Fuel Cells in Public Transportation

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Chemistry of a Fuel Cell

Anode side:
$2H_2 \Rightarrow 4H^+ + 4e^-$
Cathode side:
$O_2 + 4H^+ + 4e^- \Rightarrow 2H_2O$

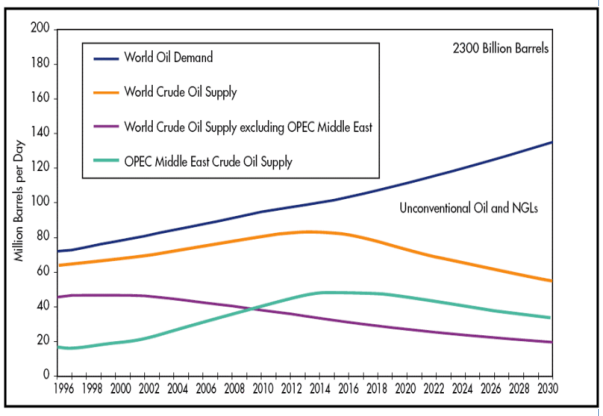
Net reaction:
$2H_2 + O_2 \Rightarrow 2H_2O$

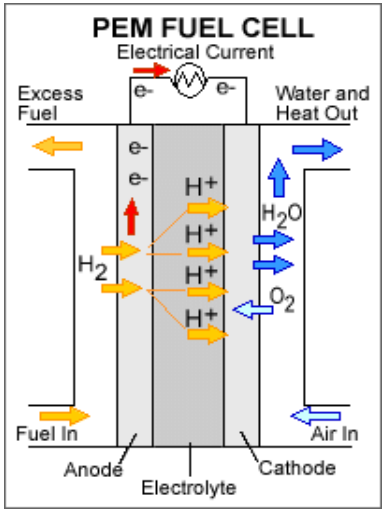
Abstract

Oil is a non-renewable fuel source that can support world usage for less than 50 years. This project proposes the implementation of fuel cells in public transportation in order to supplement a significant portion of fossil fuel use. This will also allow the public to become accustomed to fuel cell technology. Proton Exchange Membrane (PEM) fuel cells are currently capable of replacing internal combustion engines in vehicles; the cost and lack of support infrastructure are currently the biggest barriers to their use.

Fuel Cell Facts

•Fuel cells have been around since the 1800s.
•While many believe fuel cell technology to be a future goal, the technology actually exists and is in perfect, tested working order *right now*.
•Currently, there are five major types of fuel cell: Phosphoric Acid FC, Alkaline FC, Solid Oxide FC, Molten Carbonate FC, and PEMFC.
•PEM fuel cells are the best for portable applications because, in comparison to other types of fuel cells, they are small, lightweight, and operate at only 35˚C.
•The amount of oil consumed daily in the US for transportation is 14 million barrels, which is 70% of the total oil usage per day.
•Today, PEM fuel cells output between 50 and 250 kW of power.
•The projected cost to import oil over the next 20 years is roughly $3 trillion; the estimated cost to build a hydrogen infrastructure is $100 billion.
•PEMFC power output is projected to be nearly 30 mpg better than gas fueled engines.
•Fuel cell buses are not new; there have been several instances of successful use on a small, public scale.
•Since fuel cells are still expensive, the cost of a fuel cell bus is approx. 3 billion dollars, which is about 10 times more than a diesel bus.





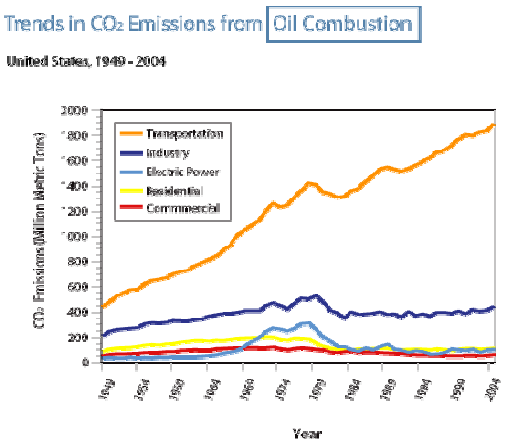
Project Goals/Objectives

•Raise public awareness of the effectiveness of fuel cells

•Explore the use of fuel cells as a supplement to oil

•Compile and examine the current policies and technologies, and, based upon these,

•Create a current and reasonable proposal for fuel cell use in public transportation systems



Hydrogen Generation

Typical hydrogen production methods include:
•Hydrolysis using external power from the grid or other sources
•Reformation from methane, gasoline, or other hydrogen carrier fuels (external and internal)
•Direct use of carrier fuels
There is, however, a method using $NaBH_4$ and a cobalt-boron catalyst that is extremely effective. By coming in contact with the catalyst, the stabilized $NaBH_4$ solution begins to produce hydrogen, a reaction that can be stopped by simply removing the catalyst, which is not consumed.
$NaBH_4(aq)+2H_2O \xrightarrow{\text{catalyst}} 4H_2 + NaBO_2(aq) + \text{heat}(217kJ)$
Producing hydrogen using this method right at the fueling stations will eliminate the need to compress or transport the hydrogen gas after it is produced, and the by-product is completely recyclable.

Conclusions

Current fuel cell technology is more than adequate for use in public transportation. Use of the hydrogen production method described above solves many fuel transport, safety, and cost issues. The costs and lack of infrastructure are significant problems, but overall the benefits of using them would be more than worthwhile. Implementing this technology in public transportation will put it on display and be an enormous step in the right direction.

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Images

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