

Syllabus

Course No. : EN 234 (Elective Course)

Course Title : Introduction to hydrogen as an energy carrier (Credits - 4.0)

Unit 1 (C-1): Properties of hydrogen :

Thermodynamics properties, Hydrogen as fuel, energy content, comparison with other fuels. global status of supply and demand, economic analysis of hydrogen as fuel.

Unit 2 (Credit - 1.5) : Commercial Methods of hydrogen production :

Steam reforming : fundamentals of steam reforming, advanced methods of steam reforming, partial oxidation, autothermal reforming, combined reforming, reforming using alternate energy sources, hydrogen production from methane, coal and biomass.

Electrolysis : fundamentals for electrolysis of water, components of electrolytic cell, configuration of electrolyser stack, different electrolyser technologies,

Other technologies : Overview of Photoelectrochemical, electrochemical, biochemical , high temp water splitting , thermochemical cycles for hydrogen production, technical and economic comparison of different production methods and global status of production methods.

Unit 3 (Credit-1): Hydrogen processing and storage :

Introduction to hydrogen separation and purification ,storage, fundamentals of hydrogen compression and expansion, mechanical and non-mechanical hydrogen compressors, compressed hydrogen tank types, hydrogen liquefaction, liquid state hydrogen storage tanks, fundamentals of hydrogen storage in adsorption-based materials, metal hydrides, types of metal hydrides, metal hydride-based systems, novel materials for solid state hydrogen storage, long distance hydrogen transport via pipelines, ships and in form of LOHC, hydrogen transport via road; hydrogen refuelling stations.

Unit 4 (C-0.5) : Hydrogen handling and safety :

Properties of hydrogen associated with hazards, classification of hydrogen hazards, compressed and liquid hydrogen related hazards, regulation, codes and standards, utilization of hydrogen in various sectors, global status and future directions.

Learning Outcomes :

After completing this course, student should be able to:

1. Know about the characteristic properties of hydrogen as fuel.
2. Understand the basic concepts of hydrogen production by reforming
3. Understanding electrolysis processes, hydrogen electrolyser principles
4. Ways of processing, transporting and storing hydrogen
5. Hydrogen safety, Understand the hazards of handling, storage, transportation etc.

Reference books :

1. Hydrogen Fuel-Production, Transport, and Storage, edited by Ram B. Gupta, CRC Press, Taylor & Francis Group, 2009, ISBN - 978-1-4200-4575-8.
2. Fuel Cell Fundamentals by Ryan O'hayre, Suk-Won Cha, Whitney G. Colella, and Fritz B. Prinz, John Wiley & Sons, Inc. 2016, ISBN – 978-1-1191-1420-8.
3. Hydrogen Storage: State-Of-The-Art and Future Perspective by E. Tzimas, C. Filiou, S.D. Peteves and J.-B. Veyret, European Communities, 2003, ISBN - 92-894-6950-1.
4. Global Hydrogen Review 2021, IEA Publications, 2021, www.iea.org.
5. Hydrogen Production by Electrolysis, edited by Agata Godula-Jopek, Wiley-VCH Verlag GmbH & Co, 2015, ISBN - 978-3-527-67653-8.
6. Handbook of Hydrogen Storage - New Materials for Future Energy Storage, Edited by Michael Hirscher, Wiley-VCH Verlag GmbH & Co, 2010, ISBN - 978-3-527-32273-2.