Hydrogen Training Solutions

PRINCIPLES OF PROTON EXCHANGE MEMBRANE (PEM) ELECTROLYSER OPERATIONS

Technology for Producing Clean and Sustainable Hydrogen

Conducted by your Expert Instructor: Hunor Kacso

Hunor is a Hydrogen Engineer with a passion for electrolysis technology. He has been instrumental in deploying some of the world's largest and most advanced electrolyser systems. As a subject matter expert, Hunor has led training courses on cutting-edge electrolyser technology to energy professionals across the globe. He has designed comprehensive training programs from the ground up, traveling internationally to share his electrolysis expertise.

What other past participant have shared about your expert course instructor`s training courses

- "Hunor has been a fundamental element in some of the SSoW we have seen implemented within ITM Power in recent weeks, which has originated from your training sessions and knowledge", ***Global HSE Manager, McLaren.***
- "I found that the general electrolyser principles course and the stack development training gave a wider understanding of technical aspects of our products to colleagues. This helped them support the further development of our products", ***Senior Manager, ITM Power.***
- "Leading a team of highly skilled engineers is critical to our core business, to ensuring that the engineers remain highly skilled is the key to successful, the training delivered by Hunor has been significant in ensuring that the most updated information, best practices and core knowledge is conveyed and delivered to the team. The attention to detail, method of delivery and passion that Hunor has for hydrogen and developing peoples understanding on a platform that they can put into practice what they have learnt, is second to none. Thank you Hunor", ***Operations Director, Motive Fuels.***

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About this Classroom Training Course:

Sustainable green hydrogen is entering the mainstream, offering immense potential as a clean, renewable energy vector as the key to decarbonisation hard and abate sectors. Produced through electrolysis powered by renewable electricity, sustainable green hydrogen is gaining major momentum amid intensifying global decarbonization efforts.

With rapid advancements in Proton Exchange Membrane (PEM) electrolysis driving down costs dramatically, green hydrogen is now economically viable for transport, heating and energy storage applications. Leading corporations across sectors are ramping up investments in electrolysis to scale up green hydrogen production.

Participants attending this course will be equipped with everything needed to get hands-on with this PEM electrolysis technology. Through immersive sessions, participants will gain comprehensive technical knowledge to seamlessly integrate PEM systems across the energy transition. Participants will master the safety protocols for end-to-end hydrogen production, storage and handling via interactive exercises and simulations.

Participants will also assess real-world risks and technical opportunities through experiments, demonstrations and case studies under expert guidance. Uniquely designed, this course offers the perfect blend of technical knowledge and practical skills to give participants an unparalleled edge. With demand surging for professionals with cross-disciplinary PEM electrolysis expertise, this training prepares participants to thrive at the forefront of the booming green hydrogen economy.

Objectives of this Classroom Training Course:

By the end of this three days training course the delegate will be able to:

- List the six major dangerous properties of hydrogen and identify the applicable safety mechanisms for an acceptable safety integrity level (SIL).
- Define the three hazardous zones and understand their implications to safety compliance.
- Describe current best industry practices to enhance safety, efficiency, cost effective operation, simplified system designs, and reliability.
- Generalise the full balance of plant of an advanced, Megawatt scale PEM Electrolyser and name pressure categories of systems.
- Understand the electrochemical operation of a PEM Electrolyser Cell/ Stack and describe advanced design characteristics and industry standards of reliable stacks.
- Distinguish purpose of and operation of the Water Purification System including water conductivity requirements.
- Gain detailed knowledge of the dryer and deoxidiser, including other parts of the gas handling system and pressure control.
- Analyse the make-up of the DC Power Supply Unit including voltage and current levels.
- Distinguish the control system for automated generation and enhanced safety.

Who Should Attend this Classroom Course?

This course has been designed for those working in the energy sector looking to further develop their careers to keep up to date on emerging technologies. This course is right for you if your role includes one of the following:

- Chemical and Electrical Engineers who involve in chemical and electrical engineering .
- Process Engineers specialising in process engineering can enhance their knowledge of the specific processes involved in PEM electrolysis, optimising efficiency and performance.
- Design Engineers who involve in the design of electrochemical systems.
- Validation Engineers who responsible for validating and ensuring the reliability and performance of PEM electrolysis systems.
- EC&I Engineers (Electrical, Control, and Instrumentation) who specialise in electrical, control, and instrumentation aspects.
- Project Engineers and Manager who involve in the planning, execution, and monitoring of projects related to hydrogen production.
- Commissioning Engineers who responsible for commissioning and bringing PEM electrolysis systems into operation.
- Test Engineers and Technicians who involve in testing and troubleshooting the performance of PEM electrolysis systems
- Maintenance Engineers are who responsible for the upkeep and optimal functioning of PEM electrolysis systems.
- Researchers who are in the fields of electrochemistry, energy, and related disciplines.
- Environmental Scientists who concern with environmental sustainability and clean energy solution.
- Renewable Energy Professionals who work in the renewable energy sector, especially those dealing with hydrogen production and storage.
- Industry Professionals who work in industries related to hydrogen production, fuel cells, clean energy technologies, sustainable energy initiatives or those involve in technologies related to hydrogen production and storage.

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Delivery of this Course:

This course will be delivered face-to-face over 3-day sessions, comprising of 8 hours per day, 1 hour lunch and 2 breaks of 15 minutes per day. Course Duration: 24 hours in total. This course can also be delivered through Virtual Inspector Led Training.

Other useful information at a glance:

Course level	Beginner - Intermediate
Maximum number of participants	20

Learning Approach:

- Course material will be provided for future reference.
- Each topic begins with a statement of the intended learning outcome (LO).
- Activities such as quizzes, videos and assessment will be incorporated.

About your Expert Instructor:

With over 6 years of specialization in Proton Exchange Membrane (PEM) electrolysis, Hunor has earned recognition as a hydrogen engineering expert. His unparalleled industry experience powers innovations that are driving down costs and catalysing the green hydrogen economy. Having designed and deployed some of the largest electrolysis systems, Hunor possesses extensive operational expertise across the entire project lifecycle - from conceptual design to commissioning fully integrated MW-scale plants. He has been instrumental in enhancing reliability, efficiency, and safety across generations of electrolyser technology.

As an inspiring instructor, Hunor has trained many professionals worldwide through comprehensive courses tailored to equip trainees with cutting-edge expertise in PEM. His training programs have become a catalyst for upskilling corporations to thrive in the hydrogen future. With a passion for empowering others, Hunor continues to shape the next generation of clean hydrogen experts. His pioneering contributions are accelerating the global transition to sustainable energy. Backed by industry experience and technical excellence, Hunor is an expert in electrolysis.

After completing his engineering education, Hunor worked his way up in the electrolyser manufacturer (ITM), rather than in an academic setting. This is because electrolysis is such an emerging technology at industrial sectors. However, to give back to alma mater, Hunor has worked by providing content, involved in material development and provides industrial experience with the University of Sheffield, Brunel University London, and the AMRC. Furthermore, Hunor conducted highly technical training on electrolysis equipment to support people and enable business growth at ITM Power. The results were astounding, and the teams have reportedly reduced their training time by up to 50%, improved productivity, and eased the burdens of team leaders.

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3 DAYS COURSE OUTLINE

Day 1

Module 1: Introduction to Electrolysis

Applications of PEM Electrolysis

- Hydrogen production for fuel cells
- Energy storage and grid balancing
- Industrial and chemical applications
- Emerging applications in the energy sector
- Other Electrolysis Types
    - Alkaline, AEM, SOEC

Environment and Sustainability

- Environmental impact assessment
  Water usage and sourcing
- Green hydrogen production
- Carbon footprint and emissions reduction

Case Studies and Practical Examples

- Real-world applications and success stories
- Performance data and efficiency improvements
- Economic feasibility

Module 2: Hydrogen Safety

Compliance and Regulations

- EX Compliance and Hazardous Zones
- Pressure Testing and Leak Testing
- Regulatory and Safety Considerations
- Codes and standards for PEM electrolysis
- Safety protocols and emergency shutdown procedures
- Compliance with regulations

Module 3: System Overview

Overview of Entire Electrolyser System including Balance of Plant (BoP)

- Overview of Each Subsystem
- Pressure Categories of Systems
- Oxygen management
- Plant layout considerations
- Equipment sizing and selection
- Process flow diagrams

Activities: Quizzes

Day 2

Module 4: Electrolyser Stack

PEM Electrolyser Components

- Electrolyser stack makeup
- Electrolyte membrane
- Electrodes (anode and cathode)
- Current collectors/ gas diffusion layers
- Bipolar plate
- Stack end plates

Working Principles

- Role of the proton exchange membrane
- Electrochemical reactions at the anode and cathode
- Ion transport within the electrolyser Cell/ Stack
- Electrolyser Cell Operation (Electrochemical)
- IV Characteristics

Operating Parameters

- Stack Safety
- Temperature and its effect on performance
- Pressure requirements
- Current density and voltage
- Implications for efficiency and hydrogen production rate

Energy Input and Efficiency

- Energy input sources (e.g., electricity)
- Faraday's law of electrolysis
- Efficiency calculations
- Factors affecting energy efficiency

Durability

- Preventive maintenance practices
- Electrolyser lifespan
- Lifetime Indicators and Healthy Stack Designs

Challenges and Future Developments

- Technical challenges
- Cost reduction strategies
- Research and innovation in PEM electrolysis
- Integration with renewable energy sources

Module 5: Water Purification System

- Water Quality and Stack End of Life Implications
- Water Particle Filtration
- Reverse Osmosis
- Demineralisation and DI Resin System
- UV Light
- Water Quality Monitoring
- Water Repatriation

Activities: Video, Group Discussion

Day 3

Module 6: Hydrogen Purification

Gas separation and purification

- Hydrogen gas generation
- Purity standards and monitoring
- Impurities and byproducts
- Hydrogen Water Separation
- Temperature Swing Gas Dryer Operation
- Pressure Control on Hydrogen System

Module 7: Power Supply and Stack Power

- AC Transformer
- AC to DC Conversion (Rectification)
- DC – DC Chopper
- Power electronics and distribution

Module 8: Control System

- Logic Flow Diagram and Troubleshooting Introduction
- SCADA Link
- Electrical system design
- Control system architecture
- Safety systems and codes

Module 9: Operation and Maintenance

- Startup and shutdown
- Monitoring critical parameters
- Diagnosing issues
- Maintenance requirements
- Stack lifetime management
- Safety protocols

Module 10: Economic Analysis and Emerging Technologies

Economic Analysis

- Capital and operating costs
- Modelling operational expenditures
- Hydrogen pricing scenarios
- Business case development

Emerging Technologies

- Advanced materials and catalysts
- Improving efficiency and durability
- Quality control and testing methods
- Novel system designs and integration

Activities: Assessment