Theoretical and applied electrochemistry (annotation)

About the course

The course provides an overview of the main principles of electrochemistry and electric double layer theory, an introduction to electrochemical steady state and transient methods and to electrochemical engineering including current distribution and ionic transport by migration and diffusion.

Outline of content

Basic notions of electrochemistry: oxidation-reduction processes, an electric current, conducting media, potential, voltage, polarization;

Electrochemical experiments: mesuring instruments, a power supply and control devices, main electrochemical methods;

Description of electrochemical systems: characteristics of systems in thermodynamic equilibrium, properties of systems with an electric current flow;

Faraday's law, electrochemical equivalent, current efficiency, energy consumption calculations;

Chronopotentiometry, chronoamperometry, linear sweep voltammetry.

Educator

Andrey Yasinskiy, Department of Metallurgy of Non-Ferrous Metals, Siberian Federal University
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Special Features

The course is focused on fundamental research of electrode reactions kinetics and its applications to metallurgy.

Theoretical and applied electrochemistry (syllabi)

Instructor	Contact information
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Course description

The course provides description and analysis of the matter transformations on the atomic scale caused by shifts of electronic charge what can be controlled by electronic devices. As electrochemistry applies

to a scientific discipline as well as to a sector of industry, the course will contain both theoretical and applied aspects.

Course aims

The course is aimed at providing students with deep understanding of electrochemical thermodynamics and kinetics.

Course objectives

1. To make students familiar with basic notions of electrochemistry: oxidation-reduction, potential, overvoltage.
2. To give students an understanding of the electric double layer theory.
3. To ensure that students know fundamental principles of Faraday's law and able to use it for engineering calculations.
4. To make students familiar with steady state and transient electrochemical methods: chronopotentiometry, chronoamperometry, linear sweep voltammetry, i-Interrupt.

Learning outcomes

By the end of the course, students will be able:

- to classify and characterize electrochemical cell modes;
- to calculate electromotive force of chemical power source and electrodes potential as a function of activity (concentration);
- to calculate current efficiency and energy consumption of commercial cells;
- to solve mass transfer problems;
- to develop 2- and 3-electrodes electrochemical chains for investigations;
- to develop physical hydrodynamic models of electrochemical apparatus;
- to use linear sweep voltammetry to identify electrode processes;
- to evaluate the effect of bath chemistry (не нашла такого термина) on energy consumption in commercial cells;
- to interpret results of chronopotentiometry and chronoamperometry;
- to define electrolyte resistance by means of i-interrupt method;
- to define electrodes overvoltage;
- to recommend ways to improve commercial electrochemical devices.

Outline of content

Week	Lectures	Practice Sessions / Assignments	Hours

1-2	Introduction to electrochemistry. Modes of an electrochemical cell	Modes of an electrochemical cell. Spontaneous or forced current flow	16
3-5	Electric double layer theory. Notions of potential - voltage – polarization. Voltages and potentials in an electrochemical cell. A standard hydrogen electrode. Reference electrodes. The polarity of electrodes.	Electrode potential and Electromotive force calculation	18
6-10	Experimental electrochemistry. Measurement devices, power supply and control devices, different types of electronic control units. Steady state. Main electrochemical methods	Experimental cell development. 2- and 3-electrode cell experiments.	28
11-14	Thermodynamic features of electrochemistry. Thermodynamic equilibrium. Nernst equation	Electrochemical methods: linear sweep voltammetry, chronomethods, i-interrupt. Interpretation of results.	20
15-16	Fundamental principles of Faraday's law, charge conservation law, electrochemical equivalent, current efficiency, energy consumption in electrochemical cell	Faraday's law. Current efficiency and energy consumption calculations.	22
17-18		Written examination	4
	Self-study training		36

Assessments and assessments methods

The course assessment assignments will include:

- Short-response questionnaire
- Written examination

Student's grades will be based on the following scheme:

- 40 % Short-response questionnaire and class participation
- 60 % Written examination

Attendance policy

Students are expected to attend classes regularly, consistent attendance gives an opportunity to gain a good command of the concepts and materials of the course.

Recommended reading

- The electrochemical society. Advancing solid state & electrochemical science & technology. Available online on http://www.electrochem.org/

- K. B. Oldham, J. C. Myland, and A. B. Bond, Electrochemical Science and Technology, John Wiley & Sons, Chichester (2012), ISBN 978047071045 (PB). Also available as e-book

- Lefrou C., Fabry P., Poignet J-C. Electrochemistry: The Basics, With Examples, Springer Heidelberg New York Dordrecht London, 2012. XVI, 352 p. 200 illus. — ISBN 978-3-642-30249-7, ISBN 978-3-642-30250-3, DOI 10.1007/978-3-642-30250-3.