Blended Intensive Program

STUDY GUIDE

The Circularity of Polymers

BLENDED INTENSIVE PROGRAM

Academic year: 2022-2023

Study Guide number: 9007FTIIWK

Semester: 2nd SEM

Contact hours: 34

Credits: 3

Study load (hours): 84

Contract Restriction(s): Not applicable

Language of instruction: English

Exam: 2nd semester

Subject area: Chemical Engineering

Instructor(s): Pieter Billen, Philippe Nimmegeers, Cristina Moyaert, Sofie Krol -

1. Prerequisites:

- The student is expected to have a knowledge of speaking and writing of English, as well as knowledge of reading and comprehending of English.
- The student is expected to have a general notion of the basic concepts of Chemistry, Biochemistry, Materials Science.
- The student is recommended to have knowledge of organic chemistry and polymer chemistry.
- The student is recommended to have basic notions of economics.

2. Learning outcomes:

- The student can relate the chemical structure of polymers to its circularity potential
- The student understands the thermodynamic limitations of recycling
- The student has a solid knowledge of the complexity of various polymer waste types/mixes
- The student can explain the tension between market demands (i.e. technical performance and/or aesthetics) and circular design
- The student can map material flows in a value chain
- The student knows the state-of-the-art in mechanical recycling of polymers
- The student knows the state-of-the-art in (thermo)chemical recycling of both polyolefin-type materials and of heteropolymers

3. Course Contents:

The course will cover several domains related to the circularity of polymers. Before the in-person intensive week, the student is expected to follow some lectures about Introduction to polymer science: the idea is that the student knows how polymers are synthesized, and what their main structure-property relations are.

During the in-person intensive week, each day lectures are given related to one of the 5 main domains related to the circularity of polymers. These domains are defined as: 1. Defining the problem of polymer circularity, 2. Insight into plastic waste of all sorts, 3. Insight into molecular carbon cycles. 4. Design for circularity and for energy and 5. Circular policies.

The lectures are given by scientific experts, and are composed of both practice as well as international state-of-the-art research. The lectures will follow the following schedule:

DAY 1: Defining the problem of polymer circularity

- Synthesis of polyolefins
- Synthesis of heteropolymers
- Overall ecological balance of Bio-PE
- The boundaries of circularity
- Keynote lecture

DAY 2: Plastic waste of all sorts

- MFA of plastics
- Characterization of plastic waste
- Sorting and refining
- Mechanical recycling 1
- Mechanical recycling 2

DAY 3: Molecular Carbon Cycles

- Introduction to chemical recycling
- Chemical recycling of polyolefins
- Chemical recycling of heteropolymers
- Biobased polymers 1
- Biobased polymers 2
- Keynote lecture

DAY 4: Molecular Carbon Cycles

- Composites for energy savings
- Recycling of composites
- Circular product design
- Technical visit

DAY 5: Circular Policies

- LCA of plastics
- Circularity policies
- Design-from-recycling

- Recycled materials in civil applications

4. International Dimension:

This course stimulates international and intercultural competences:

- Students use course materials in a foreign language.
- Students give presentations in a foreign language.
- Students write papers in a foreign language.
- Students compare the course contents in an international context.
- Students reflect on their own cultural frame of reference in relation to other perspectives.
- Students collaborate with peers from different countries.

5. Teaching method and planned learning activities:

5.1 Used teaching methods

- Lectures from international professors
- Online Screencasts
- Personal work
- Assignment
- Technical visit
- Keynote speakers from industry

5.2 Planned learning activities and teaching methods

The course mainly consists of lectures from guest speakers. The students will get a group task, in which they will discuss a topical matter with respect to circular economy. These projects will be evaluated (presentation and defense) during one online lecture near the end of the semester.

6. Assessment methods and criteria:

6.1 Used assessment methods

The assessment consists of the following four components:

- 20% Pre-test (introduction to polymers science lectures – self study)
- 50% Team Paper (corrected with 25% spread max. based on peer evaluations)
- 20% Team Presentation
- 10% Individual Defense

The student is expected to pass each component of the evaluation above separately, being the pre-test, the paper, the presentation, and the defense. If a student does not pass one or more components, they shall have to retake the failed component(s) in June.

6.2 Assessment criteria

Written assignment:

The aim of the paper is to propose a state-of-the-art circular value chain for various polymer types, taking into account the material's properties, recent circularity innovations (e.g. chemical recycling, new sorting technologies, reversible bonding, biobased plastics…) and currently existing waste management schemes. The idea is that your new material value

chain has a higher circularity than the currently existing systems in various EU countries. First of all, evidently, you inventorize and study novel circularity technologies related to the polymer of your assignment. You analyze what is currently the material flow of the plastic in question, and suggest how this should change to accommodate novel technologies. This could involve, non-exhaustively, changes in collection methods, changes in sorting, different product designs or production changes, modifications to the polymer itself, etc.

7. Study Material:

7.1 Required reading

- Lecture slides
- Scientific journal papers

7.2 Optional reading

The following study material can be studied voluntarily:

- State-of-the-art literature

8. Contact Information:

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