

Safety Snippet: Hydrogen Fire Safety



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Introduction

A number of industrial processes including ammonia production and petroleum refining, utilize hydrogen as a part of their manufacturing processes. Recent research and investment into hydrogen technologies have led to an increase in its use as a cleaner alternative fuel to carbon-based fuels like natural gas. As a result, many industries, government bodies, and utilities suppliers are interested in expanding the use of hydrogen gas as a fuel source. As these goals are pursued, it is critical that the related safety considerations are well understood and implemented to avoid personnel, environmental, and equipment harm.



Flammability Information

One of the major safety concerns when using hydrogen in a process is that the gas is highly flammable. Its light weight makes it less of a threat for explosion than heavier gases like propane, but hydrogen has much broader flammability limits than many common flammable gasses and fuels. It also has a much lower Minimum Ignition Energy (MIE) than most flammable gasses. As a result, fires are major concerns when working with hydrogen processes. Table 1 provides flammability information on hydrogen along with other flammable gasses and vapors at atmospheric conditions for comparison.

In This Issue

Hazards associated with hydrogen are discussed along with recommended practices for safe work practices and hydrogen fire safety.

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<https://www.NebulaSafety.com>

Table 1: Flammability Data for Common Flammable Substances

Substance	LFL (%)	UFL (%)	Lowest Possible MIE (mJ)
Hydrogen	4	75	0.016
Methane	5	17	0.21
Propane	2	10	0.25
n-Pentane	1.4	8	0.28

LFL – Lower Flammability Limit

UFL – Upper Flammability Limit

Figure 1 depicts the flammability envelope for hydrogen based on the concentration of hydrogen, oxygen, and nitrogen in atmosphere.

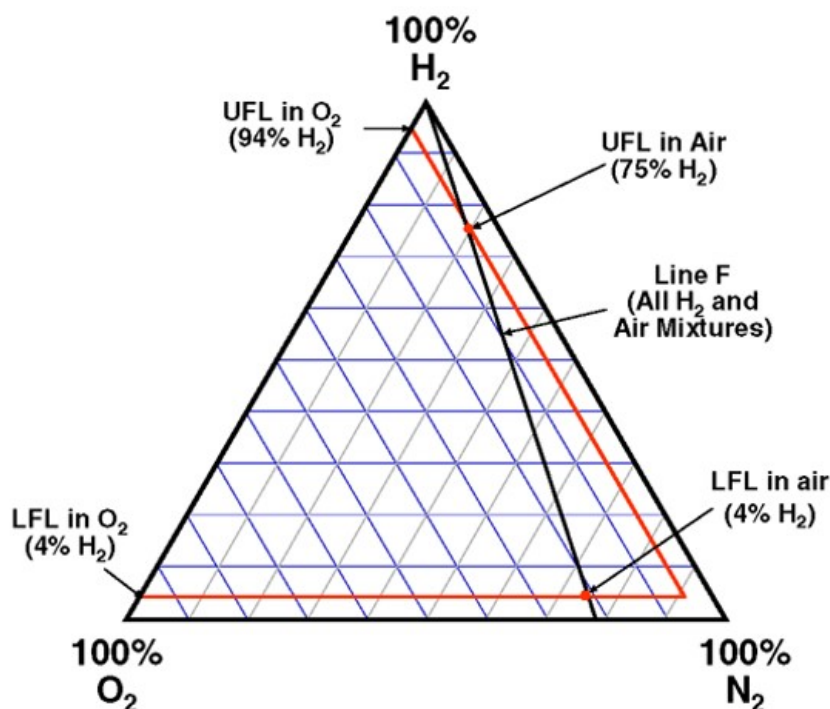


Figure 1: Tertiary Diagram for Hydrogen, Oxygen, and Nitrogen
(with flammability envelope for ambient conditions)

Ignition Sources

When working with hydrogen, it is important to take into consideration all possible sources of ignition in and around the process due to the highly flammable nature of the gas. There are various mechanisms that can cause ignition in processes that use hydrogen. Table 2 presents common ignition sources for consideration grouped by category.

Table 2: Common Ignition Sources	
Electrical	Sparks from Electronics
	Static Discharge
	Electric Arcs
	Electrical Charge from Equipment Operation
Mechanical	Mechanical Sparks
	Heavy Impacts/Friction
	Metal Fractures
Thermal	Hot Surfaces
	Open Flames
	Exhausts
	Catalysts or Reactive Materials
Other sources	Radiation
	Adiabatic Compression

Minimizing Hazards

Eliminating ignition sources is paramount to avoiding hydrogen related fires. Below are several ways to help mitigate risks associated with hydrogen fires along with supplemental standards for implementation guidance.

- Ensure proper grounding of equipment.
 - API RP 2003, “Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents”
 - NFPA 77, “Recommended Practice on Static Electricity”
- Follow proper material selection guidelines.
 - API RP 941, “Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plants”
- Follow electrical installation standards.
 - OSHA 1910.103©(1)(ix), “Hydrogen Electrical systems”
- Avoid leaks from high pressure as high velocity releases could act as a mechanism for self-ignition. This can be accomplished by following relevant standards on hydrogen storage safety found in the following:
 - AMSE Boiler and Pressure Vessel Code, section VII & VIII – for gas and liquid storage respectively
 - API 620, “Recommended Rules for Design and Construction of Large, Welded, Low-Pressure Storage Tanks”

Fighting Hydrogen Fires

NFPA 2 Chapter 4, “Hydrogen Technologies Code – General Fire Safety Requirements” has information on appropriate fire detection, alarm, and protection systems. Some important guidelines for hydrogen fire safety are:

- Only properly trained and equipped firefighters should respond to hydrogen fires.
- If possible, shut off the release source and exhaust the hydrogen to prevent reignition.
- Because hydrogen is colorless and odorless, and because its flames are rather transparent, it is important to install proper monitoring such as thermal imaging and flame detection.

Reach out to the Nebula Safety & Environmental Team at NebulaSafety.com for additional information. Additionally, Nebula Safety can conduct a gap analysis for your facility to identify applicable deficiencies and opportunities for improvement.

References:

1. <https://eepower.com/technical-articles/grounding-and-bonding-to-prevent-static-electricity-in-the-petroleum-industry/>
2. <https://catalog.nfpa.org/NFPA-2-Hydrogen-Technologies-Code-P1144.aspx?cid=D533>
3. <https://h2tools.org/bestpractices/fire-protection-and-suppression>
4. <https://h2tools.org/bestpractices/hydrogen-properties-leak-detection-considerations>
5. https://www.engineeringtoolbox.com/explosive-concentration-limits-d_423.html
6. <https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.103>