



## Subject card

Subject name and code	Diffusion Operations in Bioprocess Engineering, PG_00054884						
Field of study	Biotechnology						
Date of commencement of studies	October 2021		Academic year of realisation of subject		2023/2024		
Education level	first-cycle studies		Subject group		Obligatory subject group in the field of study Subject group related to scientific research in the field of study		
Mode of study	Full-time studies		Mode of delivery		at the university		
Year of study	3		Language of instruction		Polish		
Semester of study	5		ECTS credits		6.0		
Learning profile	general academic profile		Assessment form		exam		
Conducting unit	Department of Process Engineering and Chemical Technology -> Faculty of Chemistry						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. inż. Donata Konopacka-Łyskawa				
	Teachers		dr inż. Izabela Wysocka  dr inż. Natalia Łukasik  dr inż. Iwona Hołowacz  dr inż. Piotr Rybarczyk  dr inż. Bartosz Szulczyński  dr hab. inż. Donata Konopacka-Łyskawa				
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	30.0	15.0	0.0	75
	E-learning hours included: 0.0						
Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan		Participation in consultation hours		Self-study	SUM
	Number of study hours	75		10.0		65.0	150
Subject objectives	To familiarize students with the concepts of diffusion operation/mass transter processes. Presenting students the opportunities to use mathematical equations in the description of the unit operations used in bioprocess engineering. Developing students' computing skills for the relevant unit operations.						
Learning outcomes	Course outcome		Subject outcome		Method of verification		
	K6_W10		identifies diffusion processes in a given technology; explains the connections between the physicochemical balance of the system and the course of selected diffusion operations used to obtain biotechnological products.		[SW3] Assessment of knowledge contained in written work and projects [SW1] Assessment of factual knowledge		
	K6_W09		explains the principle of separating mixtures using diffusion operations such as absorption, extraction, distillation, and drying; demonstrates preparation in the use of methods of learned operations to separate biotechnological products.		[SW3] Assessment of knowledge contained in written work and projects [SW1] Assessment of factual knowledge		
	K6_U10		is able to describe mass transfer processes, indicate the driving force of the process, and prepare a mass balance of selected processes; is able to perform calculations of selected unit processes.		[SU5] Assessment of ability to present the results of task [SU3] Assessment of ability to use knowledge gained from the subject [SU1] Assessment of task fulfilment		

Subject contents	Differential, equilibrium and steam distillation. Co- and counter-current condensation. Continuous rectification: mass and heat balance, number of theoretical plates, column dephlegmator, efficiency of the plate, height of the packing bed. Periodic rectification: with constant distillate composition and constant reflux. Counter-current absorption, counter-current absorption with recirculation of part of the solvent; number of theoretical plates; plate efficiency; height of the packing bed. Extraction: single-stage extraction, co-current multi-stage extraction, multi-stage counter-current extraction, extraction with mutual insolubility of solvents. Drying of porous solids: moist air parameters, drying equilibrium and kinetics. Crystallization.		
Prerequisites and co-requisites	Properties of liquids and gases. Physicochemical equilibria: liquid-vapor, liquid-liquid, gas-liquid.		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Written exam	60.0%	40.0%
	Tests at lectures	50.0%	15.0%
	Project	60.0%	20.0%
	Laboratory	100.0%	25.0%
Recommended reading	Basic literature	1. W. L. McCabe, J. C. Smith, P. Harriot, Unit operations of chemical engineering, McGraw-Hill Comp. Inc. (7th ed.) 2005  2. D. W. Green (ed.): Perry's Chemical Engineers' Handbook, The McGraw-Hill Comp. Inc. (7th ed.) 1997.  3. S. Katah, J. Houruchi, F. Yoshida: Biochemical Engineering, Wiley 2015.	
	Supplementary literature	1. J.D. Seader, E. J. Henley, D. Keith Roper: Separation process principles, 3rd Ed., Wiley, 2010  2. Scientific paper	
	eResources addresses	Adresy na platformie eNauczanie: Operacje dyfuzyjne w inżynierii bioprosesowej - Moodle ID: 34022 <a href="https://enauczanie.pg.edu.pl/moodle/course/view.php?id=34022">https://enauczanie.pg.edu.pl/moodle/course/view.php?id=34022</a> Operacje dyfuzyjne w inżynierii bioprosesowej - Moodle ID: 34022 <a href="https://enauczanie.pg.edu.pl/moodle/course/view.php?id=34022">https://enauczanie.pg.edu.pl/moodle/course/view.php?id=34022</a>	

<p>Example issues/ example questions/ tasks being completed</p>	<p>1. Explain the operation of condensers a / fully condensing, b / co-current partially condensing and c / counter-current partly condensing . Using the charts <math>t = f(x, y)</math>, <math>y^* = f(x)</math> indicate the product compositions for the selected composition of the vapour entering the condenser. Draw flows of liquid and vapor streams during partial counter-current condensation and write the mass balance of the streams, the mass balance of the more volatile component and the mass balance of a differential portion of vapour. Show that the counter-current condenser is more effective than one theoretical plate.</p> <p>2. Draw a scheme of the column for continuous rectification. Based on the used symbols in the drawing, write the material and heat balance. Specify the thermal state of the feed, indicate the possible values for the five distinguished thermal states of feed . Discuss impact of the feed condition on a / the position of the inlet plate in the rectification column - justify the answer with the appropriate diagrams; b / the liquid and vapor stream at the top and bottom of the column based on the appropriate balance relationships. Discuss the amount of heat received in the condenser and delivered to the boiler change if the reflux decreases?</p> <p>3. Draw a diagram of the absorption column. Write the mass balance of the absorbed component for this process. Based on the use symbols, determine the volume of gas introducing to the column. a / Draw the equilibrium line and the operating line for the process in which the minimum amount of absorbent was used on the exemplary equilibrium; b / on the same chart draw the operating line for the same amount of absorbent was used, but a lower degree of absorption was achieved; c / Write the equation of operating lines for the processes describe in points /a/ and / b /; d / Determine the excess of solvent in relation to the minimum amount for absorption from point / b /. Write the dependence on the number of mass transfer units in the gas phase; explain the meaning of the variables in the appropriate chart. How will the number of mass transfer units change if the consumption of absorbent increases?</p> <p>4. Draw a scheme of counter-current extraction and write the material balance for the whole process and for the third stage of this extraction, when the secondary solvent B is contaminated with component C (B with a small proportion of component C). Explain a) using the Gibbs triangle to determine the minimum and maximum amount of solvent in countercurrent extraction; b) how to determine the mass and composition of the extract and raffinate produced in the second extraction stage. Present the process of counter-current multi-stage extraction in a rectangular diagram when solvent B contains a small amount of component C. Indicate the change of the concentration of the component extracted on the second theoretical plate? Explain the concept of theoretical plate in extraction.</p>
<p>Work placement</p>	<p>Not applicable</p>