Hydrogen: Exceptional Properties and Hazard Assessment & Mitigation

23 to 25 July 2024
Woburn MA, US

Fires from intentionally ignited fuel tanks containing hydrogen (left) v. gasoline (right)

Instructor:
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BlazeTech
Bringing Science to Safety
Offering Fire Safety Courses since 1998

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Ubi fumus, ibi ignis

BlazeTech Corporation

Our services to the evolving hydrogen industry include safety assessments, testing, modeling and simulation, consulting, accident investigation and reconstruction, and expert witness. We have performed several assessments of the processing, handling, storage, and transportation of hydrogen in the chemical and transportation industries as well as its potential use in aviation. We have also conducted fire tests involving hydrogen and participated in national large-scale tests of the spill, dispersion, and ignition of cryogenic fuels. Our product ADORA is the premier Environmental and Safety offsite Consequence Analysis tool available for use by organizations involved with the assessment of the safety and environmental impacts of the accidental discharge of hazardous chemicals. We provide, also, customized training at client facilities expanding on any subject matter in this course.

Course Developer and Main Lecturer

Dr. N. Albert Moussa, Technical Director of BlazeTech, has over 40 years of experience in fire and explosion in a variety of applications. He authored one book on flammability and over 200 publications, presentations, and reports. In 1979, he participated in a national committee organized by the Electric Power Institute to assess the potential hazards of a hydrogen bubble suspected inside a nuclear reactor at the Three Mile Island power plant due to loss of coolant. In 1982, he compared the crash fire hazards of the Lockheed 400-passenger aircraft fueled by liquid hydrogen, versus liquid methane, gasoline, and jet A. He has since worked on safety assessments of components and entire systems involving gaseous and cryogenic hydrogen. Since 1998, he has taught professional courses on fire and has given invited lectures at several universities and the NTSB Training Center. His credentials include: William Lockwood Memorial Lecture Award, Engineer of the Year by the NE- AIAA Section, AIAA Distinguished Lecturer, Best Papers by SAE and ASEI, and several ASME citations. He served on national committees and was Associate Editor of an ASME Journal. He received his B.S. (with Honors) from Stanford U. and M.S./PhD from MIT, with both dissertations on fire.

Course Would Benefit:

Engineers, Designers, Developers, Manufacturers, Program Managers, Safety Officers, Regulatory Agents, Emergency Responders, Hazard/Risk Analysists, Fuel Cell Operators, Transport Specialists, Tunnel Authority Operators/Managers, Researchers, Accident Investigators, and anyone responsible for safe hydrogen generation, handling, storage, and usage across industries such as power generation, data centers, transportation systems, chemical plants, industrial processing, heating systems, refueling stations/tank farms, and airports.

Course Objectives & Organization

Decarbonization will promote the use of hydrogen and introduce technologies and processes that pose safety challenges for the new users of hydrogen, thus the motivation for this course. Expect a comprehensive and unique treatment of practical fire, explosion, and dispersion hazards of hydrogen and how to mitigate against them. Drawing upon the chemical industry experience with pressurized and liquified systems, we will discuss initiating events, their evolution, systems survivability, design issues, protection methods and forensic implications. We will adapt them to the case of hydrogen with the fundamentals introduced as needed. This approach is tailored to professionals who want to broaden and deepen their knowledge to enable handling new situations. The course is illustrated by videotapes and photographs of real events and well controlled and instrumented bench- and full-scale tests. Attendees will benefit from a grasp of:

- Hazard assessment of the accidental releases of pressurized/liquified hydrogen and their mitigations -- both qualitatively and quantitatively to benefit managers and engineers, respectively
- Scenario evolution from leak to dispersion, fire, or explosion depending on local conditions
- Related fundamentals and the properties of hydrogen that differentiate it from other chemicals
- Simplified analyses/computer models with depth coverage tailored to the interest of the attendees.
- What to ask from subject matter experts
- Dynamic class discussion of current issues.

Coverage depth depends on class interests. Attendees receive class notes containing a wealth of key data and a certificate of completion. Course is equivalent to three Continuing Education Credit Units.

1. Introduction

- H2 production: Green, Blue, Grey, Black
- Hydrogen as a Fuel v. Energy Carrier
- Fuel Cells v. Combustion Systems
- Hydrogen v. lithium-ion batteries.

2. Exceptional Properties that Differentiate Hydrogen from Other Gases

- Negative Joule-Thomson coefficient
- Thermal diffusion, thermophoresis
- Hydrogen embrittlement of metals, polymers
- Formation of peroxides and hydrides
- Flammability properties of hydrogen

3. Accidental Release of Hydrogen

- Discharge flow rates at temperature and pressure: gas v. liquid, leak v. large dump
- Compressed gas heats up upon expansion!
- Jet formation and mixing with surrounding air
- Air condensation around a liquid H2 leak
- Spreading and boiling of a liquid H2 pool
- Spreading of initially-dense H2 vapors
- Formation and rise of buoyant puffs/plumes
- Dilution and dispersion prior to ignition?

4. Hydrogen Fires in the Open Air

- Pool and jet fires (turbulent diffusion flames)
- Wind effect on heating adjacent structures.
- Reactive dispersion and fire plumes
- Delayed ignition and vapor cloud fires
- Thermal radiation, Domino events, fireballs
- Test results of liquid spills at various scales
- Mitigation strategies: disperse or ignite?

5. Hydrogen Fires Inside Structures

- Ignition and burning of hydrogen
- H2 enhancement of materials already burning: FAA test results
- Pressure rise and thermal damage
- Fire plume emanating from openings.
- Mitigation strategies: ventilate to preempt ignition; once ignited let burn or extinguish?

6. Hydrogen Explosions

- H2 gas accumulation in structures
- Deflagration, detonation, DDT and their dependence on local conditions
- Requirements for H2/open air detonation
- Quasi-static v. dynamic pressure rise
- Incident/reflected pressures and impulse
- Blast analysis and structural failure
- Survey of TNT equivalent yields of hydrogen
- Mitigation strategies

7. H2 Safety Assessment in Transportation

- Storage as compressed gas v. liquid
- Hazards of high-pressure hydrogen tanks
- Lessons learned from hydrogen car fleet
- Tube Trailer fire in Diamond Bar, CA
- Applications to long haul transport
- Liquid tank configurations in aircraft
- Comparative crash fire for H2 v. fossil fuels
- Pros and cons for H2 transport as ammonia
- Adaption of lessons learned from shipping liquified gases and mitigation strategies.

8. Hydrogen Safety Assessment in Facilities

- Data centers, backup power, and airports
- Lessons learned from chemical plants
- Protection of liquid hydrogen storage tanks
- Fire suppression considerations
- Explosion in Gangneung, South Korea
- Adaption of lessons learned from storage of liquified gases and mitigation strategies.
- Hazard/ Risk Assessment

9. Blended H2/Natural Gas in Pipelines

- Flammability properties of H2/NG ratios
- Fire/radiation as function of H2/NG ratios
- Challenges in residential and commercial use

10. Closure

- Review of Mitigation strategies

Course Schedule and Location

8:00 to 17:00 Tuesday-Thursday, 23 to 25 July 2024
BlazeTech Corporation
29 B Montvale Ave., Woburn, MA 01801 USA

Fee and Registration

Fee: $3,500. To register, fill out form below.

Payments:

-Credit cards: fax to BlazeTech 781-759-0703

-Wire payments: contact us for details.

-Checks: mail to BlazeTech; discount $200 if check is received 2 months before course starts.

Registration incomplete until payment is received.

No walk-ins. We reserve the right to cancel course.

Participants must show compliance with US Federal and Massachusetts Covid-19 travel requirements, otherwise denied entrance.

Registration Form

Name: _____

Title/Position: _____

Company: _____

Address: _____

City, State, Zip: _____

Country: _____

Phone/Fax: _____

E-mail: _____

Specific Interest: _____

Payment: ☐ Check ☐ Credit Card ☐ Wire

Card #: _____

Expiration Date: _____ Amount: _____

3- or 4-Digits Security Code on card: _____

Name on Card: _____

Signature: _____Date:____

Billing Address for Card: _____

_____

How did you hear about the course?

☐ Colleague ☐ Website ☐ Email ☐ Other: