GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2024-2025

Thermochemical Conversion of Biomass (I002677)

Course size *(nominal values; actual values may depend on programme)*

Credits 4.0 **Study time 120 h**

Course offerings and teaching methods in academic year 2024-2025

A (semester 2)	Dutch	Gent	lecture group work independent work

Lecturers in academic year 2024-2025

Ronsse, Frederik	LA24	lecturer-in-charge
Ghysels, Stef	LA24	co-lecturer

Offered in the following programmes in 2024-2025	**crdts**	**offering**
International Master of Science in Sustainable and Innovative Natural Resource Management	4	A
Master of Science in Bioscience Engineering: Chemistry and Bioprocess Technology	4	A
Master of Science in Bioscience Engineering: Environmental Technology	4	A
Master of Science in Chemical Engineering	4	A
Master of Science in Chemical Engineering	4	A

Teaching languages

Dutch

Keywords

Biomass, biorefineries, thermochemical conversion, combustion, gasification, pyrolysis, heat, electricity, bio-fuels

Position of the course

Processes for biomass thermo-chemical conversion for the production of heat, electricity, bio-fuels or chemicals.

Contents

Summary

Thermochemical biomass conversion is based on decomposition at high temperatures (and sometimes high pressures), and subsequent chemical conversion whether or not in the presence of catalytic materials. Traditional processes are combustion, gasification and carbonization. The corresponding products are heat, combustible gases and charcoal respectively. This course is meant to explain the principles of both traditional and new thermo-chemical conversion processes and to discuss the various process routes in relation to the products desired. Biomass resources and properties are considered with special attention for environmental impact and aspects of sustainability. Although biological conversion routes are not a topic in this course, the relation between biological and thermochemical process routes will be clarified. In modern biorefinery concepts, both process types are often combined.

The contents of the course are as follows:

Part 1: Biomass resources, composition, types and properties relevant to their thermochemical conversion

Part 2: Traditional conversion processes and production routes: combustion for the (co)generation of heat and electricity and carbonisation (slow pyrolysis) for the production of charcoal and biochar

Part 3: Gasification, reactor systems and syngas usage
Part 4: Fast pyrolysis and catalytic fast pyrolysis, reactor systems, chemistry of fast pyrolysis reactions and valorisation of pyrolysis oil
Part 5: Integration of thermochemical conversion in the biorefinery, real-life case studies of thermochemical conversion systems operating on biomass and biomass-derived waste streams
Part 6: Hydrothermal processes: liquefaction, carbonisation and gasification in hot, compressed water. Properties of sub and super critical water.

Initial competences

Basic knowledge of organic chemistry (nomenclature and fundamental reactions), chemical reactors, transport phenomena, and process technology will make the course contents easier to understand. The course does not assume any previous training in bio-renewable resources.

Final competences

1 Advanced knowledge in thermochemical conversion process of biomass, including gasification, pyrolysis, combustion and hydrothermal conversion techniques.
2 Advanced knowledge in industrial application potential of products resulting of thermochemical biomass conversion.
3 Evaluating biomass conversion processes, both qualitative and quantitative, on the basis of technical feasability, economic potential and impact on environment and society.
4 Able to position thermochemical conversion processes in the wider framework of the future, biobased economy.

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Group work, Lecture, Practical, Independent work

Extra information on the teaching methods

- The course is taught in oral lectures.
- Also, an assignment is given to each group of 4 students which culminates in a written report. The content of which includes a short and functional literature survey, a process engineering calculation and a techno-economic evaluation.
- Finally, one lab practical exercise is foreseen (micropyrolysis) in which a short written report has to be made.

Study material

Type: Slides

Name: Slides of the course
Indicative price: Free or paid by faculty
Optional: no
Language : English
Number of Slides : 250
Oldest Usable Edition : 2023
Available on Ufora : Yes
Online Available : Yes
Available in the Library : No
Available through Student Association : Yes

References

- Robert C. Brown, “Bio-renewable Resources”, Iowa State Press, Ames, 2003.
- Robert C. Brown, "Thermochemical Processing of Biomass", John Wiley & Sons, 2011.
- Ashok Pandey, Thallada Bhaskar, Michael Stöcker and Rajeev Sukumaran, "Recent advances in thermochemical conversion of biomass, 1st edition", Elsevier, 2015.

Course content-related study coaching

The teacher is available for further information during the theory lecture and

afterwards. On request and upon appointment, individual assistance may be provided covering both theory as well as the group-based assignment.

Assessment moments

continuous assessment

Examination methods in case of periodic assessment during the first examination period

Oral assessment

Examination methods in case of periodic assessment during the second examination period

Examination methods in case of permanent assessment

Peer and/or self assessment, Assignment

Possibilities of retake in case of permanent assessment

examination during the second examination period is possible in modified form

Extra information on the examination methods

- The evaluation is performed using the group assignment. The evaluation of the written assignment is done by the teacher(s) using a list of competences (content, own contribution and critical discussion).
- Finally, the students also assess their peers, but only among the member of their own group (for the assigment and lab practical exercise).
- Advanced insights into the subject matter is evaluated by means of an oral exam.

Calculation of the examination mark

The end grade is determined by the oral exam (50% of the final grade), by the the final written report (25% of the final grade), the report of the lab practical exercise (15% of the final grade) and the peer assessment (10% of the final grade).

Students who eschew permanent evaluations for this course unit may be failed by the examinator.