

Technical Courses H2 - 12/10/2026 – Agenda

11 :00 - 11 :30

Part 1: **Hydrogen liquefaction – Sources, availability and supply chain**

Speaker: **Yan PENNEC - ALAT**

Resume : This presentation assesses the current liquid hydrogen (LH2) supply landscape, focusing on market volumes across sectors like aerospace, refining, and H2 mobility. We will examine global liquefaction capacity, infrastructure requirements, and the role of BOG management. The session concludes with a TCO analysis to provide a clear economic outlook for liquid hydrogen deployment.

11 :30 - 12 :00

Part 2: **Hydrogen liquefaction technologies - from industrial plant to components**

Speaker: **Thomas Fayer - ALAT**

Resume : As energy transitions accelerate worldwide, liquid hydrogen (LH2) is becoming a key vector for high-density storage and heavy-duty transport. Designing reliable and energy-efficient liquefaction plants requires a precise understanding of deep cryogenics, cycle thermodynamics, and chemical phenomena. This course will present the fundamental principles for designing a hydrogen liquefaction plant, detailing the Claude cycle, precooling strategies, and deep cryogenic stages. Some focus will be given to ortho-to-para conversion, catalyst integration, boil-off losses, molecule transportation. Some illustration with large-scale industrial units—such as a 30 tpd facility on the Air Liquide US West Coast Liquefier and associated transport logistics—will be presented.

12 :00 - 12 :30

Part 3 : **Liquid hydrogen technologies for the mobility market**

Speaker: **Wassim OUAKRIM / Gaetan COLEIRO - ALAT**

Liquid hydrogen (LH2) is emerging as a potential energy carrier to decarbonize heavy transport thanks to its high gravimetric energy density. For most of applications of the heavy mobility market, it can provide high fueling speeds and transport range to meet the challenging requirements of these systems and compete with traditional fuels. This course aims to present the role of LH2 across the mobility market (heavy duty, maritime, aviation), and show some concrete application examples to illustrate how LH2 can be integrated into modern vehicles and transport infrastructures.

Lunch break

2 :00 pm - 2 :30 pm

Part 4 :Main Challenges for Liquid Hydrogen Storage

Speaker: Jérôme LOSCO - Airbus

While hydrogen, particularly in liquid form, is emerging as a promising alternative to address environmental challenges, its cryogenic storage presents major technical constraints for the mobility industry. This presentation provides an overview of the technological bottlenecks identified to date regarding cryogenic storage.

2 :30 pm - 3 :00 pm

Part 5 : Hydrogen embrittlement of metallic materials – an overview

Speaker: Laurent BRIOTTET - CEA/LITEN

Resume: When exposed to H₂, metallic materials may experience a deterioration in their mechanical properties such as loss of ductility and fracture toughness, or an increase in the rate of fatigue crack growth. This phenomenon may compromise the safety of infrastructure or components that come into contact with hydrogen. It is therefore important to understand and quantify this in order to ensure the integrity of these facilities. This presentation will begin by describing the various methods used to detect hydrogen embrittlement depending on the environment and on the mechanical loading. The main hydrogen embrittlement mechanisms occurring around room temperature will be presented and analysed. Finally, some insights on hydrogen embrittlement sensitivity of metallic materials at low temperature will be provided.

3 :00 pm - 3 :30 pm

Part 6 : Physical properties of hydrogen

Speaker: Jean-Marc PONCET/Davide DURI - CEA/DSBT

Resume: Working with hydrogen and its isotopes (deuterium and tritium) at cryogenic temperatures require the appraisal and detailed understanding of the specific physical and transport properties of the H₂ molecules which depend on the spin composition and vary according to the temperature and the departure from the thermodynamic equilibrium. Depending on the application and the temporal evolution of the molecule through a system (i.e. from a liquid storage condition to an heated gaseous flow or vice versa) the variation of the properties can affect significantly the performance and must be taken into account. In this presentation we will examine the evolution of the hydrogen properties depending on the ortho-para hydrogen composition and transition, the equations of states, the dynamics of the natural vs catalytically-enhanced transition as long as the techniques to characterize the composition (and the stability) of the H₂ at low temperatures.

Afternoon break

3 : 50 pm - 4 :20 pm

Part 7 : ***LH2 spillage, evaporation, explosive atmosphere formation and ignition consequences: Experiments and Simulation.***

Speaker: ***Etienne STUDER - CEA/ISAS***

Resume : A liquid hydrogen leak following a rupture of the supply hose or a failure of a component in the liquid circuit constitutes a potential accident, the consequences of which must be assessed to ensure of high level of safety. The behavior is complex right from the source, where the cryogen may be two-phase, with a liquid phase capable of forming a pool on the ground. The gas cloud, part of which originates from the breach, is then fed by the evaporation of this pool, caused mainly by heat transfer with the ground. Near the release point, this cloud behaves like a heavy gas, but subsequently acquires sufficient buoyancy to disperse. Ignition will result in a partially premixed flame, which may produce overpressures and a fireball with the associated blast and thermal radiation safety distances. One must not overlook the phenomenon of condensation or desublimation of air components, which can significantly alter the scenario described above. All these points are illustrated by experimental data and numerical simulations.

4 :20 pm - 4 :50 pm

Part 8 : ***Regulatory framework (focus on hydrogen)***

Speaker: ***JM Poncet - CEA/DSBT***

Resume : Regulatory framework has to be done for the construction and the follow up of all equipments. General information are given in the presentation and rapidly it is oriented to the specificity of hydrogen with the difficulties encountered to size the pressure relief devices with this fluid. They are explained either by a lack of input data or by unclear standards. Information are given in annexes to help persons that want to go further.