

## 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 2023-2024

A (semester 2)

Dutch

Gent

group work

lecture

independent work

### Lecturers in academic year 2023-2024

Ronsse, Frederik

LA24

lecturer-in-charge

### Offered in the following programmes in 2023-2024

**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 thermochemical 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

(Approved)

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 feasibility, 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, Independent work

### **Extra information on the teaching methods**

- The course is taught in oral lectures.
- Also, an assignment subject is given to each group of 4 students which culminates in a written report. The content of which includes a literature review, process engineering calculations and techno-economic evaluation. Guidance will be provided during project meetings (on appointment and per individual group, at least two mandatory appointments for interim feedback). The end result is presented to fellow students and discussed.
- A list of assignment topics is made available for each group to choose from.

### **Learning materials and price**

Slides (in English) will be made available to the students, together with a selection of relevant publications (review papers and book chapters), using the Ufora e-learning platform. Slides used in the courses are also distributed via the student club VLK, for price see [link](#)

### **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**

### **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 (the use of literature, proper referencing, use of language and style, content, own contribution and critical discussion).
- The assignment is presented as well in front of fellow students (10' of presentation) and afterwards, group members are questioned (individually and collectively) to assess their insight into the subject matter dealt with in the assignment.
- It is assumed that upon questioning, the basic principles taught in the theory lectures have been properly acquisitioned.
- Finally, the students also assess their peers, but only among the member of their own group.

#### **Calculation of the examination mark**

The end grade is solely determined by the result of the project which will be determined by judging the final written report (50% of the final grade) its oral presentation and defense (30% of the final grade) and the peer assessment (20% of the final grade).

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