lbirc2109a
2023

Process engineering: Unit operations

3.00 credits	30.0 h + 7.5 h	Q2

Teacher(s)	Debecker Damien ;
Language :	French > English-friendly
Place of the course	Louvain-la-Neuve
Prerequisites	Transfer phenoma (for partim A) Physical chemistry I and II + fuild mecanics (for partim B)
Main themes	Partim A - Particles in flowing medium - Study of a flowing liquid through porous media and membranes - Mechanical processes for physical separation: sedimentation, decantation, centrifugation, filtration, cycloning, membrane separation - Drying processes : drying, lyophilisation, atomisation Partim B - Diffusion, mass transfer and energy transfer between phases (diffusion theory, mass transfer coefficients, film theory). - Phase equilibrium - Fluid/fluid and fluid/solid separation processes involving mass transfer : Distillation, liquid-liquid extraction, absorption, adsorption, crystallization
Learning outcomes	
Evaluation methods	Written exam systematically covering the LO (theory and exercises). If a field study in the industry is organized, the evaluation of the report and its presentation accounts for 20% of the final grade.
Teaching methods	Lecture with a powerpoint presentation as the main support (available via Moodle). Even if the slides are used as a support for the lectures, an important part of the course is given orally and on the blackboard (e.g. explanations, examples, mathematic developments, etc.). Quantitative exercises of dimensioning with a tutor. Scientific articles are recommended for reading as a complement to the course. Students may be instructed to visit a production plant of their choice and to study a unitary operation involved in the production process. If so, a short, didactical and critical report is requested, in the form of a poster. The report is presented to other students. Some lecture may be tought remotely (Teams).
Content	**Introduction** Objectives, instructions, process engineering and unitary operations: definitions, main working principles of unitary operations for separation, the different operating modes, context, classification of unitary operations **Partim A** **Separation processes based on mechanical action** Particles in fluids (Context, Description of a divided solid, the isolated particle, a bunch of particles, Characterization of a bed of particles) / Sedimentation and Centrifugation (Definitions, Interactions between the fluid and one particle, flow regimes, sedimentation rate) / Flows through porous media (Darcy law, Kozeny Carman model, turbulent flow, Ergun relation) / Filtration (Context, Support filtration, Coupling the variables, Humidity ratio, Cake dimensions, Resistance to the flow, Operating modes, Filtration technologies) / Membrane separation (Description, Applications, Diffusion principles, Materials, Mass transfer, Dialysis, Electrodialysis, Inverted osmosis, Gas permeation, Pervaporation, Membranes in bioprocesses) **Drying processes** Motivation / Definitions and concepts (wet solid, gaz-liquid-solid equilibrium, wetting enthalpy, sorption isotherms, equilibrium diagrams) / Techniques et set-up (classification, machines often used in the industry, drying by ebullition, drying by flow, lyophilisation, drying of bio-products) / Theoretical principles of drying (drying kinetics, hygrometry, wet air diagram, case study: the drying of cereals in a grain silo) / Alternative mode for providing energy / supercritical drying **Partim B** **Fluid/fluid separation and fluid/solid separation involving mass transfer**

	Liquid-gaz equilibrium of binary systems (Reminders, the Raoult law, non ideal mixtures, Influence of pressure, Systems with more than two species) / Distillation (Basic working principles of distillation, Simple discontinuous distillation(batch), Continuous distillation(flash distillation), Fractionated distillation: working principle, Plate colonne, the method of Sorel, the method of Lewis, the method of Mc Cabe & Thiele, Study of the column with the equilibrium diagram, vapor injection, the method of Ponchon& Savarit, Study of the columns with the enthalpy diagram, Rectification of azeotropic mixtures, Rectification mixtures with more than two species, Column efficiency) / Liquid-liquid extraction (Reminders on ternary diagrams, Extraction in one contact stage, Extraction with multiple contact stages, Countercurrent extraction with separate contact stages, Countercurrent extraction with uninterrupted contact, Countercurrent extraction with reflux) / Gas absorption by liquids (Equilibrium condition, Graphical representation, Number theoretical stages, Continuous transfer, Absorption of several species, Absorption with chemical reaction) / Adsorption (Adsorption on a solid, Adsorption equilibrium for a pure gas, Adsorption equilibrium for a gaseous binary mixture, Adsorption equilibrium for a liquid binary mixture - Adsorption separated stages, Adsorption in fixed bed) / Crystallization (Definitions, the crystalline state, Solubility curves, Sursaturation curves, Basic principles of crystallization in solution, Crystallization processes, Purity and morphology of crystals
Inline resources	Moodle: - slides posted at the beginning of the semester - list of exercices - remainders for mathematical formula - instructions for the plants visit
Bibliography	Aucun support payant n'est obligatoire. Une impression des diapositives (powerpoint) utilisées au cours et préalablement mises à disposition sur Moodle est vivement recommandée. Comme supports de cours facultatifs et disponibles en bibliothèque : - Introduction au génie des procédés de D. Ronze (Editions Tec et Doc, 2008), ISBN : 978-2-7430-1066-9 - Separation process principles de E.J. Henley, J.D. Seader, D.K. Roper (Wiley, 2011) ISBN : 978-0-470-64611-3 - Le pétrole - Rafinage et genie chimique I de P. Wuithier (Editions Technip, 1972) ISBN : 2-7108-0198-1 - Procédés de séparation de J.P. Wauquier ((Editions Technip, 1998) ISBN : 2-7108-0671-1
Other infos	This course can be given in English.
Faculty or entity in charge	AGRO

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Environmental Bioengineering	BIRE2M	3		🔍
Master [120] in Agricultural Bioengineering	BIRA2M	3		🔍