ENV-500

Solid waste engineering

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Cursus	Sem.	Type
Energy Science and Technology	MA1, MA3	Opt.
Energy minor	H	Opt.
Environmental Sciences and Engineering	MA1, MA3	Opt.
Minor in Engineering for sustainability	H	Opt.

Language of teaching	English
Credits	4
Session	Winter
Semester	Fall
Exam	During the semester
Workload	120h
Weeks	14
Hours	**4 weekly**
Lecture	2 weekly
Exercises	1 weekly
Project	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. Transversal skills will be fostered as well.

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 3rd Edition was also adapted in view of the needs of the students who are taking the Solid Waste Engineering course at EPFL. 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.
It is recommended to buy the book in advance of the course as e-book or as printed edition. (One can get the book at the Rolex Learning Center book store, but if they run out of stock the delivery may take several weeks). A limited stock of books can be borrowed from the teacher for a deposit of CHF 100.
In a few cases the activities at EPFL and the home reading will be complemented with field visits to waste treatment facilities. In addition a group work will focus on specific waste related aspects. These learnings will be transcribed into a video so that these group specific learnings can be made available to the other students in this and in future courses.

Keywords

Waste Technologies, Recycling, Recovery, Secondary Resources, Mechanical Treatment, Biological Treatment, Thermal Treatment, Co-treatment, Landfilling, Residues and Secondary Wastes, Stabilization, Heavy Metals, Biomass,

Bioenergy, Technical Ordinance on Waste, Material and Elemental Flow Analysis

Learning Prerequisites

Required courses

No specific course is required.

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:

- Judge some waste characteristics
- 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
- Transcribe teaching content into a video presentation

Transversal skills

- Identify the different roles that are involved in well-functioning teams and assume different roles, including leadership roles.
- Respect relevant legal guidelines and ethical codes for the profession.
- Demonstrate a capacity for creativity.
- Manage priorities.
- Demonstrate the capacity for critical thinking

Teaching methods

The structure and content of the book "Solid Waste Engineering" is the red thread for the course content which will be complemented with information from other sources (see "further literature" given below). It is expected that students learn directly from reading the book. The teacher will only highlight specific aspects. A relevant time of contact hours (lecture time) will be used for field visits, excursions and discussions with the teacher, including discussions related to the group project
The allocation of 2h lectures, 1h exercise, 1h project time, is no indicative for the structure of the course but is rather a rough estimate of the sum of the time allocated during all afternoons. Some lectures will last longer than 4 hours on the days with field visits. Every afternoon is different and you cannot conclude from a former experience to the next one. Field visits, excursions, and the development of a group work will play a central role in studying and understanding wastes and resources management related challenges and process technologies. If possible, the dates of the field visits will be set to best match with the dates foreseen in the semester for a given learning and reading content. However, this is not always possible. Excursions and visits will take place according to the availability of companies and experts. Due to the excursions and project work less time for classic teaching is available and the amount of reading at home will be substantial. Time in the class will also be allocated for contact time with the teacher in the frame of the project

development. If needed also contact hours outside the regular course time will be possible on request in person or Zoom.
A beach litter survey will be performed with the entire class together with a specialist in this field and we will visit waste treatement facilities where we will have exchange with the experts on site.
The project team will aim to produce a video, which is covering a relevant part of a book chapter in Solid Waste Engineering or is related to the litter survey which will be performed with the entire class. In addition the teacher will provide a list of topics from which the students can select. However, students can also make an own suggestion, which the teacher has to approve. Goal is to transfer teaching content into small videos which will support future teaching of this course.
Considering the learning outcomes and the transversal skills described above the students have to justify their planned approach in delivering a short proposal structured in the following way:
a) Content and focus of the video
b) Justification for your choice of content. Why will this be helpful for students? How does it fit into the logic and concept of the book Solid Waste Engineering. Describe cognitive levels and transversal skills which are considered in the video.
c) Methods to be used in the video (didactic and graphic elements you want to use)
d) Description of how the result will look like (screenplay for the video)
e) Organizational structure of your team (roles in the team, information flow, and decision rules)
f) Work to be performed (a time plan with milestones and deliverables complements this part: who is doing what and when)
The course structure is in such way, that the first part of the semester will be used to read and study the content of the book and learn from field experiences. Based on that we initiate the second part which is focussing on the team project.

Expected student activities

- **General expectations and specific prerequisits expected by the teacher.** This course is of very general and interdisciplinary nature. No specific prerequisits are expected by the teacher to successfully pass this course. But, if you are not interested to also work on your transversal skills and your interest is solely in the topic Solid Waste Engineering, then this may not be the right course format for you. Therefore, read and understand the content of the course description, before you inscribe to the course.
If you expect a classic lecture, you will be disapointed. If you are not flexible enough to join the field visits because of other lectures or activities during the afternoon, you will miss important elemenents. As this course is offered to students in the the 1st and 3rd master, you should consider your schedule for other courses to choose the right time point to follow this course. You may choose the year which best fits with your other activities.
If you are open for new experiences, also if they are not always assumed to be direcly required for the aquisition of the credits, then this course will be an enriching element in your studies and potentially relevant for your future career as an environmental engineer.
- 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 the litter survey.
- Once you have inscribed to an excursion your participation is mandatory (this is because of organizational and cost reasons).
- **Performing substantial reading and other work at home** (the working load of 120h is high and corresponds on average to about ***one working day/week***).
- Team oriented working. Team working is a relevant part of this course. It is expected that during the time frame in which the group work is performed, all students will be available for the exchange with the teacher and/or the colleagues of their project.
- Safety. At waste treatment facilities work is done with heavy machinery and large trucks are driving at unclear places to unloading wastes or take away residues and products. Therefore to avoid accidents the group has to stay together.
Please follow strictly the advise given by the teacher and instructors on site. Clothing should be appropriate for the weather conditions and a rather dirty site, compareable with a construction site. Therefore, **wear good and closed shoes**.
Disabled students should contact the teacher as early as possible to discuss options in order to organize the participation at the litter survey and site visits.

Assessment methods

The students will deliver
- The proposal for the team project and video making will account 15% of the mark (as team)
- The video which will account 35% of the mark (as team)
- The written exam which will account 40% of the mark
- The self evaluation report with a focus on the team and project development will be delivered by every student, it

accounts for 10% of the mark
Further evaluation criteria will be provided when the team project will be initiated.

Supervision

Office hours	Yes
Assistants	Yes
Forum	Yes
Others	- Moodle (- Google Documents, or other platforms 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, which is much cheaper)
There is also a paperback version (with SI units) available which can be ordered in the book store at the Rolex Learning Center. In the internet there are different versions available, please make sure you organize the 3rd edition which does not correspond to earlier editions and has substatially more content. For the learning it is irrelevant if you work with the original version of the book (hardcover) or the version in which SI units were implemented by the publisher (paperback).
Further advanced 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
And for topics related to aquatic chemistry:
Werner Stumm, ETHZ (1992): Chemistry of the Solid-Water Interface. JOHN WILEY & SONS, INC.

Ressources en bibliothèque

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

Notes/Handbook

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

Moodle Link

- https://go.epfl.ch/ENV-500

Prerequisite for