# Industrial Polymerization Processes

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**European credits ECTS:** 6

**Teaching Language:** English

**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 they 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 homopolymerizations 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 in linear systems

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 modeling

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.