UCLouvain

lmapr2231 — Metallurgical and electrochemical processes

2020

Due to the COVID-19 crisis, the information below is subject to change, in particular that concerning the teaching mode (presential, distance or in a comodal or hybrid format).

5 credits	30.0 h + 22.5 h	Q2

Teacher(s)	Proost Joris ;
Language :	English
Place of the course	Louvain-la-Neuve
Main themes	A first part of the course provides an introduction to electrochemical processes, based on previously developed concepts in chemical thermodynamics. The course starts with a description of aqueous, ionic solutions. Next, quantitative expressions are derived that establish the conditions of electrochemical equilibrium for redox reactions occurring at electrode surfaces. Finally, it is explained how, based on the concept of overpotential, classical rate theory can be applied to describe the kinetics of charge transfer at electrodes. Some typical current-potential regimes are discussed, as well as relevant technological applications. In a second part, both the chemical and the electrochemical thermodynamic and kinetic principles will be applied to the processing and the chemical stability of inorganic materials. Most materials in use by mankind are indeed unstable relative to their environment. It is shown that, for understanding and describing this chemical (in)stability, the same thermodynamic and kinetic principles can be used as the ones governing their metallurgical extraction (corrosion is merely metal extraction in reverse). Specific attention will be given in this part to the construction and interpretation of relevant metallurgical engineering diagrams.
Aims	1 **Contribution of the course to the program objectives** Having regard to the LO of the programme "Bachelor in Engineering", this activity contributes to the development and acquisition of the following LO : • AA1.1, AA1.2 • AA2.3, AA2.6, AA2.7 • AA4.1, AA4.2, AA4.3 **Specific learning outcomes of the course** More specifically, with respect to the disciplinary LO, the student at the end of the course will be able to : • determine, based on thermodynamic equations and diagrammes, the appropriate operating conditions to produce a metal from its oxidised form, either by reduction in a gaseous atmosphere, or electrochemically in an aqueous medium ; • identify and derive mass and energy balances for such a process ; • apply the principles of electrochemical kinetics to understand a number of technological applications (corrosion, electrodeposition, fuel cells). Transversal Learning Outcomes Students will also be able to complete an elaborate exercise as a written examination under time constraint, as well as explain in their own words a theoretical concept during a final examination. - - - - *The contribution of this Teaching Unit to the development and command of the skills and learning outcomes of the programme(s) can be accessed at the end of this sheet, in the section entitled "Programmes/courses offering this Teaching Unit".*
Evaluation methods	**Due to the COVID-19 crisis, the information in this section is particularly likely to change.** In 2020-21, the evaluation will be carried out continuously during the year, the mode of which will be discussed at the start of the course in consultation with the student.
Teaching methods	**Due to the COVID-19 crisis, the information in this section is particularly likely to change.** In 2020-2021, the course should in principle not be taken by students of the Master KIMA since its content has already been covered in the LMAPR-1231 course of the BAC FYKI. Its content is offered in the form of book chapters to be read independently, with periodic interactions with the teacher.
Content	Part 1 : Metallurgical processes : • Ellingham, Kellogg and Chaudron diagrams, for predicting high temperature reactivity of inorganic materials in gaseous environments ; • Applications : the relative stability of oxides, the working principle of a blast furnace;

	Part 2 : Electrochemical processes : • description of ionic solutions and ion-solvent interactions (Debye-Hückel) ; • structure of electrified interfaces (double layer, zeita-potential) ; • electrochemical free energy change (Nernst) ; • Pourbaix diagrams, for predicting low temperature reactivity of inorganic materials in aqueous solutions ; • overpotentials and electrode kinetics (Butler-Volmer, polarisation curves) ; • electrode reactions and processes of technological interest (electrodeposition, fuel cells)
Faculty or entity in charge	FYKI

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Aims
Master [120] in Chemical and Materials Engineering	KIMA2M	5		
Interdisciplinary Advanced Master in Science and Management of the Environment and Sustainable Development	ENVI2MC	5		
Minor in Engineering Sciences : Applied Chemistry and Physics (only available for reenrolment)	MINFYKI	5		
Master [120] in Environmental Science and Management	ENVI2M	5		