250669 - TRACAVAARI - Advanced Treatment of Industrial Wastewater

Coordinating unit: 250 - ETSECCPB - Barcelona School of Civil Engineering
Teaching unit: 714 - ETP - Department of Textile and Paper Engineering
Academic year: 2015
Degree: MASTER'S DEGREE IN ENVIRONMENTAL ENGINEERING (Syllabus 2014). (Teaching unit Optional)
ECTS credits: 5
Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: MARTIN CRESPI ROSELL
Others: MARTIN CRESPI ROSELL, FRANCESC TORRADES CARNE

Opening hours
Timetable: Monday morning from 9h. to 13 h.h.
Any day Monday through Friday, by E-Mail

Teaching methodology
The course consists of 3 hours per week of classes in the classroom (large group).

It lectures dedicated to a total of 22 hours in a big group, in which the teacher explains the concepts and basic raw materials.

Engaged a total of 8 hours (medium group), to solve problems with more interaction with students. Performed exercises to consolidate the learning objectives and general specifics.

The other 15 hours in total, 9 are devoted to lab work, and 6 h. to assisted works.

We employ support material in the form of detailed syllabus by the virtual campus Atenea content, programming and evaluation activities directed learning and literature.

Learning objectives of the subject
CE01 - Apply scientific concepts to environmental problems and their correlation with technological concepts.
CE08-Dimension unconventional systems and advanced treatment and raise their mass balance and energy.

Explore scientific concepts and technical principles of quality management of the receiving means, atmosphere, water and soil, and applied to problem solving.
Explore scientific concepts and technical principles of management and treatment of gaseous emissions, water supply, sewage and waste and remediation techniques for groundwater and contaminated soils.
Sized systems for the treatment of major pollutants vectors in specific sectors of activity.
Interprets rules, identifies goals, assesses technical alternatives proposed unconventional solutions and priority actions.

Characteristics of effluents from the main industrial sectors.
Advanced oxidation processes.
Processes Fenton.
Photocatalysis.
Ozonation.
Photochemical Processes.
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Wet oxidation.
Processes coupled.
Advanced Biological Processes.
Membrane Bioreactors (MBR).
Sequential biological reactors (SBR).
Fixed bed reactors. Biocilindros and biodiscs. Mobile fixed bed.
Granular anaerobic reactors fixed and expanded bed.
Combined systems.
New treatment techniques and use of sludge.
Control systems treatment plants.

The objectives of the course are to enable students to evaluate the quality of a wastewater depending on the characterization parameters. Select and design the treatment process depending on the quality of wastewater, the destination of the treated water (landfill, recycling, reuse) of the rules and other conditions as the waste taxes. Do the basic design of a wastewater treatment plant of Industrial effluents. Manage the sludge produced in the sewage treatment plant. Learn to manage wastewater treatment plants by physicochemical processes and by biological process. Relate the major operating problems with the causes that produce, and learn the changes to be introduced in the purification plant to solve these problems.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 125h</th>
<th>Theory classes: 15h</th>
<th>12.00%</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Practical classes: 10h</td>
<td>8.00%</td>
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<tr>
<td></td>
<td>Laboratory classes: 10h</td>
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<tr>
<td></td>
<td>Guided activities: 10h</td>
<td>8.00%</td>
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<tr>
<td></td>
<td>Self study: 80h</td>
<td>64.00%</td>
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# Content

## Topic 1: Basic regulations on wastewater (M.Crespi)

**Learning time:** 4h 48m  
- Theory classes: 1h  
- Practical classes: 1h  
- Self study: 2h 48m

**Description:**  
Competent organisms: European Legislation, Spanish legislation, Autonomic Legislation, Local Administration Legislation.  
- Policy discharge to: Continental waters, Public System.  
- Law for wastewater reusing.  
- Calculation of discharge fees in Catalonia (DUCA)  
- Calculation fees for wastewaters in Catalonia (DUCA)

**Specific objectives:**  
- Identify the legislation applicable in each case for wastewater.  
- Set discharge values for the main parameters of pollution of wastewaters.  
- Perform calculations relating to the declaration of use and pollution charges of water (DUCA) existing Catalonia.

## Theme 2: Major pollutants related with legislation and water use (M.Crespi)

**Learning time:** 4h 48m  
- Theory classes: 2h  
- Self study: 2h 48m

**Description:**  
Nature and types of pollutants in wastewaters.  
- Heavy metals, metals and organometalic compounds.  
- Inorganic Pollutants.  
- Nutrients.  
- Effluent characterization studies

**Specific objectives:**  
- Identify the main families of pollutants in wastewaters.  
- Understanding the effect that different pollutants produced on the aquatic living organisms.  
- Understand the concepts of biodegradability, acute and chronic toxicity, bioaccumulation, substances that consume oxygen.
### Item 3: Test of pollutants related with legislation and water use (M.Crespi)

**Learning time:** 9h 36m  
- Theory classes: 2h  
- Practical classes: 1h  
- Laboratory classes: 1h  
- Self study: 5h 36m

**Description:**  
Flow measurement in open channel and in pipe.  
- Main parameters to test: Organic Matter: Chemical Oxygen Demand (COD).  
- Biochemical Oxygen Demand (BOD).  
- Total Organic Carbon (TOC).  
- Other important parameters: Suspended Solids (SS).  
- Dissolved Solids (DS).  
- Conductivity and solts (SOL).  
- Nitrogen.  
- Phosphorus.  
- Toxics.  
- Collection and preservation of samples.  
Solving exercises on COD, BOD  
Laboratory tests on COD, MES, conductivity, color etc.

**Specific objectives:**  
- Know the most important parameters in the characterization of an effluent.  
- Identify the errors that may occur in the analysis and interpretation of the different parameters.  
- To choose the most suitable techniques for analytical determinations.  
- Improve understanding of COD and BOD  
- Learn about the organization of a water laboratory

### Topic 4: Main wastewater treatments (M.Crespi)

**Learning time:** 9h 36m  
- Theory classes: 3h  
- Practical classes: 1h  
- Self study: 5h 36m

**Description:**  
Main wastewater treatment processes for industrial effluents.  
- Physical processes: Screening, settling, flotation, filtration.  
- Physicochemical processes: chemical coagulation / flocculation, electro-coagulation, adsorption, chemical and electrochemical oxidation, membrane processes.  
- Biological processes: aerobic, anaerobic and mixed processes.  
Presentation of practical cases

**Specific objectives:**  
- Know the fundamentals of the main wastewater treatment processes.  
- Identify the type of contaminants that each process can remove best.  
- Know the magnitude of the economic costs of each process.  
- Identify the wastewater treatment processes best suited to each type of industrial effluent.  
Learning to focus on solving complex industrial effluents
## Item 5: Pollutant characteristics of industrial and urban effluents (M.Crespi)

### Description:
- General characteristics of municipal effluents.
- Characteristics of the main industrial sectors: *Textile and tanning industry* *Paper Industry* *Chemical Industry* *Fine Chemical Industry* *Food industry* *Mining*

### Specific objectives:
- Knowing the most important characteristics of effluents from each sector industrial.
- Identify the degree of difficulty in treating industrial effluents to the limits required by law.
- Understanding the differences in composition that condition the treatment of domestic and industrial effluents.

### Learning time:
- Theory classes: 1h
- Self study: 1h 24m

## Item 6: Implementation of advanced oxidation processes (AOPs) to effluent treatment (F.Torrades)

### Description:
- Fenton Processes
- Fotocatálisis
- Ozonization
- Fotochemical processes
- Wet Oxidation Processes
- Coupled processes
- Applications

### Discussion of case studies

### Specific objectives:
- Know the fundamentals of advanced oxidation processes.
- Identify the type of contaminants that each process can eliminate best.
- Know the magnitude of the economic costs of each treatment.
- Identify the feasibility of AOPs

### Learning time:
- Theory classes: 3h
- Practical classes: 1h
- Self study: 5h 36m

## Item 7: Physicochemical processes of coagulation-flocculation (M.Crespi)

### Description:
- Coagulant and floculant Products
- Jar test test.
- Decanters.
- Flotators : DAF and CAF.

### Specific objectives:
- Design and evaluate the results of the Jar Test
- Do the basic design of a wastewater treatment coagulation-flocculation plant.

### Learning time:
- Practical classes: 2h
- Self study: 2h 48m
# Item 8: Biological wastewater treatment processes (M. Crespi)

**Learning time:** 4h 48m
- Theory classes: 2h
- Self study: 2h 48m

**Description:**
- Fundamentals of biological processes.
- Respirometric Tests.
- Aerobic processes.
- Activated sludge processes.
- Microorganisms.
- F/M ratio.
- Oxygen consumption.
- Nutrient Effect of pH and temperature.
- Design of a wastewater activated sludge treatment plant.

**Specific objectives:**
- To know the different types of microorganisms involved in biological treatment and its role in the process.
- Knowing how biological processes properly removing nutrients.
- Specify the nomenclature and symbols used in the study of these processes.
- Identify and define correctly the influence of the parameters and factors that govern biological processes.

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# Item 9: Wastewater biological treatment processes II (M. Crespi)

**Learning time:** 9h 36m
- Theory classes: 3h
- Practical classes: 1h
- Self study: 5h 36m

**Description:**
Membrane bioreactors (MBR).
- Sequential biological reactors (SBR).
- Fixed bed systems: trickling filters.
- Hybrid systems: Biocilindros and biodiscs, MBBR, IFAS.

**Dimensioning an the activated sludge plant**, a trickling filter and a MBBR.

**Specific objectives:**
- To know the main aerobic biological processes other than the activated sludge.
- How to do a pilot plant study plan.
- Basic calculation of an activated biological process from parameters obtained in a pilot plant study. Idem for a trickling filter and MBBR.
- Know alternatives to remodeling a biological treatment plant.
- Get to know the basic mechanisms for biological wastewater treatment plants of industrial effluents.
### Item 10: Management of sludge from a wastewater treatment plant (M.Crespi)

**Learning time:** 7h 11m
- Theory classes: 1h
- Laboratory classes: 2h
- Self study: 4h 11m

**Description:**
- Disposal: landfill, composting, agriculture.
- Preparation and testing of different polyelectrolytes for sludge dewatering.

**Specific objectives:**
- Explain the values and the main applications of the different processes of sludge management.
- Plan and solve material balance calculations of sludge treatment processes.
- Meet alternatives to recovery of sludge.
- Test techniques for optimizing sludge dewatering.

### Item 11: Control systems of wastewater treatment plants (M.Crespi)

**Learning time:** 7h 11m
- Theory classes: 2h
- Practical classes: 1h
- Self study: 4h 11m

**Description:**
- Control of a WWTP fisicoquímica.
- Control methods of biological WWTP. SVI calculation.
- Calculation of sludge recirculation.
- Sludge waste calculation.
- Methods for microscopic observation of sludge.
- Most common problems in the process of activated sludge.
- Filamentous microorganisms.

**Specific objectives:**
- To know the different methods of control of a physicochemical treatment plant to optimize performance and reduce costes.
- Understanding the basis of different methods of control of a activated sludge treatment plant.
- Perform calculations for control of a WWTP from plant experimental data.
- Identify the most common operating problems and propose solutions.
- Know major control parameters.
Item 12: Technologies for recycling and reuse of effluents (M.Crespi)

Learning time: 19h 12m
- Theory classes: 2h
- Laboratory classes: 6h
- Self study: 11h 12m

Description:
Parameters that determine the reutilización.-Aspects related with health.- Technologies used in the recovery of water.- Examples of reuse and recycling industry

Specific objectives:
- Distinguish between reuse and recycling.- Know the legal conditions for reusing efluentes.- To be able to identify the most efficient technologies for reuse and recycling of efluentes.- Design the most appropriate combination of processes to allow reuse or recycling according to effluent composition.

Qualification system

The rating will be obtained from the continuous assessment marks and corresponding laboratory.

Continuous assessment consists of different activities, both individual and group training and additive nature, carried out during the year (in the classroom and outside of it).

The evaluation tests consist on issues associated with the concepts of the course learning objectives with regard to knowledge and understanding, and to one year of application.

Regulations for carrying out activities

Failure to perform a laboratory or continuous assessment activity in the scheduled period will result in a mark of zero in that activity.
Bibliography

Basic:

WEF. Biofilm Reactors. WEF, 2013.
APHA-AWWA-WEF. Standart Methods for the Examination of Water and Wastewater. 21th Ed..
SAWYER AND McCARTY.. Chemistry for environmental engineering.. McGraw-Hill,
PARSONS S., Advanced Oxidation Processes for Water and Wastewater Treatment.. IWA publishing,

Complementary:

varis. Manuales DWA.
varis. Manuales IWA.