COURSE DESCRIPTION CARD - SYLLABUS

Course name
Sustainable separation processes [S1TOZ1>ZPS]

Course

Field of study
Circular System Technologies

Year/Semester
3/6

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
30

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points

4,00

Coordinators

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Lecturers

Prerequisites

Fundamental knowledge of general chemistry, physical chemistry, thermodynamics, organic chemical technology, and chemical engineering, as well as environmental protection, including types of pollution; the ability to acquire knowledge from the indicated sources.

Course objective

The aim of course is to gain theoretical knowledge on sustainable separation processes. Theoretical foundations of individual separation techniques belonging both to the group of classical methods and membrane separation techniques. Understanding the main areas of application of separation processes in the chemical, food, pharmaceutical and environmental protection industries. Understanding the principles of building membrane installations. In addition, the aim of the course is to acquire theoretical knowledge and practical skills in the field of design and modeling multi-stage separation processes.

Course-related learning outcomes

Knowledge:
k_w03 student has mathematical, physical, and chemical knowledge necessary to describe the concepts, ideas, and principles of circular system technologies as well as the characteristics of the connections and dependencies between its components
k_w12 student has a basic knowledge of the life cycle of products, devices, and installations used in circular system technologies
k_w22 student has knowledge of physical and chemical fundamentals of unit processes in cilcular system technologies
k_w24 student knows and describes the technological solutions and the rules of operation of devices used in water treatment, waste gas purification and waste management

Skills:
k_u11 student analyzes and verifies the existing technical solutions in the field of circular system technologies
k_u12 student is able to select and evaluate the usefulness of tools and methods for solving problems regarding circular system technologies
k_u17 student is able to develop a mass and energy balance for both unit processes and the entire installation used in circular system technologies

Social competences:
k_k02 student is independent and creative in individual work and works effectively in a team, playing various roles; objectively assesses the effects of his own work and team members
k_u09 student is able to interact with other people as part of work on circular system technologies

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
Written/oral exam (stationary or online on the e-courses platform) including 3-5 open questions, assessed on a point scale (51% -60% (3.0), 61% -70% (3.5); 71% -80% (4.0), 81% -90% (4.5), 91% -100% (5.0)
Laboratory classes: graded student"s activity during laboratory classes including correct laboratory reports prepared by students.

Programme content

Sustainable separation processes. Separation techniques. The main areas of application of separation processes. The principles building membrane installations. Membrane distillation. Membrane reactors. Design and modeling multi-stage separation processes.

Course topics

Lectures:
1. Classification and brief description of the separation processes.
2. Classic separation processes (extraction; vacuum concentration; ion exchange; crystallization; adsorption).
3. Membrane separation techniques - basic concepts and definitions.
4. Modeling of the mass transport through the membranes, concentration polarization, and membrane fouling.
5. Theoretical background and application areas of pressure-driven membrane processes (MF, UF, NF, RO, FO).
6. Concentration-driven membrane processes (characteristics of the processes: GS, DD, PV, and examples of application areas.
7. Current-driven membrane techniques (classic ED and bipolar ED).
8. Membrane distillation (process characteristics and application examples)
9. Principles of construction and operation of membrane reactors (catalytic membranes)
10. The multi-stage and hybrid separation systems based on membrane techniques used in the processes of air purification, wastewater treatment, and the production of bio-organic compounds.
11. Designing sustainable separation processes - problematic issues.
12. Renewable energy sources in membrane processes.

13. The use of sustainable separation processes in innovative technological solutions.
14. Sustainable separation techniques in water recovery processes.
Laboratory classes.
Practical experiments made by students using reserach equipment in the laboratory.

Teaching methods

Lecture illustrated by multimedia presentation and group discussion.
Laboratory classes: Fisrt-hand experience provided by practical experiments

Bibliography

Basic
1. K. Scott, Handbook of industrial membranes, Elsevier Advanced Technology, 1998
2. M. Bodzek, J. Bohdziewicz, K. Konieczny, Techniki membranowe w ochronie środowiska, Wydawnictwo Politechniki Śląskiej, Gliwice, 1997
3. J. Rautenbach, Procesy membranowe, WNT, Warszawa 1996
4. Biernacka, T. Suchecka, Techniki membranowe w ochronie środowiska, Wyd. SGGW, Warszawa 2004
Additional
1. Z. Zhang, W. Zhang, E. Lichtfouse, Membranes for Environmental Applications, Springer, 2020
2. M. Szczygiełda, K. Prochaska, Downstream separation and purification of bio-based alpha-kethoglutaric acid from post-fermentation broth using a multi-stage membrane process, Process Biochem., 96 (2020) 38-48.
2. M. Szczygiełda, K. Prochaska, Alpha-ketoglutaric acid production using electrodialysis with bipolar membrane, J. Membr. Sci., 536 (2017) 37-43.
3. J. Antczak, M. Szczygiełda, K. Prochaska, Nanofiltration separation of succinic acid from post-fermentation broth: Impact of process conditions and fouling analysis, J. Ind. Eng. Chem., 77 (2019), 253-261.
4. M. Szczygiełda, J. Antczak, K. Prochaska, Separation and concentration of succinic acid from post-fermentation broth by bipolar membrane electrodialysis (EDBM), Sep. Purif. Technol., 181 (2017) 53-59.

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	63	2,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	37	1,50