LMAPR2320 — Process development in industrial organic chemistry

2014-2015

5.0 credits	30.0 h + 15.0 h	1q

Teacher(s) :	De Wilde Juray ; Luis Alconero Patricia ; Mignon Denis ;
Language :	Anglais
Place of the course	Louvain-la-Neuve
Inline resources:	> http://icampus.uclouvain.be/claroline/course/index.php?cid=LMAPR2320
Main themes :	a) Refining and petrochemicals: After an introduction and overview of refining and the petrochemical industry, the most important processes are studied in detail, analyzing as well the flow-sheets, kinetic and catalytic aspects, the reactor concepts, aspects related to the separation and purification of reactants and products, the energy requirements and the environmental impact, and the process safety. b) Polymerization processes: after a general introduction to polymerization processes, the various types of processes are reviewed and illustrated at hand of industrial examples. A special emphasis is put on the production processes of polymers produced in large amounts worldwide, such as polyethylene (HDPE, LDPE), polypropylene (PP), polystyrene (GPPS, HIPS), PVC ' Some specific problems, such as the control of polymerization reactors and the emissions to the environment are also addressed.
Aims :	Contribution of the course to the program objectives Referring to the LOs of the KIMA diploma, the following LOs are aimed at: -- Axe 1: 1.1, 1.2; -- Axe 2: 2.2, 2.3, 2.4, 2.5; -- Axe 3: 3.1, 3.2, 3.3; -- Axe 4: 4.1, 4.2, 4.4; -- Axe 5: 5.3, 5.5, 5.6; -- Axe 6: 6.1, 6.2, 6.3. Specific learning outcomes of the course Disciplinary learning outcomes a) Refining and petrochemical processes At the end of this course the student will be able to: -- Give an overview of the processes involved in refining. -- Give an overview of the major processes using natural gas or petroleum as a feedstock (starting from steam reforming, steam cracking, or catalytic reforming). -- Describe in detail: -- the process flow sheet (species and heat) and the interaction with other processes, -- the process safety, -- the feedstock and product requirements, -- the process conditions, -- the chemistry and reaction thermodynamics and kinetics, -- the catalyst if used, -- the reactor type used and the appropriate reactor model(s), -- the measures taken to increase the energy efficiency and to reduce the environmental impact -- for the following processes: -- catalytic reforming, --

	catalytic cracking, -- hydrocracking, -- steam reforming, -- steam cracking, -- phthalic acid anhydride. -- Interpret flow sheets of (petro)chemical processes in general. -- Take a variety of measures to increase the energy efficiency and to reduce the environmental impact of (petro)chemical processes. b) Polymerization processes At the end of this course the student will be able to: -- Explain key issues of molar mass control for free radical and step-growth polymers in ideal and non ideal batch and continuous reactors -- Explain the influence of thermodynamic and physical parameters on molar mass control for free radical and step-growth polymers -- Describe the main types of industrial polymerization processes, the major industry trends and explain the applicability range, advantages and disadvantages of the various options -- Give major examples of industrial polymerization processes : polyolefins, styrenics, PVC, polyesters, polyamides and explain the key challenges in all cases Transverse learning outcomes At the end of this course the student will be able to: -- Study independently the different aspects of a (petro)chemical process. -- Present and explain the different aspects of a (petro)chemical process to a professional audience, in writing and orally. -- Read, analyze and question a scientific paper. -- Mobilize scientific and technical knowledge from various sources, including reference textbooks and the web to explain real life industrial examples of refining and petrochemical and polymerization processes. -- To use a corpus of scientific and technical knowledge, allowing to solve given problems in the discipline studied. -- To analyze, organize and develop an engineering approach for process development responding to specific needs or a given problem, the analysis of a given physical phenomenon or a system. -- To contribute, as a team member, to the realization of a project with a given discipline or multiple disciplines according to a well described approach. -- To efficiently communicate by writing and presentation, in English or French, the results of a well-defined project. -- To show a rigorous behavior and critical thinking in carrying out scientific or technical tasks with respect for ethical issues. *The contribution of this Teaching Unit to the development and command of the skills and learning outcomes of the programme(s) can be accessed at the end of this sheet, in the section entitled “Programmes/courses offering this Teaching Unit”.*
Evaluation methods :	The students will be individually graded based on the objectives indicated above. More precisely, the evaluation involves the grading of a) Refining and petrochemical processes The theoretical exam is with a written preparation and oral defense/discussion. It counts for 60% of the mark. Evaluation of the mini-projects Two mini-projects (defined in the section on Learning methods) are evaluated. They count for 40% of the mark. b) Polymerization processes -- The presentation of one seminar, individually or in groups of 2 or 3, validating the disciplinary objectives (25% of the total mark). -- An individual oral exam (25% of the total mark).

Teaching methods :	This course combines ex-cathedra teaching and projects with tutoring. Refining and petrochemical processes The theoretical courses are ex-cathedra. The students are encouraged to ask questions. During the course, the students are asked to read, analyze and question a number of scientific papers. Two mini-projects are foreseen to train the students in studying and understanding a (petro)chemical process and its modeling in an independent way. Mini-project 1: (a) or (b): (a) "Fluid Catalytic Cracking: reactor and regenerator simulation" allows the students to study the coupling between the FCC reactor and the regenerator. Furthermore, the sensitivity of the process performance to a number of variables is studied. Apart from developing the technical skills of the students, the mini-project also aims at teaching the students how to report a typical technical study in a scientific and concise way, both in writing and orally in front of an audience. (b) "Steam cracking of ethane : three-dimensional simulation of the furnace" aims at familiarizing the students with CFD (Computational Fluid Dynamics) type models, allowing the detailed simulation of the hydrodynamics in the furnace, including the methane combustion reactions in the burners of the furnace and accounting for radiation. Working in groups of 2, each group studies a specific furnace design and evaluates the flow pattern in the furnace, the species concentration profiles, the distribution of the heat fluxes between the different reactor tubes suspended in the furnace, etc.. Apart from developing technical skills, the mini-project aims at familiarizing the students with working in group and with technical and scientific reporting. Mini-project 2: The students are asked to study a (petro)chemical process of choice and present its main characteristics (flow sheet, safety aspects, reactor type, etc.), both in writing and orally in front of an audience.
Content :	a) Refining and petrochemicals -- Introduction and overview of refining and the petrochemical industry; -- Steam reforming; -- Catalytic reforming; -- Steam cracking; -- Catalytic cracking; -- Hydrocracking; -- Phtalic acid anhydride. b) Polymerization processes -- Introduction to polymerization processes -- Suspension Polymerization -- Emulsion Polymerization -- Step-Growth Polymerization -- Coordination Polymerization -- Free-Radical Polymerization: Homogeneous Systems -- Free-Radical Polymerization: Heterogeneous Systems -- Control of Polymerization Reactors -- Identification of emissions: water, air, waste
Bibliography :	Course notes are provided to the students and available via iCampus.
Other infos :	This course requires basic knowledge in organic chemistry and chemical engineering (chemistry, thermodynamics, kinetics, reactor design and transport phenomena, polymer chemistry).
Cycle and year of study :	> Master [120] in Biomedical Engineering > Master [120] in Chemical and Materials Engineering
Faculty or entity in charge:	FYKI