UCLouvain

lmapr2330

2026

Reactor Design

5.00 credits	30.0 h + 30.0 h	Q2

Teacher(s)	De Wilde Juray ;
Language :	English > French-friendly
Place of the course	Louvain-la-Neuve
Main themes	The different types of chemical reactors and their modeling are addressed
Learning outcomes	**At the end of this learning unit, the student is able to :** • Axis 1: 1.1, 1.2, 1.3 • Axis 2: 2.2, 2.4, 2.5 • Axis 3: 3.2, 3.3 • Axis 4: 4.1, 4.4 • Axis 5: 5.3, 5.5 • Axis 6: 6.1, 6.3, 6.4 Specific AA: • Chapters 7 and 12: Complex single-phase flows, 3D modeling of chemical reactors, turbulence and practical modeling approaches, residence time distribution methods – theoretical description and application to the calculation of chemical reactor performance. • Chapter 11: Complex models for fixed bed reactors – stationary and transient models, pseudo-homogeneous and heterogeneous models, ideal plug flow model, non-ideal flow models 1D + axial dispersion and 2D with radial dispersion, heat recovery from exothermic reactions and stability analysis, reactors with recycle. • Chapter 13: Fluidized bed reactors, general characteristics, modeling of bubbling fluidized bed reactors, modeling of circulating fluidized bed/riser reactors. • Chapter 14: Multiphase reactors, general characteristics, modeling of multiphase reactors – different approaches, transport phenomena, and correlations for multiphase reactors.
Evaluation methods	The students are evaluated individually. The demands will be specified explicitly in advance of the exam. The exam consists of a theoretical part and an exercise. The latter is open book (only the text book used for the course can be used) and counts for 20% of the marks. The theoretical exam is with a written preparation and oral defense/discussion. The exercise is written. Evaluation of the mini-project One mini-project on the simulation of a methane steam reforming reactor, including a parametric sensitivity study, is evaluated. It counts for 10% of the marks.
Teaching methods	The physical concepts and theory are explained in the theoretical sessions. The students are encouraged to ask questions. At the beginning of each theoretical course, the course is placed into context and an overview of what will be studied is given. At the end of each theoretical session, the content is summarized and placed into context again. A session with exercises follows each theoretical session to practice the theory. The exercises focus where possible on practical problems. One mini-project "3D simulation of a cold-shot type cooling in a fixed bed ammonia synthesis reactor" aims at familiarizing the students with CFD (Computational Fluid Dynamics) type simulation models and different important aspects, such as the modeling of turbulence, boundary conditions, the required grid independency of the results, the interpretation of the results, etc.. In groups of 2-3, the students have to propose their own design of a cold shot cooling system and to evaluate its performance in terms of cooling and temperature uniformity. Besides the development of technical skills, the project aims at teaching the students to work in group and how to report a technical study in a scientific and clear way. One mini-project "Methane steam reforming: reactor simulation and sensitivity study" allows the students to apply a reactor model with detailed reaction kinetics and accounting for intraparticle diffusion limitations to design a commercial steam reformer. Furthermore, the sensitivity of the reactor 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 work in group (of 2-3) and how to report a typical technical study in a scientific and concise way, both in writing and orally in front of an audience. Lab sessions on fixed bed and fluidized bed reactors are foreseen. They aim at familiarizing the students with these two of the most important reactor technologies and at carrying out measurements of the hydrodynamic behavior and confronting the experimental data with theoretical correlations. In preparation of the exam, a question-answer and discussion session on the content of the course is foreseen.
Content	• The modeling of chemical reactors; • The batch and semibatch reactors;

	• The plug flow reactor; • The perfectly mixed flow reactor; • Complex flow patterns; • Fixed bed catalytic reactors; • Fluidized bed and transport reactors; • Multiphase flow reactors.
Inline resources	https://moodleucl.uclouvain.be/course/view.php?id=10045
Bibliography	Livre: "Chemical Reactor Analysis and Design" par G.F. Froment, K.B. Bischoff, and J. De Wilde, 3ème edition. Wiley, 2010. Le livre peut être acheté via la librairie Libris-Agora à Louvain-la-Neuve ou directement via le web. Quelques exemplaires du livre sont disponibles dans la bibliothèque BSE.
Other infos	Particular attention is paid to the units of the different variables and terms appearing in the mathematical equations in the course. It is highly reommended to have background in : • Mathematics (Analysis), • Chemistry (basis), • Transport phenomena, • Reaction kinetics
Faculty or entity in charge	FYKI

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Chemical and Materials Engineering	KIMA2M	5		🔍
Master [120] in Biomedical Engineering	GBIO2M	5		🔍