FACULTY OF CHEMISTRY

SUBJECT CARD

Name of subject in English: Diffusion Processes
Main field of study (if applicable): Chemical and Process Engineering
Specialization (if applicable):
Profile: academic
Level and form of studies: 1nd level, full-time
Kind of subject: obligatory
Subject code:
Group of courses: NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	45		45	30	
Number of hours of total student workload (CNPS)	120		90	60	
Form of crediting	Exam		crediting with grade	crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points	4		3	2	
including number of ECTS points for practical (P) classes			3	2	
including number of ECTS points for direct teacher-student contact (BU) classes	1,95		2,1	1,5	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Know of physical chemistry and processes thermodynamic.
2. Know of foundations of chemical engineering.

SUBJECT OBJECTIVES

C1. Introduce of theory of mass transfer between two phases.
C2. Classification methods of mass transfer apparatus.
C3. Know mathematical description of mass transfer rate in diffusional processes.
C4. Introduce of calculation methods of selected apparatus used for diffusional separation of components.
C5. Learn carrying out simple calculations of kinetic parameters of mass transfer processes.
C6. Learn to work out project procedures of selected mass transfer apparatus.
C7. Introduce of selected measurements methods of characteristic parameters of mass transfer processes in different apparatus.

SUBJECT LEARNING OUTCOMES

related to knowledge:
PEK_W01 – know theory of mass transfer processes
PEK_W02 – can classificate of mass transfer apparatus
PEK_W03 – know mathematical description of diffusional mass transport
PEK_W04 – know methods of description mass transfer processes occurring in the different construction mass transfer apparatus.

related to skills:
PEK_U01 – can match mass transfer apparatus for realization of different mass transfer processes.

PEK_U02 – can carry out balance and kinetic calculations different kinds of mass transfer apparatus. PEK_U03 – can make experimental measurements of characteristic parameters of mass transfer in laboratory scale apparatus.		
ROGRAMME CONTENT		
Lectures		**Number of hours**
Lec 1	Theory of diffusion in gas and liquid phases, diffusivity fo two- and multicomponent mixtures, equation of diffusion rate.	3
Lec 2	Mass transfer and overall mass transfer processes, expression methods of mass transfer and overall mass transfer coefficients.	3
Lec 3	Classification of mass transfer apparatus, number of theoretical stages.	3
Lec 4	Number of real stages, definitions of stage efficiency.	3
Lec 5	Colburn method, WRPT, HTU, NTU	3
Lec 6	Absorbers, rules of realization and design of absorption process.	3
Lec 7	Distillation equilibria, examples of simple distillations, steady state and unsteady state processes.	3
Lec 8	Rectification of two component mixtures, minimal number of theoretical plates (stages), minimal reflux ratio.	3
Lec 9	Multicomponent rectification, rules of design.	3
Lec 10	Special cases of rectification, column and systems for azeptropes separation, using of separating components.	3
Lec 11	Extractors, methods of process realization, process design using Gibbs triangle and Cartesian diagram.	3
Lec 12	Extraction in a liquid - solid system. Crystallization from solutions.	3
Lec 13	Adsorbers design, methods of realization of adsorption process.	3
Lec 14	Drying of solids, air humidification, Molier diagram, drying curves, dryers design.	3
Lec 15	The use of new separation methods: membrane processes, chromatography, ion exchange, supercritical extraction.	3
	Total hours	**45**
Laboratory		**Number of hours**
Lab1	Organizational activities. Becoming acquainted with rules of health and safety at work in research laboratory. Presentation of basic apparatus used in experiments.	3
Lab2	Extraction efficiency in the liquid - liquid system.	3
Lab3	Volume overall mass transfer coefficient and high of mass transfer unit.	3
Lab4	Influence of mixing energy on mass transfer coefficient in the solid – liquid system.	3
Lab5	Influence of mixing energy on mass transfer in RDC column.	3
Lab6	Efficiency of sieve plate in the desorption process of gas.	3
Lab7	Extraction efficiency in the liquid - liquid system II.	3
Lab8	Partial colloquium I.	3
Lab9	Influence of liquid pulsation on mass transfer rate.	3
Lab10	Volume overall mass transfer coefficient and high of mass transfer unit.II.	3
Lab11	Mass transfer from solid surface in conditions of natural convection.	3

Lab12	Determination of mass transfer coefficient from solid surface in conditions forced convection.	3
Lab13	Measurement of axial mixing with the use of impulse method.	3
Lab14	Supplementary laboratory, partial colloquium II.	3
Lab15	Repeat colloquium and credit.	3
	Total hours	**45**
Project		**Number of hours**
Proj 1	Calculation methods of overall mass transfer coefficients in the gas – liquid systems. Project of absorber. Partial colloquium I.	10
Proj 2	Balance calculations of simple distillations and rectifications in two component system. Project of rectification column. Partial colloquium II.	10
Proj 3	Methods of realization and calculation of liquid – liquid extraction processes. Project of extractor. Partial colloquium III.	10
	Total hours	**30**

TEACHING TOOLS USED

N1. Lecture with multimedia presentation.
N2. Solving of problems.
N3. Implementation of calculations and design with using own procedures worked out in Excel.
N4. Presentation of projects.
N5. Experiments performing and preparing of report.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes number	Way of evaluating learning outcomes achievement
C(lecture)	PEK_W01 – PEK_W04	Examination
F1(project)	PEK_U01, PEK_U02	Partial colloquium I
F2(project)	PEK_U01, PEK_U02	Project report I
F3(project)	PEK_U01 PEK_U02	Partial colloquium II,
F4(project)	PEK_U01 PEK_U02	Project report II
F5(project)	PEK_U01 PEK_U02	Partial colloquium III,
F6(project)	PEK_U01 PEK_U02	Project report III
C(project) = (F1+0,8F2+F3+0,8F4+F5+0,8F6)/6		
F1 (laboratory)	PEK_U03	Partial colloquium I
F2 (laboratory)	PEK_U03	Partial colloquium II
F3 (laboratory)	PEK_U03	Evaluate of reports La2 – La7, La9 – La13 and calculation of average grade
C(laboratorium) = (F1+F2+F3)/3		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Binay K. Dutta, Principles of Mass Transfer and Separation Processes, PHI, 2011.
[2] Jaime Benitez, Principles and Modern Applications of Mass Transfer Operations, Wiley, 2016.
[3] R. Byron Bird, Warren E. Stewart, Edwin N. Lightfoot, Daniel J. Klingenberg, Introductory Transport Phenomena, Wiley, 2014.
[4] Don Green, Robert Perry. Perry's Chemical Engineers' Handbook, Eighth Edition, McGraw-Hill Professional, 2007.
[5] Z. Ziołkowski, Destylacja i rektyfikacja w przemyśle chemicznym, WNT Warszawa 1978.
[6] J. Ciborowski, Podstawy inżynierii chemicznej, WNT, Warszawa1982.
[7] M. Serwiński, Zasady inżynierii chemicznej i procesowej, WNT, Warszawa 1982.
[8] Z. Kawala, A. Kołek, M. Pająk, J. Szust, Zbiór zadań z podstawowych procesów inżynierii chemicznej cz. I – III. Skrypty PWr.
[9] Praca zbiorowa, Zadania projektowe z inżynierii procesowej, Oficyna Wydawnicza Politechniki Warszawskiej, W-wa 1986.
[10] Laboratorium Inżynierii Procesowej cz.I. Przenoszenie pędu i procesy mechaniczne – praca zbiorowa pod redakcją Danuty Beliny-Freundlich, 1981.
[11] Laboratorium Inżynierii Procesowej cz.II. Przenoszenie ciepła i masy – praca zbiorowa pod redakcją Danuty Beliny-Freundlich, 1981.
[12] Instrukcje do ćwiczeń, dostępne na stronie Wydziału Chemicznego Pwr.

SECONDARY LITERATURE:

[1] Don Green, Robert Perry. Perry's Chemical Engineers' Handbook, Eighth Edition, McGraw-Hill Professional; 8 edition (November 13, 2007).
[2] R. Byron, Warren E. Stewart, Edwin N. Lightfoot. Transport Phenomena, Revised 2nd Edition. John Wiley & Sons, Inc.; 2nd edition (December 11, 2006).
[3] E. L. Cussler. Diffusion: Mass Transfer in Fluid Systems (Cambridge Series in Chemical Engineering), Cambridge University Press; 3 edition (February 2, 2009).
[4] K.F.Pawłow, P.G.Romankow, A.A.Noskow. Przykłady i zadania z zakresu aparatury i inżynierii chemicznej, WNT W-wa 1988.
[5] Selecki A., Gradoń L., Podstawowe procesy przemysłu chemicznego, WNT, Warszawa1985.
[6] Kembłowski Z., Podstawy teoretyczne inżynierii chemicznej i procesowej, WNT, Warszawa 1985.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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