Hanze

Course: Bio Energy Conversion — credits: 10

Course code	RWVM23BEC
Name	Bio Energy Conversion
Study year	2026-2027
ECTS credits	10
Language	English
Coordinator	A. Perl
Modes of delivery	Education
Assessments	Lab BioFuels - Assignment Theory Biochemical Conversion - Assignment Thermochemical Conversion - Assignment

Learning outcomes

After completion of this module the student is able to:

1. Understand biological and (bio)thermochemical conversion processes.
2. Apply the biological conversion in an experimental environment.
3. Model a (bio)thermochemical conversion plant and evaluate its technical and economic aspects.
4. Communicate conclusions in a scientific report.

Content

Biochemical Conversion:

Chemical and physical bonds, chemical groups, biomolecules, biopolymers, enzymes and their reactions
Organisms, cell structures, genetics, metabolism, catabolism, anabolism, cycles,
photosynthesis, carbon cycle
Reaction order and rate, reactor types, steady state, mass and energy balances for various reactor types
Physical and chemical properties of various biomaterials, overview of biochemical conversion routes, chemical content, main structural chemical constituents
Biomass cultivation, harvesting, collection, and supply chain management, biomass pretreatment technologies, downstream processing, separation
1 generation biofuels
What defines it. Which type of biofuels it produces. Advantages and disadvantages of this generation. The pretreatments required for the most used biomass type.
Differences between the two main producers of bioethanol: EUA and Brazil. The story of bioethanol in Brazil: from when it started, shortages, price, production, evolving techniques
2 generation biofuels
Types of fuels. A real case of 2nd generation biofuel production: the processes to produce biofuels, effect of operating conditions on chemical composition, heating value and yield of biogas, biochar and bio-oil
3 and 4 generation biofuels
Types of processes and fuels. Enzymes used to modify microorganisms. The barriers it overcome, and its concept. New problems that comes with it.
Lifecycle analysis (LCA) and consolidated bioprocessing
The importance of LCA. The steps of LCA for biofuels (raw material production, transportation, manufacturing, storage..) Sustainability of biofuels: The social, economic and environmental performance of the renewable energy source. What determines which biofuel generation is more suitable for each case.
The innovative approach of consolidated bioprocessing. Advantages and disadvantages. CBP and pretreatments processes. Case studies

Thermochemical conversion:

Basic properties of biomass feedstocks- and -derived energy carriers

- Organic and inorganic compositions of raw and mechanically/thermally upgraded lignocellulosic biomass
- Physical properties of raw and mechanically/thermally upgraded lignocellulosic biomass energy carriers
- Suitability of different biomass types for specific thermochemical processes

Basics of thermochemical conversion processes:

- Torrefaction
  - dry/wet
- Pyrolysis
  - fast/slow
- Gasification
  - direct/indirect
  - producer gas purification and upgrading to various qualities
- Combustion

    - direct/air-staged
    - for heat and/or power generation
- Typical temperature levels, scales and overall mass/energy efficiencies
- Compositions of typical flue-, process- and producer-gasses, including by-products, impurities and emissions

Specific technology solutions for pyrolysis, gasification and combustion:
- Grate-fired/fixed/moving bed systems
- Fluidised-bed systems
- Pulverised-fuel systems
- Typical technical bottlenecks and solutions to overcome those for each specific technology solution
- The technological maturity and the role in the current and (potential) future heat and power market.

Aspen Programming Topics
- Introduction to bio refinery
- Aspen computer Lab unit operations (1), utilities & coupling Unit Ops (2), closing loops & optimization (3,4), business case tutorial(5)

Included in programme(s)

European Master in Renewable Energy

School(s)

Engineering, Life Sciences & ICT

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