Product Safety Assessment

Hydrogen

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Names
- CAS No. 1333-74-0
- Hydrogen Linde
- Hydrogen St. Charles
- Hydrogen 100%
- Hydrogen U-4
- Hydrogen cell

Product Overview
- Hydrogen is a colorless, odorless, flammable gas. Hydrogen is produced from the steam reforming of natural gas (made up primarily of methane) into synthesis gas or syn gas. Synthesis gas is a mixture of carbon monoxide and hydrogen. Dow produces hydrogen as a by-product in the manufacturing of ethylene. For further details, see Product Description.
- Hydrogen is used as a raw material for the production of other chemicals. For further details, see Product Uses.
- Workplace exposure to hydrogen gas could occur during manufacturing. Because hydrogen is used as industrial intermediate in closed systems, occupational exposure is expected to be minimal. Pure hydrogen gas only exists in nature in trace amounts; therefore consumer contact is not likely. For further details, see Exposure Potential.
- Hydrogen has no known health hazards other than as a simple asphyxiant; at high concentrations it could cause suffocation by displacement of oxygen. For further details, see Health Information.
- Hydrogen gas released to the environment would disperse in the air. Hydrogen released to water may result in decreases in the dissolved oxygen content of natural waters. Hydrogen gas is not expected to be acutely toxic to fish and other aquatic organisms. For further details, see Environmental Information.
- Hydrogen gas is very flammable. At concentrations greater than its lower flammable limit (4.1% in air) it becomes a fire and explosion hazard. It is stable under recommended storage conditions. Avoid contact with oxidizing materials. For further details, see Physical Hazard Information.
**Manufacture of Product**

- **Capacity** – In 2006 the estimated hydrogen production capacity in the U.S. was 10.7 million metric tonnes (nearly 23.5 billion pounds).
- **Process** – About 95% of the hydrogen produced in the U.S. is made by steam-methane reforming, a process in which high-temperature steam (700–1000°C) reacts with a methane source, such as natural gas, under pressure and in the presence of a catalyst to produce hydrogen, carbon monoxide, and a small amount of carbon dioxide. Next, the carbon monoxide is further reacted with steam using another catalyst to produce carbon dioxide and more hydrogen (the water-gas shift reaction). Finally, carbon dioxide and other impurities are removed leaving (essentially) pure hydrogen.

\[ \text{CH}_4 + \text{H}_2\text{O} \rightarrow \text{CO} + 3\text{H}_2 \quad (1) \]

\[ \text{CO} + \text{H}_2\text{O} \rightarrow \text{CO}_2 + \text{H}_2 \quad (2) \]

**Product Description**

Hydrogen is a colorless, odorless, flammable gas. It is estimated to make up more than 90% of all the atoms, or three quarters of the mass of the universe. Although it is the most abundant element on Earth, only trace amounts of pure hydrogen gas exist in the atmosphere (less than 1 ppm by volume). It occurs chiefly in combination with oxygen (water) and is also present bonded to carbon atoms in organic matter (plants, animals, petroleum, coal, etc.).

**Product Uses**

In the U.S. hydrogen is mainly used for petroleum refining and fertilizer production. Dow uses hydrogen derived from natural gas for the production of Oxo chemicals and hydrogen cyanide; raw materials for the manufacture of plastics, perfumes, pesticides, pharmaceuticals, and many other products.

**Exposure Potential**

Hydrogen is used as an industrial raw material for the manufacture of other chemicals. Based on the uses for hydrogen, the public could be exposed through:

- **Workplace exposure** – Exposure can occur in a manufacturing facility that performs steam reforming to generate hydrogen. Most hydrogen manufactured for chemical synthesis is consumed at or near the production site. It is produced and consumed in closed systems with engineering controls that prevent fugitive emissions. Those working with hydrogen in manufacturing operations could be exposed during maintenance, sampling, testing, or other procedures. Due to its physical properties, inhalation is the only significant route of hydrogen exposure. Each facility should have a thorough training program for employees and appropriate work processes, ventilation, and safety equipment in place to limit unnecessary exposure. See [Health Information](#).

- **Consumer exposure to products containing hydrogen gas** – Pure hydrogen gas is present only in trace amounts in the Earth’s atmosphere. Presently, no consumer products contain hydrogen gas. Fuel cells based on hydrogen may eventually replace conventional internal-combustion engines in some vehicles. See [Health Information](#).

- **Environmental releases** – Because it is a gas, any hydrogen released to the environment would immediately disperse into the atmosphere. If hydrogen is released to water, it could result in decreases in the dissolved oxygen concentration. See [Environmental](#), [Health](#), and [Physical Hazard Information](#).

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**Chemical Equations**

\[ \text{CH}_4 + \text{H}_2\text{O} \rightarrow \text{CO} + 3\text{H}_2 \]

\[ \text{CO} + \text{H}_2\text{O} \rightarrow \text{CO}_2 + \text{H}_2 \]
• **Large release** – Stop the flow of gas. Evacuate personnel and extinguish all ignition sources. Ventilate the area. Ground and bond all containers and handling equipment. Use fine water spray to reduce vapors. Keep upwind of the release. Only trained personnel must be involved in clean-up operations. Positive pressure, self-contained breathing apparatus (SCBA) with an approved full-face mask is recommended for emergency work. The public should be warned of downwind vapor explosion hazards. See [Environmental, Health, and Physical Hazard Information](#).

• **In case of fire** – Keep people away, isolate the fire and deny unnecessary entry. Do not extinguish. If flames are accidentally extinguished, explosive re-ignition could occur. Stop flow of product and allow the fire to burn out. Eliminate ignition sources. Once product flow has stopped, small fires may be extinguished with a water fog or fine spray, dry-chemical or carbon-dioxide extinguisher, or foam. For an unignited vapor cloud, use water spray to knock down and control the dispersion of vapors. Firefighters should wear positive-pressure, self-contained breathing apparatus (SCBA) and protective firefighting clothing. Follow emergency procedures carefully. See [Environmental, Health, and Physical Hazard Information](#).

For more information, see the relevant [Safety Data Sheet](#).

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**Health Information**

**Eye or skin contact** – There are no hazards associated with eye or skin contact with hydrogen gas.

**Inhalation** – In confined or poorly ventilated areas, hydrogen gas can accumulate and cause unconsciousness and death due to displacement of oxygen (suffocation).

**Ingestion** – Swallowing hydrogen gas is unlikely.

For more information, see the relevant [Safety Data Sheet](#).

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**Environmental Information**

Hydrogen gas released to the air would disperse into the upper atmosphere. The lightest of all gases, hydrogen combines with other elements in air to form compounds or quickly rises to the upper atmosphere and dissipates, leaving virtually no hydrogen gas on the Earth’s surface or lower atmosphere.

At normal temperature hydrogen is not very reactive and biodegradation is not expected to be a major fate pathway. Hydrogen gas released to natural waters may lead to decreases in the dissolved oxygen content. Hydrogen gas is not likely to accumulate in the food chain (bioconcentration potential is low) and is expected to be practically non-toxic to fish and other aquatic organisms.

For more information, see the relevant [Safety Data Sheet](#).

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**Physical Hazard Information**

Hydrogen gas is flammable and an explosion hazard. Electrically bond and ground all containers and equipment before transfer or use of this material. Hydrogen is stable under recommended storage conditions. Store this material away from heat, sparks, and flame. Avoid contact with oxidizing materials.
For more information, see the relevant Safety Data Sheet.

**Regulatory Information**
Regulations may exist that govern the manufacture, sale, transportation, use, and/or disposal of hydrogen. These regulations may vary by city, state, country, or geographic region. Information may be found by consulting the relevant Safety Data Sheet or Contact Us.

**Additional Information**
- Safety Data Sheet (http://www.dow.com/webapps/msds/msdssearch.aspx)
- Contact Us (www.dow.com/assistance/dowcig.htm)
- Los Alamos National Laboratory Chemistry Division, University of California (for the) U.S Department of Energy website – Hydrogen (http://periodic.lanl.gov/1.shtml)

For more business information about hydrogen, contact the Dow Customer Information Group at www.dow.com/assistance/dowcig.htm.
References

1. Hydrogen Material Safety Data Sheet, The Dow Chemical Company
5. Los Alamos National Laboratory Chemistry Division, University of California (for the) U.S Department of Energy website – Hydrogen (http://periodic.lanl.gov/1.shtml)

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