

# MODULE 2

## HYDROGEN STORAGE AND TRANSPORTATION TECHNOLOGIES

### Knowledge Assessment for Module 2

Select one accurate response for each question.

**Question 1: What is the molar mass of hydrogen ( $H_2$ ) as stated in the mini-lecture?**

- A. Approximately 1.008 g/mol
- B. Approximately 4.003 g/mol
- C. Approximately 18.015 g/mol
- D. Approximately 2.016 g/mol

**Question 2: Which method of hydrogen storage possesses a significantly higher volumetric energy density yet necessitates extremely low temperatures?**

- A. Compressed hydrogen gas ( $CGH_2$ )
- B. Hydrogen within metal hydrides
- C. Liquid hydrogen ( $LH_2$ )
- D. Hydrogen in ammonia

**Question 3: What percentage of the energy present in hydrogen can be captured through the liquefaction process (cryogenics)?**

- A. Between 5% and 10%
- B. Between 10% and 20%
- C. Between 30% and 40%
- D. Exceeding 50%

**Question 4: Which category of pressure vessel (Type I-IV) is the most technologically sophisticated, lightweight, and constructed with a polymer liner entirely encased in carbon fiber?**

- A. Type I
- B. Type II
- C. Type III
- D. Type IV

**Question 5: What is the primary economic challenge associated with the storage of liquid hydrogen (LH2)?**

- A. Reduced bulk density
- B. Elevated storage pressure
- C. Significant costs associated with the liquefaction process (energy consumption)
- D. Potential for material embrittlement

**Question 6: What is the term for the phenomenon of gradual hydrogen evaporation from cryogenic tanks, despite the presence of insulation, as discussed in the mini-lecture and podcast?**

- A. Evaporation Phenomenon
- B. Boil-off
- C. Thermal Loss
- D. Hydrogen Permeation

**Question 7: Which alternative method of hydrogen storage entails chemically binding it to an organic liquid (e.g., dibenzyltoluene)?**

- A. Metallic hydrides
- B. Ammonia (NH<sub>3</sub>)
- C. Liquid Organic Hydrogen Carriers (LOHC)
- D. Storage within salt caverns

**Question 8: Which international agreement governs the secure transportation of hazardous materials, including hydrogen, by road in Europe?**

- A. International Maritime Dangerous Goods Code
- B. Regulations Concerning the International Carriage of Dangerous Goods by Rail
- C. European Agreement Concerning the International Carriage of Dangerous Goods by Road
- D. International Convention for the Safety of Life at Sea

**Question 9: Based on the mini-lecture and the case study of offshore wind farms, which type of hydrogen is predominantly utilized for long-distance global maritime transport?**

- A. Compressed hydrogen gas (CGH<sub>2</sub>)
- B. Hydrogen within metal hydrides
- C. Liquid hydrogen (LH<sub>2</sub>) or ammonia (NH<sub>3</sub>)
- D. Hydrogen in underwater pipelines

**Question 10: Which mode of hydrogen transportation is the most cost-effective for transporting substantial quantities over extended distances, despite significant initial expenses?**

- A. Road transportation
- B. Rail transportation
- C. Hydrogen pipeline systems
- D. Maritime transport with cryogenic containers

**Question 11: In what ways did hydrogen detection systems and automatic safety systems (ESD) aid in managing the situation in the case study "Hydrogen Leak at the H2 Transshipment Terminal"?**

- A. They heightened the pressure on the compromised valve.
- B. They swiftly identified the leak and automatically halted the hydrogen supply.
- C. They postponed the evacuation of personnel.
- D. They activated an alarm but did not initiate any automatic response.

**Question 12: In reference to the Case Study "Hydrogen Leak at H2 Transshipment Terminal," what was the immediate cause of the pressure relief valve failure?**

- A. Human error during refueling.
- B. Deterioration of valve material.
- C. Fatigue failure of the seal resulting from a combination of material fatigue and transient loading.
- D. Deliberate damage to the valve by an unauthorized individual.

**Question 13: What action is essential following the receipt of an alarm and the evaluation of a hydrogen emergency, as outlined in the podcast "How to React to Emergency Situations in Hydrogen Logistics?"?**

- A. Promptly extinguish the flame (if present).
- B. Commencing the refueling of the vehicle.
- C. Awaiting developments.
- D. Immediately disable the source of the leak.

**Question 14: Why, in the case of hydrogen ignition, is the priority often not to directly extinguish the flame, as stated in the podcast?**

- A. The invisibility of the hydrogen flame complicates the process of aiming.
- B. A hydrogen flame rapidly consumes the ascending gas, making it crucial to cool the surrounding area.
- C. Because extinguishing a hydrogen flame is impossible.
- D. Because water consistently exacerbates issues involving hydrogen.

**Question 15: Which of the following strategies exemplifies proactive risk management in hydrogen logistics, as discussed in the Module 1 mini-lecture?**

- A. Reacting solely to failures that have transpired.
- B. Eschewing risk analysis because of its expenses.
- C. Systematically performing risk analyses (e.g., HAZOP, FMEA, QRA) to identify hazards prior to their occurrence.
- D. Restricting employee training to reduce expenses.

**Question 16: In Worksheet 1 "Selection of an Optimal Hydrogen Storage System," what is the total daily hydrogen requirement in kilograms for a city bus and passenger car refueling station, given that each of the 50 buses consumes 40 kg/day and the 200 passenger cars are not factored into the bus consumption?**

- A. 40 kilograms
- B. 200 kilograms
- C. 2000 kilograms
- D. 2000 kilograms (as  $50 \text{ buses} * 40 \text{ kilograms/bus} = 2000 \text{ kilograms}$ )

**Question 17: Based on Worksheet 1 "Selection of an Optimal Hydrogen Storage System," what is the primary requirement for a hydrogen refueling station located in the heart of a large city that impacts the selection of technology?**

- A. Ample availability of space for installations.
- B. Reduced refueling rate.
- C. Installation space is limited.
- D. Insufficient safety requirements in urban environments.

**Question 18: In reference to Worksheet 2 "HAZOP Risk Map," which of the following "keywords" is employed to identify deviations from the standard in a process?**

- A. Promptly
- B. Challenging
- C. Additional
- D. Not ever

**Question 19: Calculation: In the case study "International Hydrogen Supply for an Offshore Wind Farm," the farm generates 25 tons of green hydrogen daily. How many tons of hydrogen will be produced over the course of a week (7 days)?**

- A. 25 metric tons
- B. 100 metric tons
- C. 150 metric tons
- D. 175 metric tons

**Question 20: Which international standard, aside from the IMDG Code, is crucial for gas carrier vessels transporting liquefied gases in bulk, as indicated in the Case Study "International Supply of Hydrogen for an Offshore Wind Farm"?**

- A. ADR
- B. ISO 14687
- C. IGC Code (International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk)
- D. Seveso III Directive

**Question 21: Which of the following exemplifies a preventative measure in contingency planning, as discussed in the Module 1 mini-lecture?**

- A. Suppressing the fire.
- B. Routine inspection and maintenance of the installation.
- C. Personnel evacuation upon leak detection.
- D. Alerting emergency services following an incident.

**Question 22: What is the objective of implementing SCADA and PLC systems in hydrogen logistics?**

- A. Expanding the workforce.
- B. Producing financial reports.
- C. Monitoring and automated control of processes, reducing human errors.
- D. Detection of leaks only.

**Question 23: Which risk analysis method employs systematic brainstorming by an interdisciplinary team to evaluate potential process deviations?**

- A. Failure Mode and Effects Analysis
- B. Quantitative Risk Assessment
- C. Hazard and Operability Study
- D. Quality Management System

**Question 24: In the case study "Hydrogen Leak at H2 Transshipment Terminal," for how many years was the seal in the PRV valve utilized beyond the manufacturer's recommendation?**

- A. One year
- B. Two years
- C. Three years
- D. Five years

**Question 25: What is the fundamental basis for the advancement of the hydrogen logistics sector, as outlined in the End of Module 1 mini-lecture?**

- A. Solely global harmonization of regulations.
- B. Enhancing hydrogen production while compromising safety.
- C. Implementation of robust security protocols, comprehensive risk assessment, and preparedness to address failures.
- D. Decrease in operating expenses irrespective of other variables.

**ANSWER KEY**

1.D / 2.C / 3.C / 4.D / 5.C / 6.B / 7.C / 8.C / 9.C / 10.C / 11.B / 12.C / 13.D / 14.B / 15.C  
 16.D / 17.C / 18.C / 19.D / 20.C / 21.B / 22.C / 23.C / 24.B / 25.C /

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