

Course Structure

Course Code : SM7201

Course Title : Waste Heat Recovery

Credit Hours : 3

Course Description

Societal challenges in the XXI century. The Waste Scenario - The human factor. Waste and Energy scenarios overview, Waste Management, Energy Recovery Routes, Environmental and Social Aspects, Introduction to the methodology of Life Cycle Assessment, chemical Thermodynamics, Residues combustion, Biogas production, Liquid residues energy recovery.

Course Objectives

- To supply the students with state-of-the-art knowledge and information on the science and technology behind the valorization of the energy of non-hazardous and hazardous wastes.

Course Topics

- Introduction to the course organization. Discussion of the evaluation process. Preliminary list of the possible themes for the monographic work and presentation. Overview of the various possible themes to be chosen by the students. Groups' setting up.
- Societal challenges in the XXI century. The Waste Scenario - The human factor. Waste and Energy scenarios overview.
- Waste Management - Historical Perspective. Waste management throughout history. Evolution of the London waste management system as a case study. Emergence of waste-to-energy applications. Similarities between the current situation.
- Waste Management Today. Overview on waste management worldwide.
- Waste generation throughout the production process - from mining to final disposal - the linear economy. Difference in waste composition and management systems in different countries. International regulations on waste. Waste management hierarchy. Reduction, reuse, recycling and energy recovery in the cycle of resource management and contribution to a circular economy
- Energy Recovery Routes. Issues associated with waste management - collection, sorting, etc...Situation in waste generation and waste management in different parts of the world, with a focus on EU. Landfilling, incineration and recycling as the most relevant ways today - situation in Europe and perspectives. Waste-to-Energy in the context of waste management. Different options for the various types of waste generated.
- Environmental and Social Aspects. Waste policy and WtE plants in Europe. Contribution of Waste-to-Energy plants at the environmental and social levels

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- Debate: The development of Waste-to-Energy deters people from recycling? The gas emissions of WtE plants are particularly noxious? Evaluation of how much energy it is possible to produce with waste and what is the environmental impact. Comparison with Coal and Natural Gas.
- Introduction to the methodology of Life Cycle Assessment. Phases of LCA, definition of scope and boundaries, collection of information and inventory, impact calculation, and interpretation. Application to waste management and recycling - open-loop and closed-loop recycling. Scope variations: Cradle-to-Grave, Cradle-to-Gate, etc... Examples of impact categories. Case study examples: Vancouver waste management report; Bank note waste from the Bank of England. LCA and the construction of the waste management hierarchy.
- Examples of Life Cycle Assessment applied to waste management - case studies. Comparison of waste management scenarios in Los Angeles and Honolulu. Different alternatives for the municipal solid waste management in Rome. Waste management solution for plastic cable waste
- Introduction to chemical Thermodynamics. Energy. Enthalpy
- HCV, LCV calculation and experimental determination.
- Thermochemistry. Determination of HCV and LCV
- Thermodynamics. Basic Principles applied to Waste Management.
- Thermodynamics. Calculations applied to Waste management.
- Residues combustion. Pre-processing.
- Residues combustion. Municipal combustion units.
- Residues combustion. Other combustion units.
- Residues combustion. Co-combustion units.
- Overview on Agriculture and Forestry waste management.
- Residue Derived Fuels.
- Introduction to Gasification
- Gasification processes, technologies and examples
- Introduction to Pyrolysis
- Pyrolysis applications and calculations.
- Pyrolysis of biomass. Tire Pyrolysis.
- Plastic Pyrolysis
- Introduction to Biogas production
- Biogas Production - Landfill gas
- Introduction to Liquid residues energy recovery.
- Liquid residues energy recovery. Case study – Pulp industry.
- Students presentations

References

- *Plastics Wastes: Feedstock Recycling, Chemical Recycling and Incineration (Rapra Review Reports)* : A. Tucker 2002 Smithers Rapra Press.
- *Utilization of Plastic Wastes with Oil Shale: Basics, Methods, Composition*: L. Tiikma, 2010 LAP Lambert Academic Publishing.
- *Feedstock Recycling of Plastic Wastes (RSC Clean Technology Monographs)* : J. Aguado, D.P. Serrano, 1999 Royal Society of Chemistry
- *Feedstock Recycling and Pyrolysis of Waste Plastics: Converting Waste Plastics into Diesel and Other Fuels (Wiley Series in Polymer Science)*, : J. Scheirs, W. Kaminsky, 2006 Wiley-Blackwell.
- *Municipal Solid Waste to Energy Conversion Processes: Economic, Technical, and Renewable Comparisons*: G.C. Young, 2010 Wiley-Blackwell.