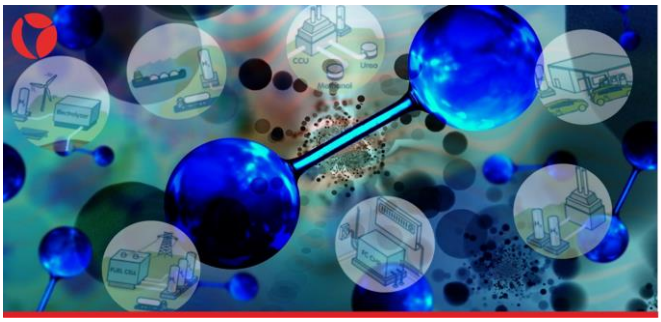
FACT SHEET

Hydrogen Technologies: A Practical Approach



A systematic and practical examination of the technologies involved in the entire hydrogen value chain.

Who Should Attend?

This course is designed for students, technicians, designers, freelancers, and engineers interested in the practical aspects of the value chain of hydrogen.

Previous knowledge of this subject is not required to attend the course.

Training Objectives

The objective is to delve into the components of the hydrogen value chain, with a practical vision of the state of development of the different technologies involved.

What to Expect?

Comprehend the peremptory energy transition we are in, and the role that hydrogen should play in it.

Understand how hydrogen is produced, stored, and transported today, and in the future. Get a grasp of the unresolved competition among different possible solutions.

Get a realistic view of the possible uses of hydrogen: as a feedstock, in the balance of renewable generation, in transportation (land, sea and air), and in heat generation.

Assimilate the challenge of the decarbonization of hydrogen itself.

Understand the concept of Levelized Cost of Hydrogen. Current and expected values. Impact of incentives.

Obtain a broad view of the state of development of the multiple hydrogen projects worldwide.

Course Duration

Full Course: 40 hs; to be completed in 2 months. The Virtual Campus will be open for 4 months (flexibility).

Methodology

At your own pace

Available 24/7, Self-paced course

“Learn by doing” concept

No scheduled sessions

Included in the course

Study Notes

Summary Videos

Conceptual Questions

Case Studies

Content

Energy Vector – Key Piece of the Puzzle

Climate Change → Energy Transition

Roles of Hydrogen in the Energy Transition

Countries' Strategies

Exercises and Case Studies

- *Assimilation Test*

Physical Chemistry of Hydrogen

Hydrogen characteristics

Atomic and molecular hydrogen

Molecules that contain hydrogen

Reactions

Unsaturated organic compounds. Hydrogenation

Gravimetric and volumetric energy density

Higher and Lower Heating Value (HHV, LHV)

Exercises and Case Studies

- *Case study: Volumetric analysis*
- *Assimilation Test*

H2 Production (I): SMR and Other Methods

Hydrogen colors

Other hydrogen classifications

Production from hydrocarbons: SMR / Autothermal / Partial Oxidation

Carbon Capture, Usage and Storage (CCS – CCUS)

Electrolysis – introduction

Alternative technologies to produce hydrogen

Exercises and Case Studies

- *Assimilation Test*

H2 Production (II): Electrolysis

History of water electrolysis

Electrolyzer Technologies

High temperature electrolysis

Anion Exchange Membrane

Alkaline

PEM

Balance of Plant (BOP)

Efficiency

New developments

Exercises and Case Studies

- *Case study: PEM Efficiency – water consumption*
- *Case study: AE Efficiency*
- *Assimilation Test*

Hydrogen Storage

Gaseous hydrogen

Compression

Pressure vessels

Underground storage

Liquid hydrogen (LH2)

Storage in carriers

Ammonia

Methanol

Liquid Organic Hydrogen Carriers (LOHC)

Solid storage

Metal hydrides

Carbon structures

Exercises and Case Studies

- *Case study: Volumetric calculation – saline storage*
- *Assimilation Test*

Hydrogen Transport

Sea transport

Liquid hydrogen

Ammonia

LOHC

Pipelines

Dedicated hydrogen pipelines (hydroducts)

Repurposing Natural Gas pipelines

Blending

Road transport

Exercises and Case Studies

- *Case study: Energy transport capacity of a repurposed pipeline*
- *Assimilation Test*

H2 Piping and Pressure Vessel Design

H2 Piping and Pipeline Systems

International codes

ASME B31.12

ASME B31

Code structure

Specificities for H2 – B31.12 vs. B31.3

Hydrogen Pipelines: Prescriptive and Performance-Based Design

Common materials for H2 piping and pipelines

General recommendations for H2 piping systems

Pressure vessels

ASME BPVC sec VIII div 3 KD-10

Exercises and Case Studies

- *Assimilation Test*

Fuel Cells and H2 Turbines

Fuel cell

Structure

Types of fuel cells. Advantages and challenges

Efficiency

Applications

Heat + electrical energy

Turbines

Blending and pure hydrogen

Hydrogen combustion challenges

H2 turbines commercial models

Fuel cells vs Turbines

Exercises and Case Studies

- *Case study: Efficiency of a fuel cell*
- *Assimilation Test*

Uses of Hydrogen (I)

H2 as an industrial feedstock

Hydrogen to electrical energy

Network balance

Electric energy storage and transportation

Heat production

Combustion

Cogeneration

Exercises and Case Studies

- *Assimilation Test*

Uses of Hydrogen (II)

Ground transportation

Lightweight transportation

Heavy transportation

Refueling infrastructure

Sea transportation

Actual examples

Competitive fuels

Expected evolution

Air Transport

Current examples

Industry roadmap

SAF. Sustainable Aviation Fuel

Exercises and Case Studies

- *Assimilation Test*

Ammonia and Methanol

Ammonia

Properties

Risks

Current uses

Potential uses

Synthesis

Decomposition into nitrogen and hydrogen

Methanol

Properties

Risks

Applications

Bio-methanol / e-Methanol

Exercises and Case Studies

- *Assimilation Test*

Safety

H2 Safety-related features

Risks from direct exposure

Leakage risks

Flammability and explosivity

Hydrogen embrittlement

Venting systems

Sensing technologies

Safety regulations related to hydrogen

Exercises and Case Studies

- *Assimilation Test*

Levelized Cost of Hydrogen

Levelized Cost of Hydrogen (LCOH)

Concept

Typical values

Examples

Levelized Cost of Storage

Levelized Cost of Transportation

Exercises and Case Studies

- *Case study: LCOH of a project*
- *Assimilation Test*

Some Hydrogen Projects

Hydrogen projects around the world

Announced investment vs. committed investment

Differences by regions

“Low carbon” investment vs renewable investment

Investment gap

Some representative projects

Exercises and Case Studies

Assimilation Test

Instructor

Electronic Engineer specialized in Petroleum Engineering with a Master's in Business Administration (MBA). Over 30 years international experience in Business and Project Management in major companies in the energy industry.

Broad experience leading innovation and process improvement projects on a global level.

Trainer and enthusiastic entrepreneur in matters of digitalization applied to education.

Tailored Training

The most effective training is one that satisfies the needs of each company's business focus and deliverables. **We adapt our training programs to each specific requirement, offering bespoke solutions for each need.** The result, 100% tailored programs, developed to maximize the time investment and deliver tangible and intangible returns to the work teams.

After assessment phase, a tailored training plan is designed in collaboration with the client. This plan is specifically tailored to meet the client's needs, focusing on effectively enhancing the capabilities of the work team. **We provide practical, dynamic, and hands-on training,** making available the best instructors in each subject.

Arveng Training

Arveng Training has developed effective and practical solutions for today's industrial challenges by delivering specific, high-quality engineering courses utilizing three different approaches: classroom, online, and tailored training. We are proud to have imparted more than 100 classroom courses, 200 online courses, and over 15 in-company sessions. Our training activities have benefitted over 1,500 professionals, our greatest accomplishment of all.

We consider our students' time to be of utmost importance. For this reason, all our courses have been designed with the main objective of quickly improving the professional skills of the participants through our expert instructors in different disciplines. **We stimulate creativity, innovation, and initiative to make the participants inquisitive, bringing good engineering practices and lessons learned to the field, that benefits their professional lives in the long term.**

Our Company

Arveng Training & Engineering SL is a leading company providing Training and Engineering services based in Madrid, Spain. Our mission and vision are to be a leading training and engineering services company, providing our clients with the best in the sector. We are a team of highly motivated, talented, highly qualified professionals with over 20 years of experience. We aim to exceed expectations by offering efficient, innovative, cost-effective, and transparent services.

Established in July 2010, mainly oriented to the industrial sector, from the very beginning Arveng has always worked with closeness, responsibility, and commitment in all areas of activity.

Through experience gained by partaking in multidisciplinary engineering projects in sectors such as Petrochemical, Energy Generation, and Industrial, we provide answers and solutions to concrete requirements, making the effort to build long-lasting and mutually beneficial relationships.