Industrial Polymerization Processes

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European credits ECTS: 6

Teaching Language: Spanish (English Friendly Course)

Supporting files: Spanish and English

	Number of course slots (1h)	Number of course slots (1h)
Magisterial	40	
Simulation assignment	10	
Practical		10

Description

- The main objective of this course is that the student acquires knowledge of the polymerization reaction engineering, so that he/she get familiar with the design of industrial polymerization reactors used for the production of the major commercial polymer families (polyolefins, PVC, styrene/acrylic copolymers, vinyl/acrylic copolymers or PET amongst others).
- The course addresses aspects like polymerization kinetics, polymerization techniques, ideal polymerization reactors and the properties of the polymers and copolymers.
- Simulation of a polymerization reactor is considered in an assignment.

Outline

Part 1: Introduction to Polymerization Processes

Microstructural features of polymers and their effect on properties
Classes of polymerizations
Polymerization techniques
Main commercial polymers

Part 2: Ideal reactors. Chemical reactions engineering

Review of the engineering of chemical reactions
Review of design equations of ideal reactors
Polymerization reactors

Part 3: Coordination polymerization engineering

Polyolefin types: microstructural classification
Catalysts for olefin polymerization and mechanism of polymerization

Polymerization kinetics for single-site catalysts

- Population balances equations for linear homopolym. in batch reactors
- The Method of moments for homopolymerization

Industrial olefin polymerization reactors

Part 4: Free radical (co)polymerization engineering in homogeneous systems

Free-radical polymers: properties and applications
Free radical polymerization mechanism and kinetics: homo and copolymerization
Diffusion controlled reactions
Kinetic balances for modeling polymer molar masses
Polymer reaction engineering aspects. Batch, semibatch, continuous and tubular reactors

Part 5: Polymerization in dispersed phase. Suspension and emulsion polymerization

Suspension polymerization

- Physical description and commercial polymers
- Formation and stability of the suspension
- "Bead" and "Powder" suspension polymerization

Emulsion polymerization

- Characteristics, commercial polymers and applications
- Physical description
- Compartmentalization of radicals
- Mechanism, thermodynamics and kinetics

Part 6: Step-growth polymerization

Introduction: Step-growth vs chain growth polymerization
Commercially important polymers produced by step-growth polymerization
Polymerization techniques
Polymerization kinetics and molar mass distribution development

- Reaction kinetics and most probable distribution
- Effect of non-stoichiometry composition

Practical computer contents

A polymerization reactor is simulated using the Predici© software. The assignment involves the students in writing the material and energy balances of a selected polymerization reactor (the free-radical polymerization of styrene is used for illustration purposes) and implementing them in Predici© to determine the evolution of monomer conversion, temperature and molar mass distributions along the polymerization.

Experimental practical contents

Solution (homogeneous) and emulsion (heterogeneous) free-radical polymerizations are carried out by the students. The conversion, molar mass and particle size distributions (in the emulsion case) are measured in the lab and the effects of reaction variables (initiator and emulsifier concentrations, reaction temperature and solids content) on the measured properties is analyzed.