

HAZARDOUS WASTE ISSUES PRESENTED BY FUEL CELLS

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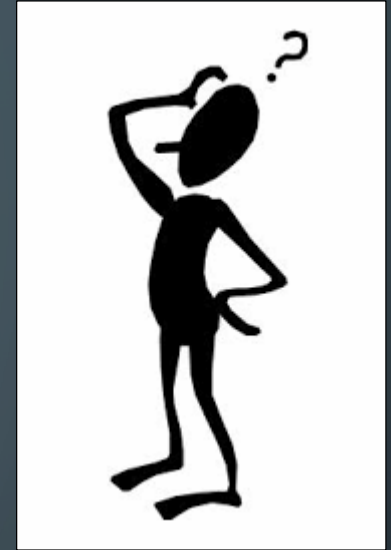
CT DEEP/WASTE ENGINEERING & ENFORCEMENT DIVISION

NEWMOA HAZARDOUS WASTE CONFERENCE CALL, 7/24/2018



WHAT IS A FUEL CELL?

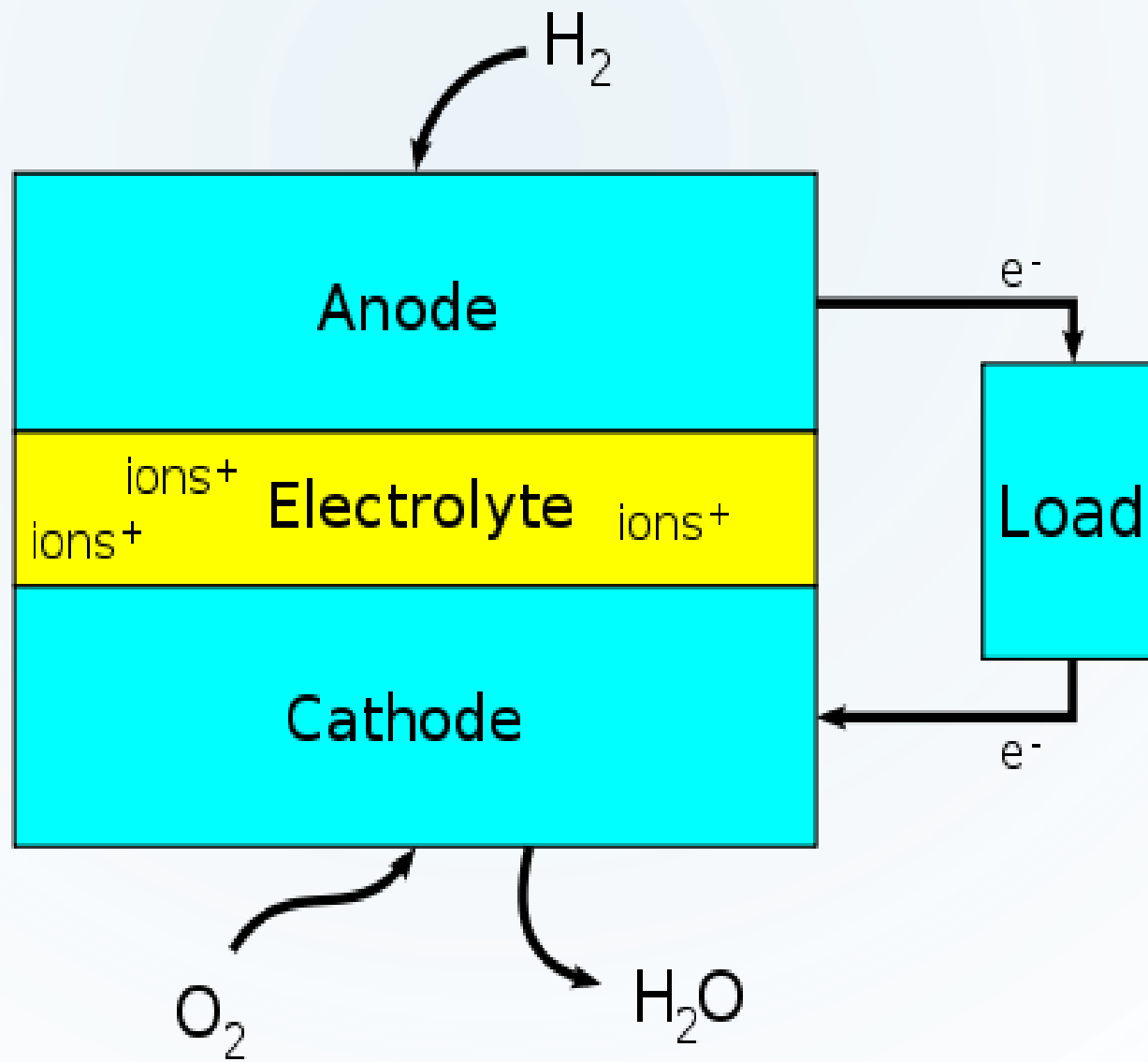
- A device that generates electricity from a fuel such as hydrogen or natural gas.
- Operates using the same chemical reaction as combustion, but produces electricity (and possibly also heat).
- Overall reaction (assuming natural gas used as the fuel):
$$\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O} + \text{electricity} + \text{heat}.$$
- Natural gas must be “reformed” into H_2 gas and CO_2 gas.
 - Some fuel cells do this prior to introduction into the fuel cell
 - Others can reform the natural gas within the fuel cell.

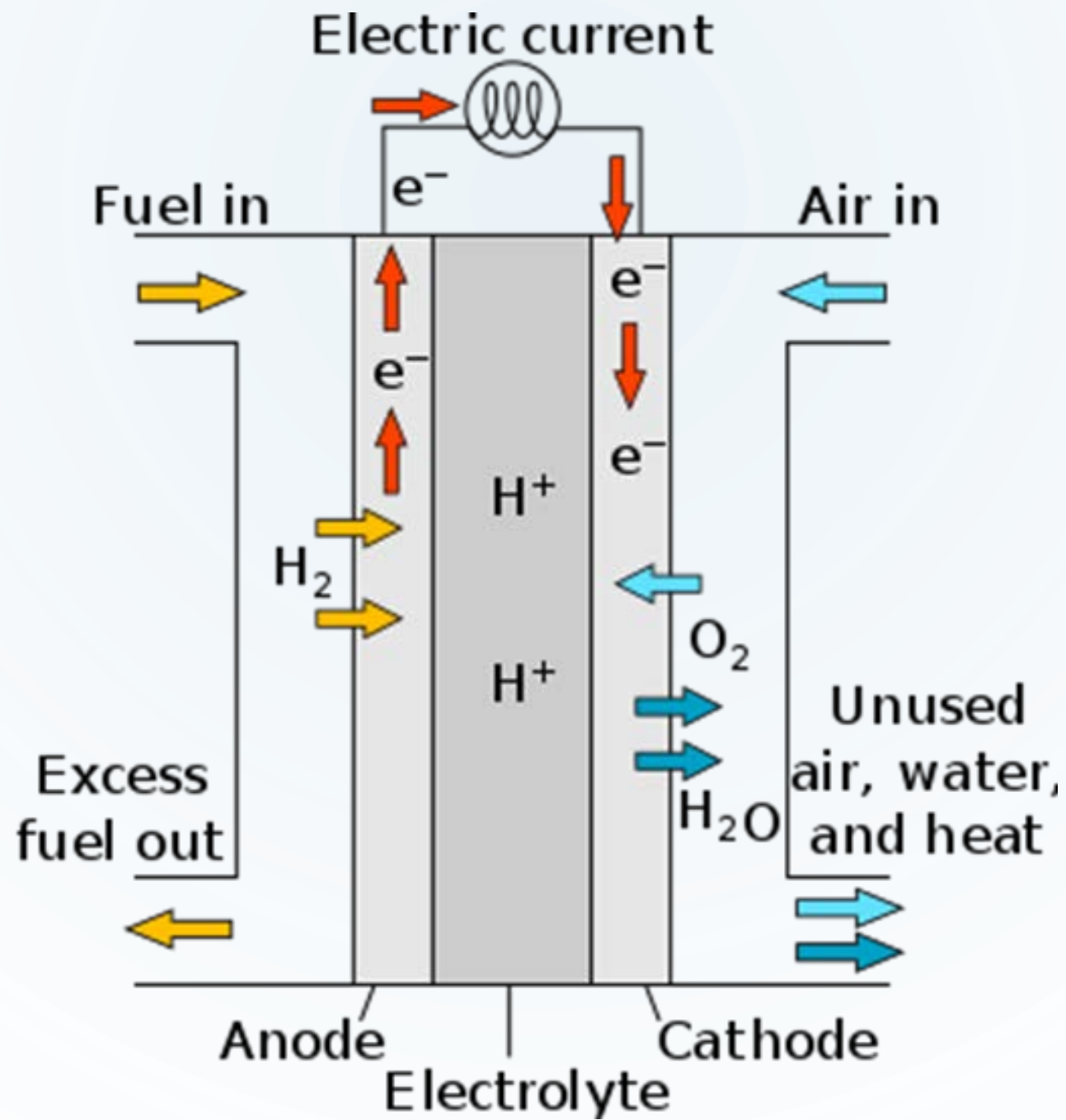


HOW DOES A FUEL CELL WORK?

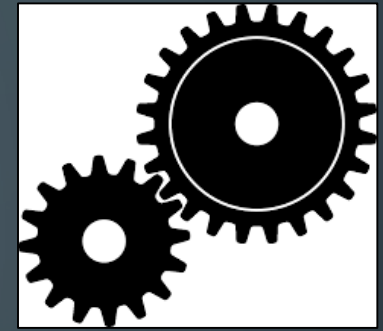
- Basically, a fuel cell operates like a battery (hence the name “fuel cell”).
- Contains an anode, a cathode and an electrolyte.
- A catalyst converts hydrogen (H_2) to hydrogen ions (H^+) at the anode, releasing electrons (e^-).
- A catalyst converts oxygen (O_2) to oxygen ions ($O^{=}$) at the cathode, consuming electrons.
- Electrons flow from the anode to the cathode – can be harnessed as electrical energy.
- The hydrogen and oxygen ions combine to produce water (H_2O).







HOW DOES A FUEL CELL WORK?



- Each cell only produces a small electrical potential (~ 0.7 Volts).
- Large numbers of individual cells must be connected in series to form a “stack” which has a much higher, more useful, voltage.
- Fuel cells come in different types, as defined by the type of electrolyte that is used. Some examples:
 - Phosphoric acid fuel cells (Doosan fuel cells, formerly UTC Power).
 - Molten carbonate fuel cells (FuelCell Energy fuel cells).
 - Solid oxide fuel cells (Bloom Energy fuel cells).

WHY FUEL CELLS?

- Abundant, cheap natural gas.
- Economic Incentives:
 - Renewable Energy Credits.
 - State incentives of various types.
- Can be more efficient than combustion.
- Competitive with power from the grid, especially in high cost areas (NE USA).
- Lower emissions than combustion.
- Operate quietly.
- Co-generation capability (electricity and heat).



FUEL CELLS IN CONNECTICUT

- CT has approximately 120 fuel cell locations, with more coming all the time.
- 2 fuel cell manufacturers in CT: Doosan (FKA UTC Power) and FuelCell Energy.
- About half of the fuel cells in CT are made by a third company, Bloom Energy.
- Vary widely in size from 110 kW to over 50 MW.
- Smaller units often built for a specific user, such as an office or government building, manufacturer, big box store/retail facility, hospital, school or college, telecom facility, or warehouse. Advantages:
 - Possible electrical cost savings;
 - Ensure power in an emergency;
 - Promotes a “green” image to the public.
- Larger units often built solely to provide power to the grid.



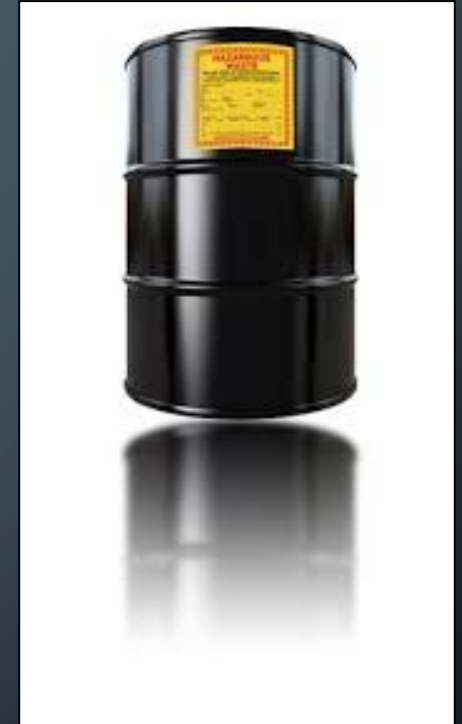
WASTES GENERATED BY FUEL CELLS

- Desulfurization filters.
 - Used to remove sulfur-containing odorant in natural gas (mercaptan).
 - Filters also pick up benzene from the natural gas (D018).
 - Filters can last anywhere from 3 months up to 2 years (depends on fuel cell size, gas supply and other factors).
 - Can be quite large (hundreds or thousands of pounds generated at a time).
 - Amount of waste generated can easily make fuel cell sites LQGs.
 - Two types: drainable and removable filter units.
 - [EPA memo](#): removable filters are hazardous waste when disconnected.



WASTES GENERATED #2

- Electrolyte and plates can contain many different potentially-hazardous constituents:
 - Examples: Cr (D007), IPA (D001), MEK (D001, D035), phosphoric acid (D002), toluene (D001).
 - Also non-haz constituents such as cerium, lanthanum, nickel, manganese, platinum, scandium, yttrium, and zirconium.
 - Require periodic replacement (ca. every 5 years).
 - Amount large enough to make the fuel cell site an LQG.
- Rectifiers – possibly contain Hg or Se? Scrap metal?



WASTES GENERATED #3



- Power storage batteries:
 - Sometimes used with fuel cells to store energy for future use.
 - Could be lead-acid or lithium ion.
 - Typical lifespan ~10 years.
- End of life management:
 - Useful life of fuel cells is 10-15 years.
 - Unit may be drained on-site and scrapped or sent off-site to be drained and scrapped.
 - Either option raises generator and TSDf issues.
- Note: chemistries can vary widely from one manufacturer to the next.



INSPECTION & ENFORCEMENT IN CT

- 2008 – NOVs issued to Pepperidge Farms (property owner) and PPL Shoreham Energy, LLC (owner and operator of fuel cell) for non-compliance with HW requirements.
- 2012 – One of two FuelCell Energy mfg. sites inspected and issued an NOV.
- 2018 – Doosan mfg. site inspected – no violations found.
- CAUTION: Although we did not see this, fuel cell manufacturers and other sites may want to receive fuel cells or fuel cell components and refurbish or dismantle them.
 - Possible TSDF activity.



INSP. & ENF. IN CT (CONT.)



- 2017 – CT DEEP received a complaint regarding Bloom Energy.
 - Complainant is from Delaware and is a vocal opponent of Bloom Energy.
 - Complaint focused on management of desulfurization filters (HW D018).
 - CT DEEP research showed that the company had 50+ fuel cell sites in CT.
 - Many lack EPA ID #s or are not shipping waste on HW manifests.
 - Fuel cells need CT Siting Council approval (due to energy production).
 - Misrepresentations made to CTC re desulf. filters and generation of HW.
 - Coordinating with CSC on HW issues associated with fuel cells.
 - Coordinating with EPA with respect to future inspection/enforcement.

BLOOM ENERGY TIME LINE



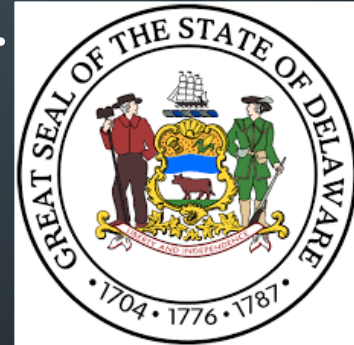
- 6/3/2015: DE DNREC letter concurring with Bloom that desulfurization units are exempt from regulation as hazardous waste under the “Manufacturing Process Unit” exemption at 40 CFR 261.4(c).
- 7/24/2015: EPA Region 3 makes inquiries to EPA Region 1 and CT DEEP regarding Bloom Energy fuel cells in Connecticut, and raises issue regarding possible hazardous waste status of desulfurization filters from fuel cells in Delaware being sent to a facility in Texas that is not a permitted hazardous waste facility.
- 9/8/2015: EPA Region 3 letter to DE DNREC – desulfurization units are not exempt as manufacturing process units.
- 9/29/2016: EPA Region 3 letter to DNREC instructing them to rescind their 6/3/2015 letter.

BLOOM ENERGY TIME LINE, CONT.

- 10/3/2016: [EPA HQ Memo](#) - Manufacturing Process Unit Exemption does not apply to filters that are removed from equipment and sent off-site for emptying/reconditioning.
- 10/27/2016: DE DNREC letter to Bloom rescinding their 6/3/2015 letter, and indicating they will not pursue enforcement for violations that occurred < 30 days after the letter.
- 12/5/2016: EPA Headquarters letter to Bloom Energy denying their request to enter into a consent order allowing Bloom to operate nationally under the Verified Recycler Exclusion until they could modify their filters so that they were no longer hazardous.
- 2/24/2017: IN DEM letter concurring with ShoreMet that their recycling process would be exempt from RCRA under the “use/reuse” provisions of 40 CFR 261.2(e).
- 4/21/2017: EPA HQ letter deferring to IN DEM position re ShoreMet recycling process.
- 10/2/2017: North Carolina pursues enforcement against Apple for HW violations.
- 6/12/2018: Bloom submits preliminary registration for IPO with SEC.

ACTIVITIES IN OTHER STATES/REGIONS

- Delaware: issued NOVs to 3 of the 5 Bloom Energy notifiers in their state.
- North Carolina: fined Apple > \$40,000 for violations associated with Bloom Energy fuel cell installation at Apple's facility in Maiden, NC.
 - HW Determinations.
 - Offering waste to transporters/facilities without EPA ID #s.
 - Failure to use manifests.
 - Failure to submit Biennial Reports.
 - Failure to maintain HW records.
- Texas: Bloom sent desulfurization filters to UniCat Svcs. and VLS Svcs. for emptying and disposal of media as HW. Both sites were LQGs, not TSDFs.



ACTIVITIES IN OTHER STATES/REGIONS

- New Mexico: Bloom Energy stopped sending filters to Texas and began sending them to ACT a permitted TSDf, for emptying and transfer to a disposal facility.
 - NM ED inspected ACT and cited HW permit violations.
 - Accepting waste w/o a manifest, failure to file un-manifested waste reports, etc.
- Indiana: IN DEM inspected 2 ShoreMet facilities and issued one NOV.
 - 2/24/2017 IN DEM letter concurring with ShoreMet that their process for recycling the filter media is exempt under use/reuse – 261.2(e).
 - Does the recycling involve reclamation?
 - EPA HQ and CA EPA have concurred with IN DEM letter.



ACTIVITIES IN OTHER STATES/REGIONS

- New York, New Jersey: Bloom Energy press statements indicate that these states have been targeted for the siting of Bloom Energy fuel cells.
- EPA Region 3:
 - Sent information request letters on 1/20/2017 and 9/1/2017.
 - Letter of intent to initiate enforcement (Show Cause Letter) on 4/17/2018.



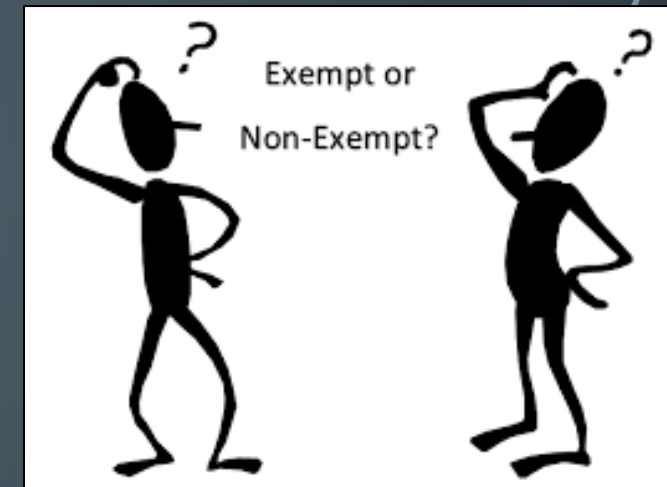
OTHER ISSUES



- Are fuel cells possibly Universal Waste Batteries?
- “... a device consisting of one or more electrically connected electrochemical cells which is designed to receive, store, and deliver electric energy...”
- Section IV.B.2.a. of the [preamble to the final UWR](#) says that the definition was modified to specify that a battery must store electrical energy in addition to receiving and delivering electrical energy.
- This would appear to rule out fuel cells as UW batteries.

OTHER ISSUES

- Do any of the Bevill Exclusions apply to fuel cell wastes?
- 40 CFR 261.4(b)(3) DNA because none of the wastes are “mining overburden returned to the mine site.”
- 40 CFR 261.4(b)(4) DNA because none of the wastes are “fly ash waste, bottom ash waste, slag waste, and flue gas emission control waste, generated primarily from the combustion of coal or other fossil fuels ...”. In particular, fuel cells do not engage in combustion.
- 40 CFR 261.4(b)(5) DNA because none of the wastes are “drilling fluids, produced waters and other wastes associated with the exploration, development, or production of crude oil, natural gas, or geothermal energy.”
- 40 CFR 261.4(b)(7) DNA because none of the wastes are “generated from the extraction, beneficiation, and processing of ores and minerals (including coal, phosphate rock, and overburden from the mining of uranium ore)...”



RESOURCES FOR ADDITIONAL INFO

- DOE fuel cell website:

<https://www.energy.gov/eere/fuelcells/fuel-cells>

- DOE website re financial incentives for fuel cells:

- <https://www.energy.gov/eere/fuelcells/financial-incentives-hydrogen-and-fuel-cell-projects>

- NCSL website on fuel cells, including state financial incentives:

- <http://www.ncsl.org/research/energy/fuel-cells-clean-and-reliable-energy.aspx>

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QUESTIONS/DISCUSSION

