GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2018-2019

Advanced Fibre and Polymer Technology (E064820)

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

Credits 6.0	Study time 180 h	Contact hrs	30.0 h

Course offerings and teaching methods in academic year 2018-2019

A (semester 1)	English	seminar: coached exercises	10.0 h
		lecture	20.0 h

Lecturers in academic year 2018-2019

D'hooge, Dagmar	TW11	lecturer-in-charge

Offered in the following programmes in 2018-2019	crdts	offering
Master of Science in Textile Engineering	6	A

Teaching languages

English

Keywords

rheology, viscoelasticity, chain dimensions, Flory-Huggins interaction parameter, polymer physics, Poiseuille flow, fiber properties, simulation of polymer flow in basic geometries, polymer degradation, spinning, injection moulding, chemical and mechanical recycling, polymer tribology and permeability, natural and synthetic textile fibres

Position of the course

The production of fibers and polymers requires dedicated processing techniques. In the first part (covered by themain lecturer), the main aspects of these techniques are covered, considering all relevant length scales. The second part addresses the textile fibres (covered by a second lecturer with textile background as contacted by the coordinator of the Master program).

Contents

PART 1:

Chapter 1: Introduction to polymer physics and different polymer length scales

- Nanoscale: mathematical description root mean square end-to-end distance and radius of gyration
  - Ideal case: freely-jointed/Gaussian chains
  - Extensions
- Micro- and macroscale
  - Overview on the main polymer properties covered in the Chapter 2-4
  - Relevance in a broader context of polymer processing: basic insights related to Chapter 5-6

Chapter 2: Thermodynamical properties

- Simplified case of ideal solution: main theory
- Extension to polymer solutions: Flory-Huggins theory

Chapter 3: Viscoelastic properties and rheological behavior

- Basic models based on constant strains or stresses
- Dynamic testing to assess key polymer properties
- Fundamentals of polymer melt flow
  - Conservation laws to describe transport of isothermal polymer melts: mass and momentum
  - Effect of shear rate on main rheological properties: shear thinning
  - Flow pattern of polymer melts in basic geometries: Poiseuille flow

Chapter 4: Application properties

- Main properties
  - importance of polymer synthesis and processing parameters
  - mechanical properties (*e.g.* elasticity modulus and toughness)
  - recovery: fibers
  - permeability: packaging
  - tribology: thermoplasts, elastomers and composites (optimal composition)
- Case studies

Chapter 5: Extrusion

- hopper section
  - pressure distribution
  - flow instabilities
  - case study
- melting section
  - basic 1D model: melt removal by drag
  - extended 2D model: convection and temperature dependent shear
  - case study: determination of optimal height for fast melting
- pressurization section
  - basic 1D model: combined drag and pressure flow
  - extended 2D model: Newtonian extrusion theory
  - relation with die
  - case study: calculation of complete pressure and temperature profile of non-Newtonian polymer melt

Chapter 6: Injection moulding

- basic 1D-model: conduction with stepwise temperature change, including extension to finite dimensions and contribution of convection
- extended Leveque model: calculation of cooling efficiency
- case study: design of preforming injection moulding step for production of polyethylene terephthalate (PET) bottles
- reactive injection moulding:
  - basic model
  - case study: highly filled copolymer of ethylene and vinyl acetate

Chapter 7: Polymer recycling

- Chemical or feedstock recycling
- Mechanical recycling

PART 2:

- Natural fibres: cotton, wool, linen, hemp
- Synthetic fibres: viscose, polyamide, PVC, polyester
- High tech fibres:
  - High-performance Polyethylene Fibres
  - Polyketone Fibres
  - Polyphenylene Sulfide Fibres
  - Aromatic Polyester Fibres
  - Carbon Fibres
  - Aramid Fibres
  - Polyimide Fibres
  - Fibres from Aromatic Heterocyclic Polymers
  - Glass Fibres
  - Basalt Fibres
  - Ceramic Fibres

Initial competences

Basic knowledge on mathematics, transport phenomena, and polymer chemistry

Final competences

1 Describing and defining the following concepts: polymer degradation extrudor sections, (non-) Newtonian extrusion theory, injection moulding, chemical/mechanical recycling, pressurization, melting efficiency, polymer modification during polymer processing.
2 Knowledge on properties and use of textile fibres.
3 Discussing the relation between process parameters and industrial performance of polymer processing units, the importance of the polymer microstructure during polymer processing, the major production processes for polymer applications.
4 Distinguishing and identifying polymer processing techniques for a given final application, applying conservation laws for mass, momentum and energy for industrial polymer processing.
5 Selecting the proper fibres for a specific use.

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

Lecture, seminar: coached exercises

Learning materials and price

Course notes and slides are made available

References

Course content-related study coaching

Evaluation methods

end-of-term evaluation

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

Written examination

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

Written examination

Examination methods in case of permanent evaluation

Possibilities of retake in case of permanent evaluation

not applicable

Calculation of the examination mark

Theory: 16 out of 20 marks; exercise: 4 out of 20 marks.
Part 1 and Part 2 are equally important, with separate exams.