Code: ING-IND/09 **Credits: 9**
Matter: Environmental Impact of Energy Systems
Main language of instruction: Italian
Other language of instruction: English

Teaching Staff

Head instructor
Prof. Lidia Lombardi - lidia.lombardi@unicusano.it

Introduction

1. *Objective of the course:*

- *introducing students to the environmental impact topic, considering the atmospheric pollution, deriving from energy conversion systems.*
- *describing the characteristics, the formation processes and the impact on the environment and human health on the main atmospheric pollutants, with reference to those originated by energy conversion systems*
- *describing the operating principles of the main systems for removing particulate matter and gaseous pollutants from gaseous streams*
- *summarizing the main regulations for waste management in Italy and EU*
- *describing the operating principles of waste combustion and energy recovery plants*
- *introducing students to Life Cycle Assessment methodology*

Objectives

2. *Course Structure:*

- Atmospheric pollution. Regulation aspects: Italian and European air quality standards and source emission limits
- Typical pollutants from energy conversion plants and emission factors
- Combustion stochiometric calculations
- Particulate matter removal systems
- Gaseous pollutants removal systems
- Waste management and energy recovery from waste
- Life Cycle Assessment

Competencies:

A. Knowledge and understanding.

Knowledge of main environmental impacts generated by energy conversion systems; understanding and ability to describe formation processes for main atmospheric pollutants.

Knowledge of main particulate and gaseous pollutants removal systems; understanding and ability to describe their operation, design parameters and working conditions influencing the performances.

Knowledge of main regulation aspects about waste management.

Knowledge of waste combustion with energy recovery processes and plants; understanding and ability to describe their operation, design parameters and working conditions influencing the performances.

Knowledge of LCA principles.

B. Applying knowledge and understanding.

Capability of solving calculation problems related to pollutant concentrations, comparison with law limits, pollutant emission factors (calculation and use), combustion products.

Capability of solving calculation problems related to preliminary sizing of particulate and gaseous pollutants removal systems.

Capability of solving calculation problems related to preliminary sizing of energy recovery from waste combustion.

Capability of analyzing an LCA study.

C. Making judgements.

Capability of selecting the appropriate solution procedures and methodologies to solve assigned problems. Capability of evaluating and explaining the results obtained by solt9in of assigned problems with respect to the results expected from theoretical study. Capability of interpreting LCA results.

D. Communication skills.

The student will be endowed with the technical-scientific language needed to interact with other experts in the discipline, and with decision makers in companies and governments. Capability of communicating and accurately describing the solutions and the methodologies used to solve assigned problems. Capability of illustrating and explaining LCA procedures and results.

E. Learning skills.

Capability of autonomously studying additional in-depth details related to the subject.

Syllabus

3. *Programme of the course:*

Subject 1. Atmospheric pollution: Ozone Layer Depletion and Greenhouse Effect. Regulation aspects: common parameters used in the Italian and European air quality standards; units for pollutants concentrations; corrections to be applied to compare with the source emission limits.
Subject 2. Typical pollutants from energy conversion plants: characteristics, effects on environment and human health, formation processes; emission factors.
Subject 3. Combustion stochiometric calculations
Subject 4. Particulate matter removal systems: cyclones, electrostatic precipitators, fabric filters.
Subject 5. Gaseous pollutants removal systems: condensation, absorption, adsorption, combustion; NOx and SOx removal systems.
Subject 7. Waste management: introduction and overview on production and treatment data in Italy and EU; waste characterization; energy recovery from waste; flue gas treatments.
Subject 8. Life Cycle Assessment: principles; ISO 14040 series; LCA phases; impact assessment methods; examples.

Evaluation system and criteria

The exam is a written test, with maximum evaluation of 25/30.
The remaining 5 points can be obtained by submitting and presenting an assignment related to "Subject 8. LCA", to be completed before the written test.
The written test consists of exercises as those solved and explained during the class. Students are required to solve the exercises accurately reporting and explaining the calculations they perform, reporting - when it makes sense - the schematic of the process/layout.
The test incorporates salso some theoretical questions.
The written exam is composed by two parts: Test 1 and Test 2, relating to the following subjects:

- Test 1: subjects 1-4.
- Test 1: subjects 5-7

Students can decide to:

- do the complete test (Test 1 + Test 2);
- do only the first part (Test 1);
- do only the second part (Test 2) if they already passed the first part (Test 1).

Students must communicate their intention to the teacher before starting the written test.

Bibliography and resources

4. *Materials to consult:*

Slides and teaching materials provided by the teacher.

5. *Recommended bibliography:*

- *Stefano Cernuschi, Michele Giugliano e Giovanni Lonati. Trattamento delle emissioni in atmosfera. Hoepli. 2016*
- *Giorgio Cau, Daniele Cocco. L'impatto ambientale dei sistemi energetici. S.G.E. 2015*
- *Vittorio Regaini - Carlo Pirola. Processi di separazione nell'industria chimica. Assorbimento, equilibri tra fasi fluide e distillazione. Teoria ed esercizi applicativi. Hoepli. 2016*
- *Thad Godish, Wayne T. Davis, Joshua S. Fu. Air Quality, Fifth Edition. CRC Press. 2014*
- *Giovanni De Feo, Sabino De Gisi, Maurizio Galasso. Rifiuti solidi. Progettazione e gestione di impianti per il trattamento e lo smaltimento. Flaccovio Dario Editore. 2012.*