester
Workload	120h
Weeks	14
Hours	**3 weekly**
Courses	2 weekly
Exercises	1 weekly
Number of positions	

Summary

The book "Solid Waste Engineering - A Global Perspective" is the basis for this course. This textbook is an excellent introduction to the field of Solid Waste Engineering and gives insight into relevant solid waste treatment technologies and practices.

Content

With the third edition of Solid Waste Engineering, the authors have decided to expand this college textbook to focus on the worldwide problem of solid waste management. This change is illustrated by the addition of “A Global Perspective” to the title. Given that we are currently using our natural resources at an unsustainable rate, polluting our oceans and land with a variety of waste products and altering our atmosphere with gases that are causing further global warming, now is the time to educate future engineers with knowledge and tools to address these worldwide problems.
The course is following the logic structure and the chapters of the book. The third edition has been rearranged to follow the hierarchy of solid waste management, reduce, reuse, recycle and recovery. Thus students will first learn about integrated waste management strategies, an expertise which will support the future engineer to take measures for pollution prevention as well as for resources conservation. In chapter 2 the students are introduced to municipal solid waste characteristics, including the identification of different waste components and materials. Component specific information is needed for recovery, separation and recycling of waste materials. The relevance of chemical, physical and mechanical properties are discussed in more detail as a basis for the chapters which follow. These properties are most helpful in order to identify potentially meaningful recycling pathways, as well as to decide about possible technological separation and purification options. The next chapter is dedicated to the collection of municipal solid waste, a key, but many times overlooked, component of integrated waste management. Following collection is mechanical processing, in most cases the necessary first step to the recycling and recovery of municipal solid waste. The students will then study mechanical, biological, and thermal processes. For each of these topics the authors have dedicated a separate chapter which will introduce the students to the basic principles of these separate disciplines in the context of waste management. Since not all waste streams can be recovered, students move on to residue management by combustion and landfilling. Finally students are exposed to the current issues in solid waste management and the principles of integrated and sustainable solid waste management.
In a few cases the lectures at EPFL and the home reading will be complemented with field visits to waste treatment facilities.

Keywords

Waste Technologies, Recycling, Recovery, Secondary Resources, Mechanical Treatment, Thermal Treatment, Co-treatment, Landfilling, Residues, Stabilization, Heavy Metals, Biomass, Bioenergy, Technical Ordinance on Waste, Material and Elemental Flow Analysis

Learning Prerequisites

Required courses

No specific course is required. For students without any chemistry background the class can be mastered but will be partly challenging.

Recommended courses

Environmental chemistry
Analyse des polluants dans l'environnement
Informatique pour l'ingénieur
Numerical analysis
Microbiologie pour l'ingénieur
Communication pour l'ingénieur

Learning Outcomes

By the end of the course, the student must be able to:

- Characterize wastes
- Assess / Evaluate waste treatment pathways
- Estimate flows and quantities of waste and materials
- Justify the choice of different waste treatment options
- Perform simple calculations to determine relevant parameters and process efficiencies
- Take into consideration measures for resources conservation and pollution prevention

Transversal skills

- Respect relevant legal guidelines and ethical codes for the profession.
- Take account of the social and human dimensions of the engineering profession.
- Demonstrate a capacity for creativity.
- Demonstrate the capacity for critical thinking
- Communicate effectively with professionals from other disciplines.
- Write a scientific or technical report.
- Make an oral presentation.
- Design and present a poster.

Teaching methods

The book "Solid Waste Engineering" is the basis for the course content which will be complemented with information from other sources (see "further literature" given below). Excursions, field visits or participation at World Resources Forum (ca. 20-30%) will play a central role in studying and understanding wastes and resources management related challenges and process technologies. If possible, the time of the visits will be set to best match with the learning content during the course. However, this is not always possible. Excursions and visits will take place according to the availability of companies and experts. Due to the excursions less time for classic ex cathedra teaching is available and the amount of reading at home will be substantial.
Parallel to the course all students will perform a specific project in a small team. Students can choose from a list of project proposals or propose their own topic which has then to be approved by the teacher. The major results of the project will be presented in a fire session. In 5 minutes or less the following information is communicated using an appropriate tool (PowerPoint, Film, Sketch, etc...):

a) Motivation and problem describtion
b) Methoths used and work performed
c) Results and discussion
e) Conclusions

About 40% of the time is allocated to teaching in the classroom. This includes classic ex-cathedra teaching, and time for questions of the students to support and help them in setting priorities for the reading and efficient studies at home. 15%

will be used for written tests (=exercises with marks) and the project presentation. The remaining time (15-25%) will be used in a flexible way for own work, coordinate the teamwork, and to obtain individual advise from the teacher. Normally every afternoon is representing a new and independent learning bloc related to a particular field or aspect of waste management or treatment technology (see content above). The course is taking place in the afternoon 2-5pm, however, some field excursions may take longer and in exceptional cases we may also have to leave earlier. The amount of field excursions at which a student is allowed to participate may be reduced in case the class is taken by more than 24 students. Students who can participate in all joint activities and are ready to invest substantially in homework will appreciate this course.

Expected student activities

- Presence on the first day of the course to decide if this course complies with your expectations. You will learn what this course is about. This is essential information for you to decide about participation.
- **Presence in the class and participation in discussions and team activities.**
- Participation at excursion(s) and the field investigation (reserve the entire afternoon on excursion days, not just 14-17)
- **Performing substantial reading and other work at home** (the working load of 120h is high and corresponds on average to about a working day/week. This is including the lectures and excursions).

Safety: *The joint experience and participation in the excursions as a group is essential. The success of the class will depend on the participation and contribution of each student.*
During excursions good shoes and warm all-weather suitable clothing is mandatory. ***Waste treatment facilities are dangerous*** *due to the trucks and other mobile heavy machinery driving on the sites. Groups should always stay together and follow the advise of the group leader or authorized staff.*
Disabled students should contact the teacher as early as possible to discuss options in order to participate at the excursions.

Assessment methods

50% Depending on the size of the class, two short tests during the semester or one regular test (class size >28) will be organized. The examination dates will be announced on the first course day.
25% Fire and poster presentation.
25% Project report which is due on December 20th.

Supervision

Office hours	Yes
Assistants	Yes
Others	- Moodle (- Google Documents, if appropriate).

Resources

Bibliography

Course book:
William A. Worrell & P. Aarne Vesilind & Christian Ludwig (2017) Solid Waste Engineering, 3rd edition. CENGAGE Learning (also available as eBook)
It is advised to buy the book at the Rolex Learning Center (SI edition, paperback, or the ebook via webpage of the publisher).
Further reading:
Christian Ludwig & Stefanie Hellweg & Samuel Stucki (2003): Municipal Solid Waste Management. SPRINGER-VERLAG BERLIN
Dr. Martin Lemann (1997): Fundamentals of Waste Technology, 1st English Edition. C. HERRMANN CONSULTING
Peter Baccini & Paul H. Brunner (1991): Metabolism of the Anthroposphere. SPRINGER-VERLAG BERLIN
or Peter Baccini & Paul H. Brunner (2012): Metabolism of the Anthroposphere. The MIT Press
Werner Stumm, ETHZ (1992): Chemistry of the Solid-Water Interface. JOHN WILEY & SONS, INC.

Ressources en bibliothèque

- Fundamentals of Waste Technology / Lemann
- Chemistry of the Solid-Water Interface / Stumm
- Metabolism of the Anthroposphere / Baccini
- Municipal Solid Waste Management / Ludwig
- Solid waste engineering /Worrell

Notes/Handbook

Information which is not given in the book "Solid Waste Engineering" will be available as electronic copies via moodle.

Moodle Link

- http://moodle.epfl.ch/enrol/index.php?id=304