Sustainable Metals Processing 2017-2018

Code: CHEM3026

Credits: 60 cr + 4-5 cr

Professor in charge: Michael Gasik

The major Sustainable Metals Processing is a specialist field that deals with the extraction of metals and mineral products from primary and secondary resources through the application of scientific principles. Considered is the bigger cycle of materials linking rigorously to product design, material science, energy recovery and bio-materials.

The (extractive metallurgy) major focuses in a multi-scale approach to the relevant physical and chemical phenomena in the processes. It covers atom-level basics of relevant phenomena, explains how unit process level models and design practices can be derived from them, and considers integrated metals extraction plants and their material flows. An important factor is sustainability of metals extraction and the system approach allowing the availability of metals over their life cycles. The aim is to educate engineers with a deep understanding on how sciences are applied with engineering skills in the metallurgical industries. They will act as metallurgical processing experts in various industries, are capable of evaluating equipment and process designs and designing feasible as well as sustainable metals extraction processes with the help of numeric simulation tools.

Learning outcomes

The core scientific and engineering knowledge to be obtained:

- Adequate knowledge of transport phenomena in homogeneous, heterogeneous and particulate systems, and a general knowledge of their atom-level origins; knowledge of their mutual interactions in extraction and refining operations and how their equipment and processes are designed.
- Adequate knowledge of chemical kinetics in various fields related to metallurgical processing industries.
- Knowledge about chemical thermodynamic, phase equilibrium and property calculations.
- Understanding on chemical equilibria, process dynamics, system engineering and their connections to process design, the best practices and flow-sheet integration.
- Understanding on societal, economic and environmental impacts to process designs and responsibilities related to metal making on the basis of system engineering.

Core scientific and engineering skills to be developed:

- System engineering and its connections to process design, the best practices and flow-sheet integration thus quantified sustainability linking product design and geology to metal production while also considering links to energy recovery as well as water recycling.
- Study experimentally metals extraction reactors and unit processes at low and high temperatures, gather data and evaluate process performance.
- Model, develop and optimize production equipment, processes and plants with the help of numerical tools.
- Act as metallurgical engineering expert in multidisciplinary groups developing feasible metals extraction processes, equipment and plants.

Content and structure

For the major (60 ECTS + 4-5 ECTS credits) the students have to take common and compulsory studies 4-5 cr + 40 cr. Additionally each student needs to select two blocks (10 cr each) of specialisation studies, total 20 cr.

Courses

Table 1. Common compulsory courses (4-5 cr)

Code	Name	Credits	Period/year
CHEM-E0100	Academic Learning Community	4-5	I-V / 1st

Table 2. Compulsory core courses (40 cr)

Code	Name	Credits	Period/year
CHEM-E6100	Fundamentals of Chemical Thermodynamics	5	I / 1st
CHEM-E6120	System Integrated and Sustainable Metals Production	5	II / 1st
CHEM-E6140	Fundamentals of Minerals Engineering and Recycling	5	I / 1st

CHEM-E6160	Fundamentals of Pyrometallurgy	5	II / 1st
CHEM-E6180	Fundamentals of Hydrometallurgy	5	I-II / 1st
CHEM-E7130	Process Modeling	5	II / 1st
CHEM-E6225	Technical Innovation Project	10	I-II / 2nd

Table 3. Specialisation courses (choose two 10 cr “blocks”, total 20 cr)

Code	Name	Credits	Period/year
Thermodynamics of Materials:			
CHEM-E6105	Thermodynamics of Solutions	5	III-V / 1st or 2nd
CHEM-E6115	Thermodynamics of Modeling and Simulation	5	III-IV / 1st or 2nd
Sustainability of Metals:			
CHEM-E6125	Environmental Management in Industry	5	IV-V / 1st or 2nd
CHEM-E6215	Circular Economy Design Forum P	5	IV-V / 1st or 2nd
Ore Dressing and Recycling:			
CHEM-E6145	Unit Operations in Mineral Processing and Recycling	5	III-IV / 1st or 2nd
CHEM-E6155	Minerals Engineering Project Work	5	III-V / 1st or 2nd
Pyrometallurgy:			
CHEM-E6165	Unit Processes in Pyrometallurgy	5	III-IV / 1st or 2nd
CHEM-E6205	Metallurgical Engineering Project Work	5	IV-V / 1st or 2nd
Hydrometallurgy:			
CHEM-E6185	Applied Electrochemistry and Corrosion	5	III-IV / 1st or 2nd
CHEM-E6195	Unit Processes and Systems in Hydrometallurgy	5	IV-V / 1st or 2nd
Chemical Engineering:			
CHEM-E7150	Reaction Engineering	5	III / 1st or 2nd
CHEM-E7120	Laboratory Project in Chemical Engineering	5	I-II / 1st or 2nd