COURSE DESCRIPTION CARD - SYLLABUS

Course name
Materials recycling in electrochemistry [S2TCh2-ES>RMwE]

Course

Field of study
Chemical Technology

Year/Semester
1/2

Area of study (specialization)
Applied Electrochemistry

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
60

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

7,00

Coordinators

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Lecturers

Prerequisites

The basic knowledge within chemistry, physics and mathematics acquired from the first-cycle studies in the fields: chemical technology, environmental technology, chemical and process engineering or other related fields. The student has knowledge in term of raw materials, products and processes used in the chemical industry he also has basic information on the design, construction chemical sources of energy.

Course objective

Gaining knowledge in term of raw materials and mterials used in electrochemistry,methodes and technologies of their recovery and recycling, including materials used for preparation of modern chemical sources of energy. Skills of the laboratory experiments related to the recycling and recovery of materials arised from electrochemical wastes electrochemistry.

Course-related learning outcomes

Knowledge:
1. Has knowledge of complex chemical processes involving correct selection of materials, raw materials, apparatus and equipment applied in the processes of neutralization and recovery and planning of laboratory experiments and drawing up the acquired results. - [K_W3]

2. Has a well-established knowledge in the field of occupational health and safety. - [K_W10]

Skills:
1. He is able to critically assess the results of experimental studies and to determine the direction of further research solving the problems in the field of chemical technology. - [K_U21]
2. He is able to design and evaluate the experiment course and the process in the field of chemical technology, is also able to make the analysis of possibilities of the unit processes integration due to the raw material and the final product, in accordance with the principles of economy of materials and energy, taking into account the principles of risk assessment. - [K_U22]

Social competences:
1. Is aware of the limitations of science and technology related to environmental protection. - [K_K2]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Rating of written answers within the subjects related to the theme of the practical classes.
Checking of current knowledge and practical skills, the ability to conduct experiments corectly during laboratory classes. An assessment of the final report achieved on the basis of experimental results.
Performing all laboratory exercises provided for the study program and obtaining credit for reports on the performed exercises. Final mark of the laboratory class: mean of the sum of the above.
In the case of on-line classes, the knowledge check will be carried out in the form of a test consisting of 3 - 5 questions for each exercise and report for the given experimental data.
The knowledge acquired during the lecture is verified by a written final exam in the subject consisting of 3-5 questions. Passing threshold: 51% of the maximum number of points.
In the case of on-line classes, the exam will take the form of a test consisting of 10 - 20 test questions and a few open questions. Passing threshold: 50% of the maximum number of points.

Programme content

Issues in term of raw materials and materials used in electrochemistry, methodes and technologies of their recovery and recycling, including materials used for preparation of modern chemical sources of energy.

Course topics

1.Introduction into the problems connected with water conditioning, solid and liquid waste management in electrochemical industry, especially related with metal surface finishing and chemical power sources production.
2.Technologies of galvanic coating application
3.Conservation and regeneration of selected solutions.
4.Secondary utilization of spent solutions.
5.Methods used for treatment of liquid and solid waste, for solutions regeneration, materials recovery and recycling.
6.Recovery of metals from post neutralization sludge
7.Reprocessing and recycling technologies of spent lead-acid batteries
8.Chosen pyro- and hydro-metarullgical methods of processing of batteries and cells
9.Reprocessing and recycling technologies of selected types of spent batteries
10.Laboratories: students carry out the neutralization of several types of galvanic wastewater (using different methods: precipitation, coagulation, electrochemical and chemical processes) associated with the recovery of selected anions and metals. Students use galvanic sludges as a source of raw materials.

Teaching methods

Lecture, problem lecture, explanation, didactic discussion, classes, laboratory exercises

Bibliography

Basic:
1. T.Stefanowicz, Gospodarka wodno-ściekowa i odpadowa w przemyśle elektrochemicznym, Wyd. Politechniki Poznańskiej, Poznań, 2001.
2. T.Stefanowicz, Otrzymywanie i odzysk metali oraz innych surowców ze ścieków i odpadów

pogalwanicznych, Wyd. Politechniki Poznańskiej, Poznań, 1992
3. Praca zbiorowa, Poradnik galwanotechnika, WNT, Warszawa, 2002.
4. A. Czerwiński, Akumulatory Baterie Ogniwa, Wyd. Komunikacji i Łączności, Warszawa, 2005.

Additional:
1. B.Bartkiewicz, K. Umiejewska, Oczyszczanie ścieków przemysłowych, Wyd. Naukowe PWN, Warszawa 2020.
2. L.K Wang, N.K. Shammas, Y.-T. Hung (eds) Advances in Hazardous Industrial Waste Treatment CRC Press, Taylor and Francis Group, Boca Raton Fl. USA 2009.
3. S.A.K.Palmer, M.A.Breton, T.J.Nunno, D.M.Sullivan, N.F.Surprenant, Metal/Cyanide Containing Wastes Treatment Technologies, Pollution Technology Review No 158, Noyes Data Co, Park Ridge, New Jersey, 1988.
4. M. B. Hocking, Handbook of Chemical Technology and Pollution Control, Elsevier Inc. 2005.
5. A.M. Anielak, Chemiczne i fizykochemiczne oczyszczanie ścieków, Wyd. Naukowe PWN, Warszawa 2000.
6. Praca zbiorowa pod red. Czerwińskiego A., Rogulskiego Z., Utylizacja i recykling zużytych akumulatorów i baterii, Przegląd Komunalny 4 (2005).
7. D.C.R. Espinosa, A. M. Bernardes, J.A.S. Tenório, An overview on the current processes for the recycling of batteries. J. Power Sources 135 (2004) 311.
8. E. Sayilgan, T. Kukrer, G. Civelekoglu, F. Ferella, A. Akcil, F. Veglio, M. Kitis, Hydrometallurgy 97 (2009) 158.
9. M. Osińska, Removal of lead(II), copper(II), cobalt(II) and nickel(II) ions from aqueous solutions using carbon gels, Journal of Sol-Gel Science and Technology 81 (2017) 678.

Breakdown of average student's workload

	Hours	ECTS
Total workload	175	7,00
Classes requiring direct contact with the teacher	94	4,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	81	3,00