

# Methods of physico-chemical investigations into metallurgical systems (annotation)

## About the course

The course provides an overview of the main physico-chemical methods used for determination of metallurgical systems' properties, such as calorimetry, viscosity, contact and non-contact methods of electrical conductivity measurement. Moreover students will learn the principles and apparatus used in chemical thermodynamics and kinetics. Also they will know more about research methods of gases solubility in metal and oxide melts.

## Outline of content

Basic methods for determining thermal characteristics: temperature measurements, calorimetry;

Determination of physical properties: measurements of viscosity, density, surface tension, electrical conductivity, magnetic susceptibility, vapor pressure, diffusion coefficients determination;

Study of equilibrium characteristics: investigation of the reactions with the participation of gas phases, determination of thermodynamic characteristics;


Kinetic study of metallurgical processes: methods and apparatus used for the investigation of chemical process kinetics, thermogravimetry, the method of melting in a suspended state.

## Special Features

This course gives a strong attention to the methods of research used in metallurgical systems, especially in a liquid state.

## Methods of physicochemical investigations into metallurgical systems (syllabi)

| Instructor  |  | Contact information   |
|---|--|---|
|  | Irina Blokhina   | pr. "Krasnoyarskiy rabochiy", 95,   |
|   | Department of composite materials and physico-chemistry of the metallurgical processes;<br><br>School of Non-Ferrous Metals and Material Science;<br><br>Siberian Federal University | Krasnoyarsk<br><br>660025 Russia<br><br>Tel.: +7 (391) 206-21-65<br><br>Fax: +7 (391) 206-21-66<br><br>E-mail: <a href="mailto:netnat1@rambler.ru">netnat1@rambler.ru</a><br><br>E-mail: <a href="mailto:iblokhina13@gmail.com">iblokhina13@gmail.com</a> |

|   |  |                                    |
|---|--|------------------------------------|
|  | <p>Nataliya Belousova</p> <p>Department of Metallurgy<br/>of Non-Ferrous metals;</p> <p>School of Non-Ferrous<br/>Metals and Material<br/>Science;</p> | <p>Siberian Federal University</p> |
|---|--|------------------------------------|

### ***Course description***

The course provides a knowledge of basic methods used in experimental determination of viscosity, density, surface tension and diffusion coefficients and calculation of thermodynamic and kinetic parameters of chemical processes in metallurgy. It contains both theoretical and practical aspects.

### ***Course aim***

To provide students with the opportunity to apply theoretical and practical knowledge of the physico-chemical methods for a competent and effective professional activity in metallurgy.

### ***Course objectives***

1. To give students the relevant information about the main principles of physico-chemical methods used for investigation of metallurgical systems and determination of their properties.
2. To teach students how to estimate experimental errors and to reduce them.
3. To make students familiar with the main equipment used for physico-chemical investigations of metallurgical systems.
4. To acquaint students with kinetics data processing approaches.

### ***Learning outcomes***

By the end of the course, students will be able

- to choose appropriate methods and tests needed for assessing physical, mechanical and operational properties of materials;
- to calculate experimental errors and to reduce them;
- to study the maximum sensitivity of different types of calorimeters;
- to determine different physical parameters of metallurgical systems: viscosity, density, surface tension; to evaluate diffusion coefficients and to calculate physical properties using the known experimental data;
- to calculate the rates of processes when the variability of the atmosphere composition is taken into account.

## ***Outline of content***

| Week  | Lectures  | Experimental (Laboratory) Sessions / Assignments   | Hours |
|-------|---|--|-------|
| 1-4   | The analysis of thermal characteristics   | Evaluation of errors in physico-chemical experiments, identification of the ways to reduce them.<br><br>Calorimetric measurements: examination of different types of calorimeters and their sensitivity, determination of the molecular weight of a gas component at the saturated vapor pressure. | 24    |
| 5-12  | Methodology of physical properties investigation: the measurement of viscosity, density, surface tension, electrical conductivity, magnetic susceptibility, determination of diffusion coefficients, vapor pressure measurement | Experimental determination of viscosity, density, surface tension and diffusion coefficients and calculation of the physical properties using the obtained experimental data   | 48    |
| 13-15 | The analysis of characteristics specific for the systems at equilibrium with the participation of gas phases, determination of thermodynamic parameters   | Determination of thermodynamic characteristics using experimental data: activity coefficients calculation on the basis of the Gibbs-Dugem equation, identification of activity for each component within binary systems, the partial excess molar Gibbs energy of ternary systems                  | 18    |
| 16-18 | Kinetics of metallurgical processes: methods and apparatus used for kinetics study of metallurgical processes, thermogravimetry, the method of melting in a suspended state   | Kinetic data processing with the use of experimental data on the oxidation of metals; calculation of rates of chemical processes taking into account the variability of the atmosphere composition; determination of the maximum possible systematic error   | 18    |

### ***Course components:***

- 108 hrs lectures and experimental sessions
- 72 hrs self-study time, including home assignments.

### ***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, otherwise they won't be able to fully understand main concepts of the course.