Advances in Corrosion Engineering - Web course

COURSE OUTLINE

Introduction - Definitions of Corrosion - Overall classification of types of corrosion-Basic electrochemistry – Galvanic and electrolytic cells – Potential measurements - EMF and Galvanic series – Galvanic corrosion and bimetallic contacts – Eh – pH diagrams – Electrode – solution interface – Electrode kinetics and polarization phenomena – Exchange current density – Polarization techniques to measure corrosion rates – Mixed potential theory – Activation and diffusion controlled mixed electrodes – Methods of corrosion prevention and control – Design, coatings and inhibition – Cathodic protection – Stray current corrosion – Passivity phenomena and development of corrosion resistant alloys – Anodic control – Biological aspects of corrosion – Microbially induced corrosion (MIC) - Principles, Types, environments and microbiology – Biofilms – Corrosion by aerobic and anaerobic bacteria – Depolarization theory – Case studies- Biofouling of titanium in sea water – Failure analyses – prevention of MIC – Corrosion of medical implants – Biocorrosion of concrete – Metallurgical factors influencing corrosion – Laboratory experiments in corrosion engineering.

COURSE DETAIL

Module	Sl. No. and topic	Hours
Module 1	**Electrochemistry of corrosion** • Lecture 1: Corrosion – introduction, definitions and types • Lecture 2: Electrochemical cells-definitions and principles • Lecture 3: Potential measurements - galvanic cells, concentration cells. • Lecture 4: EMF and Galvanic series - bimetallic couples. • Lecture 5: Eh-pH diagrams – fundamental aspects. • Lecture 6: Construction of Eh – pH diagrams. Fe-H2O-O2 diagram. • Lecture 7: Copper, Aluminium and general corrosion diagrams.	7
Module 2	**Electrode kinetics and polarization phenomena** • Lecture 8: Electrode – solution interface – definition and types of polarization. • Lecture 9: Exchange current density – polarization relationships. • Lecture 10: Polarization techniques – corrosion rate determination. • Lecture 11: Mixed potentials – concepts and Basics. • Lecture 12: Mixed potential theory – bimetallic couples • Lecture 13: Mixed potential theory – activation and diffusion controlled processes	6

NPTEL

http://nptel.iitm.ac.in

Metallurgy and Material Science

Pre-requisites:

1. Basic knowledge of physical chemistry, electrochemistry and colloidal science.
2. Basic understanding of metallurgical and materials engineering principles.
3. Basic biology concepts.

Coordinators:

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Module 3	**Methods of corrosion control** • Lecture 14: Prevention strategies – design and coatings. • Lecture 15: Prevention strategies – inhibitors and surface engineering. • Lecture 16: Cathodic protection – principles and classification. • Lecture 17: Cathodic protection – influencing factors and monitoring. • Lecture 18: Design aspects for cathodic protection. • Lecture 19: Stray current corrosion. • Lecture 20: Passivity – definitions and influencing parameters • Lecture 21: Passivity – application of mixed potential theory. • Lecture 22: Passivity – design of corrosion resistant alloys. • Lecture 23: Anodic protection.	10
Module 4	**Biological aspects of corrosion** • Lecture 24: Microbially influenced corrosion (MIC) – definitions, environments and microbiology. • Lecture 25: MIC - Electrochemical aspects and general mechanisms. • Lecture 26: MIC – Bacterial transport, attachment and affected materials. • Lecture 27: MIC - Role of aerobic and anaerobic microorganisms • Lecture 28: Mechanisms and models for SRB corrosion. • Lecture 29: MIC and Biofilms. • Lecture 30: MIC – case studies and mechanisms. • Lecture 31: Biofouling of Titanium – biofilm studies. • Lecture 32: Biofouling of Titanium- biomineralization and corrosion aspects. • Lecture 33: MIC – Failure analysis. • Lecture 34: MIC – Prevention and control. • Lecture 35: Implant materials and corrosivity of human body • Lecture 36: Medical implants - status and developments. • Lecture 37: Microbially induced concrete corrosion	14
Module 5	**Metallurgy and testing procedures** • Lecture 38: Metallurgical properties influencing corrosion. • Lecture 39: Laboratory experiments in corrosion engineering – I • Lecture 40: Laboratory experiments in corrosion engineering – II	3
	Total	40

References:

- Denny A Jones, Principles and Prevention of Corrosion (second edition), Prentice-Hall, N. J. (1996).
- M. G. Fontana, Corrosion Engineering (Third Edition) McGraw-Hill Book Company

(NY) (1987).
- H. H. Uhlig and R. W. Revie, Corrosion and Corrosion Control, Wiley (NY) (1985).
- L. L. Shreir, Corrosion. Vol I and II, Butterworths, Kent (1976).
- M.Pourbaix, Atlas of Electrochemical Equilibria in aqueous solutions, NACE, Houston (1974).
- J. O. M. Bockris and A. K. N Reddy, Modern Electrochemistry. Vol. I and II, Plenum Press (NY) (1970).
- J. D. A Miller, Microbial Aspects of Metallurgy, Medical and Tech. Pub. Co. Lancaster (1971).
- C. A. C. Sequeira, Microbial Corrosion, European Federation of Corrosion, Maney Pub. (2000).
- B. J. Little, Microbiologically Influenced corrosion, Wiley-Intersciene (2007)
- H. Videla, J. F. Wilkes, R. A. Silva, Manual of Biocorrosion, CRC Press (1996).
- S.W. Borenstein, Microbiologically influenced corrosion handbook, Woodhead Pub. Ltd, Cambridge (1994).
- From computer Web-downloads on various topics.
- R.W.Staehle, Fundamental Aspects of Corrosion of Metals in Aqueous Environments, Special lecture series on the fundamentals of corrosion, Univ. of Minnesota (USA), 1968.