

Due to the COVID-19 crisis, the information below is subject to change, in particular that concerning the teaching mode (presential, distance or in a comodal or hybrid format).

2 credits	22.5 h + 7.5 h	Q2
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Teacher(s)	Debaste Frédéric (compensates Debecker Damien) ;
Language :	French
Place of the course	Louvain-la-Neuve
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
Aims	<i>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".</i>
Evaluation methods	Due to the COVID-19 crisis, the information in this section is particularly likely to change. Written exam systematically covering the LO (theory and exercises). The written report concerning the field study in the industry weight 20% of the final grade.
Teaching methods	Due to the COVID-19 crisis, the information in this section is particularly likely to change. Lecture with a powerpoint presentation as the main support (available via iCampus). 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 company of their choice and to study a unitary operation involved in the production process. A short, didactical and critical report is asked, in the form of a poster. The report is presented to other students. Owing to the limited capacity of the class rooms, related to the restrictions of the COVID-19 crisis, some lecture may be given 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 (the Darcy law ' the Kozeny Carman model ' turbulent flow ' the 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

	<p>Partim B</p> <p>Fluid/fluid separation and fluid/solid separation involving mass transfer</p> <p>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</p>
<p>Inline resources</p>	<p>Moodle:</p> <ul style="list-style-type: none"> - slides posted at the beginning of the semester - list of exercices - remainders for mathematical formula - instructions for the plants visit
<p>Bibliography</p>	<p>Aucun support payant n'est obligatoire.</p> <p>Une impression des diapositives (powerpoint) utilisées au cours et préalablement mises à disposition sur Moodle est vivement recommandée.</p> <p>Comme supports de cours facultatifs et disponibles en bibliothèque :</p> <ul style="list-style-type: none"> - 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
<p>Other infos</p>	<p>This course can be given in English.</p>
<p>Faculty or entity in charge</p>	<p>AGRO</p>

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Aims
Master [120] in Environmental Bioengineering	BIRE2M	2		