9/9/2022

Questions for Chemistry folks:

Rules about having & using algae? Experience with it?

Experience with Hydrogen storage, specifically with metal hydrides?

Team Activities:

Take over an intramural team for a game.

Go for a quick hike on the campus trails.

Check out a downtown weekend market.

9/12/2022

Spoke to Professor Rachael Schmidt, she mostly does organic chemistry so she directed me to Dr. Rick DiPietro.

Dr. D recommended looking into platinum/palladium catalyzed hydrogenation, because storing dihydrogen as a gas SUCKS.

<https://erauprescott.summon.serialssolutions.com/?q=platinum+catalyzed+hydrogenation#!/search?ho=t&include.ft.matches=f&l=en&q=platinum%20catalyzed%20hydrogenation>

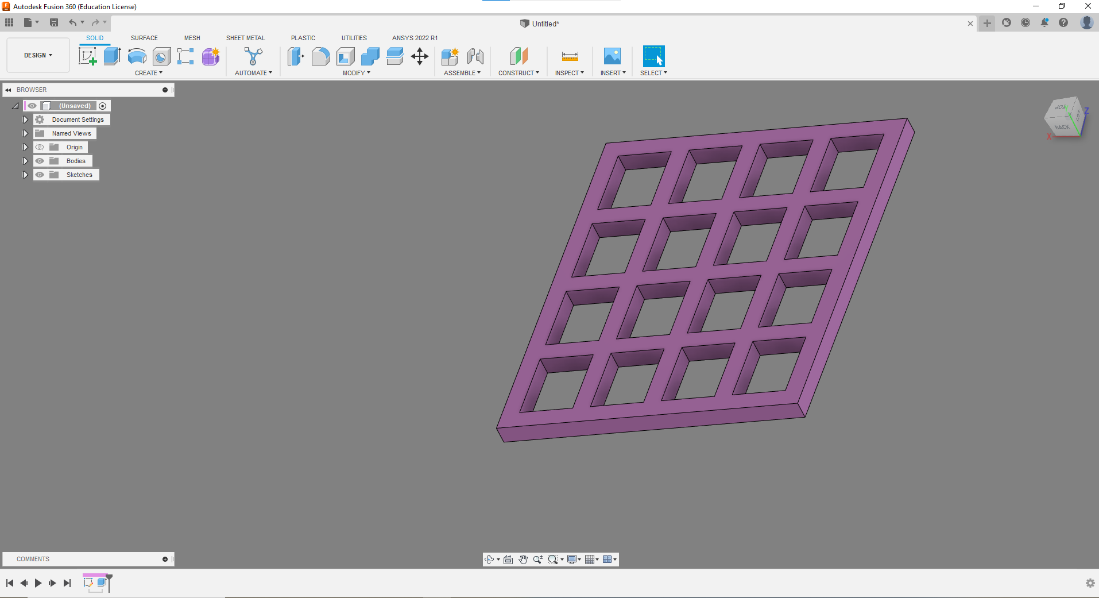
9/14/2022

‘Hydrogen Dehydrogenase’ – enzyme needed to get the dihydrogen back out of the hydrogenated molecule.

<https://pubs.acs.org/doi/10.1021/acsami.0c22192> hydrogen adsorption on activated carbons

MSC-30 (Maxsorb)  
MSP20X  
SA1500  
SA20  
TH90I  
Filtrasorb400

9/28/22



10/21/22 - Piping

<https://whatispiping.com/hydrogen-piping-and-pipeline-systems/>

The flame of hydrogen is invisible in daylight

Governing code: ASME B31.12

Common materials:

* High-purity stainless steels with hardness less than 90 HRB
* Composite pipes like PFA, PTFE, FRP, FEP, MFA
* 300 series austenitic stainless steels within temperature limits of AME B31.12 are used for piping, tubing, valves, and fittings for gaseous hydrogen
* Carbon steel can be used for gaseous hydrogen piping.
* The suitability of using carbon or low-alloy steel must be evaluated using “Nelson charts” in API RP 941 for high-temperature applications
* Seamless pipes & tubes are preferred

Single wall piping is okay.

Electrical equipment and grounding must comply with NFPA 70.

Guidelines to prevent leaks & enable easy detection:

* Use welded joints where possible
* Minimize chances of contact with cold surfaces
* Pressure relief devices
* Shutoff valves provided at safe locations
* Piping labeled to indicate content and flow direction

<https://www.asme.org/codes-standards/find-codes-standards/b31-12-hydrogen-piping-pipelines>

It costs $290 for a pdf. :(

<https://www.asiaiga.org/uploaded_docs/AIGA%20087_14_Standard%20for%20Hydrogen%20Piping%20Systems%20at%20User%20Location.pdf>

Many engineering alloys degrade when used in high-pressure hydrogen service, called ‘hydrogen embrittlement’.

When possible, austenitic stainless steels should be in annealed condition.

Carbon steels limited to operating temperatures equal to or greater than -20°F.

Plastic piping and tubing can be used in low-flow and low-pressure lab applications.

Swing-type and lift-type check valves for 1 in and larger. May be metal-to-metal or metal-to-soft material. PTFT & PCTFE are often used soft seat materials.

Poppet-type check valves are recommended for 7/8 in and smaller.

Hydrogen gas detectors should be installed above the hydrogen system. They should alarm at 1% hydrogen concentration, and shut down the system at 2%.

Plastics and elastomers may be used for internal valve seats and seals. Elastomers become brittle at lower temperatures, and shouldn’t be used there.

Sections of piping must have electrical continuity to ground.

Piping systems should be cleaned before hydrogen service. It should be suitable for level of cleanliness required by the application.

Pipe anchors and supports must consider thermal expansion and contraction of piping.

System inspection should include electrical resistance to ground (to follow NFPA 70).

Piping must be tested hydrostatically or pneumatically.

System must be purged with an inert gas to eliminate oxygen/air before admitting hydrogen. Residual oxygen reduced to less than 1%.

Methods to identify valves and piping in accordance with ASME A13.1.

Systems must be purged with an inert gas to eliminate hydrogen before opening system to atmosphere.

Maintain permanent record of inspections and repairs.

Main Take-aways

Probably use carbon steels.

System must be purged with an inert gas.

Joints should be welded.

Every part of the system must be electrically grounded.

<https://asmestandardscollection-org.ezproxy.libproxy.db.erau.edu/GetDoc.aspx?doc=ASME%20B31.12%202019>

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ASME B31.12 Hydrogen Piping and Pipelines provides standards for the piping of hydrogen gas on the industrial level. These standards should be used to inform the design choices of this system, specifically regarding materials, geometry, and inspection. This system is not bound to these standards due to its small size, but they should nonetheless be used as guidance. Deviations from these standards should be made on a case-by-case basis and clearly justified.

The piping chosen is PTFE tubing that has an inner diameter of ¼ inch because PTFE can withstand high temperatures, the pressure of the system, and is incredibly durable. The PTFE tubing can be heated to 260 degrees Celsius, which is the temperature the hydrogen gas will leave the material storage. To verify that there will be no leaks in the tubing, each piece of tubing will be inspected prior to installation using pressure tests.

A source of potential leaks in the piping subsystem comes from the interfaces with the electrolyzer, the material storage, the fuel cell, and the sensors. To ensure that there will be no leaks at these interfaces, pressure fit nozzles and Teflon tape will be used. Pressure tests will be used to verify that there is no hydrogen escaping at the interface locations.