GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Diffusion Operations in Bioprocess Engineering, PG_00054884		
Field of study	Biotechnology		
Date of commencement of studies	October 2022	Academic year of realisation of subject	2024/2025
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		

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_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.	[SU1] Assessment of task fulfilment [SU3] Assessment of ability to use knowledge gained from the subject [SU5] Assessment of ability to present the results of task
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.	[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects
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.	[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects

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. Counte-rcurrent 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	<table><tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr><tr><td>Laboratory</td><td>100.0%</td><td>25.0%</td></tr><tr><td>Project</td><td>60.0%</td><td>20.0%</td></tr><tr><td>Tests at lectures</td><td>50.0%</td><td>15.0%</td></tr><tr><td>Written exam</td><td>60.0%</td><td>40.0%</td></tr></table>

Recommended reading	Basic literature	1. W. L. McCabe, J. C. Smith, P. Harriot, Unit operations of chemical engineering, McGrow-Hill Comp. Inc. (7th ed.) 2005 2. D. W. Green (ed.): Perry's Chemical Engineers' Handbook, The McGrow-Hill Comp. Inc. (7th ed.) 1997. 3. S. Katah, J. Houriuchi, 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:

Example issues/ example questions/ tasks being completed	1. Explain the operation of condensers a / fully condensing, b / co-current partially condensing and c / counter-current partly condensing . Using the charts t = f (x, y), y * = f (x) 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. 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. Discusse the amount of heat received in the condenser and delivered to the boiler change if the reflux decreases? 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? 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.
Work placement	Not applicable