COURSE DESCRIPTION CARD - SYLLABUS

Course name
Extraction methods [S2IChiP1-IC>ME]

Course

Field of study
Chemical and Process Engineering

Year/Semester
1/2

Area of study (specialization)
Chemical Engineering

Profile of study
general academic

Level of study
second-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

Basic knowledge of separation processes, with particular emphasis on multi-stage processes and also inorganic and organic chemistry. The ability to obtain information from literature, databases and other sources, the ability to interpret them, draw conclusions and formulate opinions.

Course objective

Obtaining knowledge focused on extraction methods used in modern technologies for obtaining metals (including copper, zinc) in pyro-, hydro- and electrometallurgical processes. Developing knowledge related to metal recycling and recovery of various types of raw materials from waste streams. The aim of the laboratory exercises is to familiarize students with the laboratory technique of reactive extraction in the mixer-settler system, operation of mixing equipment and separation of two-phase solutions.

Course-related learning outcomes

Knowledge:
1. k_w03 the student has an extended and in-depth knowledge in the field of chemistry and other related areas of science, allowing to formulate and solve complex tasks related to chemical engineering.
2. k_w04 the student has knowledge of complex chemical processes, including the appropriate

selection of materials, raw materials, apparatus and devices for the implementation of chemical processes and the characterization of the obtained products.
3. k_w9 the student has knowledge of environmental protection problems related to the implementation of industrial chemical processes.

Skills:
1. k_u01 the student has the ability to obtain and critically evaluate information from literature, databases and other sources and to formulate opinions and reports on this basis.
2. k_u02 the student has the ability to work in a team and to lead a team.
3. k_u012 the student is able to properly use natural resources in industry, guided by the principles of environmental protection and sustainable development.

Social competences:
1. k_k02 the student is aware of the importance and understands the non-technical aspects and effects of engineering activities, including its impact on the environment and the related responsibility for decisions.
2. k_k01 the student understands the need for lifelong learning; is able to inspire and organize the learning process of other people; is aware of the importance and non-technical aspects and effects of engineering activities, including its impact on the environment, and the related responsibility for decisions made.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

The knowledge is verified during the written exam (lecture).
Passing the laboratory consists in obtaining credit from:
1. Short written colloquium before starting the laboratory exercises.
2. Performing all laboratory exercises provided in the study program.
3. Obtaining the evaluation of the approval of reports from the exercises performed.

Programme content

Lecture
The lecture discusses the issues of flotation, leaching of metals
from ores and secondary raw materials, digestion of alloys, separation of metal ions by classical and unconventional extraction. The lecture presents contemporary technologies for the production of copper, zinc, lead, silver,
aluminum, nickel, cobalt and other accompanying metals with pyrometallurgical, electrochemical and hydrometallurgical processes. Environmental problems resulting from the processing of ores are also discussed.
Laboratory:
1. Effect of the type of extractant on copper(II) extraction with benzophenone oxime and DEHPA.
2. Kinetics of extraction of copper (II) with nonylbenzophenone oxime.
3. Effect of temperature on cobalt extraction rate (extractant 0.3M DEHPA).
4. Effect of nickel(II) concentration on the degree of extraction with DEHPA.
6. Extraction of zinc(II) from waste hydrochloric acid with TBP.

Teaching methods

1. Lecture: multimedia presentation.
2. Laboratory exercises: carrying out planned exercises, processing the obtained results.

Bibliography

Basic
1. Z. Pater, Podstawy metalurgiii odlewnictwa, Wyd. Politechniki Lubelskiej, Lublin 2014. Wersja elektroniczna dostępna na: http://bc.pollub.pl/dlibra/publication/8929/edition/8711/content?ref=desc
2. S. Chodkowski, Metalurgia metali nieżelaznych, WGH, Warszawa 1962.
3. A. Ciszewski, Technologia chemiczna. Procesy elektrochemiczne, Wydawnictwo Politechniki Poznańskiej, Poznań 2008.
4. Mariusz Bogacki, Procesy ekstrakcyjne w hydrometalurgii, Wydawnictwo Politechniki Poznańskiej, 2012.

Additional
1. Hans-Joerg Bart, Reactive Extraction, Springer-Verlag, Berlin Heidelberg, 2001.
2. Jan Rydberg, Claude Musikas, Gregory R. Choppin, Priniples and Practices of Solvent Extraction, Marcel Dekker, Inc., New York, 1992.
3. Jan Szymanowski J, Ekstrakcja miedzi hydroksyoksymami, PWN, Warszawa - Poznań, 1990.
4. C.K. Gupta, Chemical Metallurgy - Principles and Practice. Wiley VCH, Weinheim2003.

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	60	2,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	40	1,50