GHENT UNIVERSITY

# Course Specifications

Valid as from the academic year 2022-2023

## Thermochemical Conversion of Biomass (I002677)

**Due to Covid 19, the education and evaluation methods may vary from the information displayed in the schedules and course details. Any changes will be communicated on Ufora.**

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

**Credits** 4.0 **Study time** 120 h **Contact hrs** 40.0 h

**Course offerings and teaching methods in academic year 2022-2023**

| | | | | |
|---|---|---|---|---|
| A (semester 2) | Dutch | Gent | group work | 22.5 h |
| | | | self-reliant study activities | 2.5 h |
| | | | lecture | 15.0 h |

**Lecturers in academic year 2022-2023**

| | | |
|---|---|---|
| Ronsse, Frederik | LA24 | lecturer-in-charge |

| **Offered in the following programmes in 2022-2023** | **crdts** | **offering** |
|---|---|---|
| Master of Science in Chemical Engineering | 4 | A |
| Master of Science in Sustainable Materials Engineering | 4 | A |
| Master of Science in Chemical Engineering | 4 | A |
| Master of Science in Bioscience Engineering: Chemistry and Bioprocess Technology | 4 | A |
| Master of Science in Bioscience Engineering: Environmental Technology | 4 | A |
| International Master of Science in Sustainable and Innovative Natural Resource Management | 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. Ptroperties 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, self-reliant study activities

**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, proces 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.

**Evaluation methods**

continuous assessment

**Examination methods in case of periodic evaluation during the first examination period**

**Examination methods in case of periodic evaluation during the second examination period**

**Examination methods in case of permanent evaluation**

Assignment, peer assessment, report

**Possibilities of retake  in case of permanent evaluation**

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 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.
- The end score solely depends on the group project. In case of failure of individuals in a project group, or an entire project group, an additional assignment needs to be done within six months after the beginning of the course.

**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 examinator.