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Hydrogen as an Alternative fuel for transportation

"What are the Advantages & Disadvantages?"

Class: Petroleum and Energy: Geopolitics, Economics, Strategy & Security

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Introduction:

- Hydrogen does not occur freely in nature. It can be modified by fossil fuel or by natural gas. This aspect indicates that hydrogen is like with the usage of electricity.
- The combination of oxygen from the air and water through electricity produce Hydrogen Fuel Cell. Sufficient electricity can be produced to power electric vehicle when hydrogen and oxygen from the air are fed into the proton exchange membrane fuel cell stack. Enough electricity can be produced to power electric vehicles.
- The usage of Hydrogen and fuel cell technologies will affect significant social, economical and environmental which will impact

Basic Facts on Hydrogen:

- Hydrogen distribution via high-pressure cylinders and tube trailers has a range of 100-200 miles from the production facility. For longer distances of up to 1,000 miles, hydrogen is usually transported as a liquid in super-insulated, cryogenic, over-the-road tankers, railcars, or barges, and then vaporized for use at the customer site.

- Hydrogen is one of two natural elements that combine to make water. Hydrogen is an energy carrier and it is not an energy source because it takes a great amount of energy to extort from water. One of the uses in terms of energy sources is in the use of batteries and fuel cell. Companies, nowadays, are trying to develop technologies that can efficiently take advantage of the use of hydrogen.

Advantages:

- Hydrogen can be stored as a compressed gas or liquid, or in a chemical compound.
- One of the ways to transport hydrogen is through pipelines, roads (via cylinders, cryogenic tankers, or tube trailers.
- One of the characteristics of hydrogen is that it burns nearly pollution-free, one can look at it as a final clean fuel. The process of hydrogen is that when it is burned, it transforms into heat and water vapor. Today in the type of engine which uses gasoline (an internal combustion) the combustion will produce small amounts of other gases. The other gases are mostly oxides of nitrogen as at it is used as two-thirds of nitrogen as hydrogen. When using hydrogen there is a free carbon dioxide. One of the main changes for the climate change today, is the burning and the use of fossil fuels.
- By using hydrogen to store energy from different sources would result in an unlimited supply of clear fuel.

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- Furthermore, as mentioned above, it is pollution-free, where no greenhouse gases are generated because as there is no carbon in the fuel. This creates drinkable water, which is what is exhausted from the vehicle.
- Use of hydrogen as an energy carrier, together with other alternative domestic fuels and technologies, can enhance long-term energy security while mitigating the effects of air pollution and greenhouse gas emissions.
- Technical challenges to developing cost effective hydrogen technologies include lowering the cost of hydrogen production, delivery, storage, fuel cells, and end-use applications. Hydrogen systems require effective safety codes and standards, not only to ensure that these systems are safe, but to help define design standards for future hydrogen vehicles and infrastructure. In addition, education and outreach are vital to raise awareness, accelerate technology transfer, and to increase public understanding of hydrogen energy systems.
- The use of hydrogen is that it can be cooled to produce liquid hydrogen.

Disadvantages:

- Hydrogen is a gas which can be compressed and stored in cylinders. One of the major problems is the fuel tanks. Hydrogen is compressed which will contain less energy compared to liquid fuels like ethanol or gasoline.
- Even though hydrogen is pollution-free, which in the future can make popular in transportation. However, some of the problem are: how to store hydrogen in vehicles and high costs (in comparison to gasoline).
- The usage of Hydrogen is not a very good fuel for internal combustion engine, It is not a very good fuel for an internal combustion engine. For example, the companies of BMW, Mazda, and Ford have done several tests; one of the most efficient ways to use it is in fuel cell vehicles, however this is still in the experimental stage which are still in the demonstration stage.

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- As mentioned in the advantages on the issue of transporting, the use of pipelines is limited to only a few countries and states. For example in the US: large hydrogen chemical plants and refineries are concentrated in California, Texas and Louisiana.
- Hydrogen must be produced from another energy source (upstream emissions unless renewable primary source is used).
- Currently, nearly all hydrogen produced and made is from natural gas. In that aspect, hydrogen costs more than natural gas.

Cost of Hydrogen Cars:

- As of October 2009, General Motors CEO Fritz Henderson noted that GM had reduced its hydrogen program because the cost of building hydrogen cars was too expensive. "It's still a ways away from commercialization", he said. The "Volt will likely cost around $40,000while a hydrogen vehicle would cost around $400,000. Most hydrogen cars are currently only available in demonstration models or in a lease construction in limited numbers and are not yet ready for general public use.

- In 2008, Hyundai announced its intention to produce 500 vehicles by 2010 and to start mass production of its Fuel Cell vehicles in 2012. In early 2009, Daimler announced plans to begin its Fuel Cell vehicle production in 2009 with the aim of 100,000 vehicles in 2012-2013. In 2009, Nissan started testing a new Fuel Cell vehicle in Japan.

The Cost of Hydrogen Fuelling Stations:

- According to the California Fuel Cell Partnership Report, Bringing Fuel Cell Vehicles to Market, "Opinions vary widely on the required minimum number of fueling locations needed to sustain a mass market fuel cell vehicle introduction, with some major fuel providers urging 25% or more of the existing 9,500 retail gasoline stations in California and at least one public agency suggesting that far fewer than 500 should suffice."
- The Fuel Cell Partnership report: "estimates average fueling station capital costs to be $450,000 per station for low volume, dedicated single-dispenser vehicle facilities. Converting one quarter, or 2,500 of California's gas stations to carry hydrogen would require capital expenditure of an estimated $1.125 billion. Capital costs for converting 500 stations would be $225 million".
- The Directed Technologies study: "estimates the cost for the hydrogen equivalent of a gallon of gas is $1.55 from the low-volume hydrogen dispenser. Despite the bigger capital cost for the high-volume system, it affords better economies of scale delivering hydrogen fuel for a gasoline equivalent of $0.87/gallon (untaxed)".

Cost Forecast

- Hyundai/Kia recently said that hydrogen fuel cell vehicles would cost $50,000 right now if 50,000 units were produced each year. The exact amount is difficult to estimate. However, Hyundai/Kia should be able to lower the cost of their hydrogen fuel cell vehicles by a massive cost by 2015, if this would happen.

- Toyota started their in-house hydrogen fuel cell vehicle program back in 1992. Moreover, Toyota invests nearly $1 million per hour in Research & Development. Therefore, what was estimated above, by Hyundai/Kia; Toyota is most likely in a couple of years to be ahead of them in terms of hydrogen fuel cell technology.

- Furthermore, Irv Miller, TMS group vice president, environmental and public affairs, made the following comment in August: “In 2015, our plan is to bring to market a reliable and durable fuel cell vehicle with exceptional fuel economy and zero emissions, at an affordable price.”

Examples of the use of Hydrogen in the world:

- **2003 – President George W. Bush announced in his 2003 State** of the Union Address a $1.2 billion hydrogen fuel initiative to develop the technology for commercially viable hydrogen powered fuel cells, such that "the first car driven by a child born today could be powered by hydrogen and pollution free." U.S. Secretary of Energy Spencer Abraham launched the International Partnership for the Hydrogen Economy (IPHE) to foster global cooperation in the development of hydrogen technology.
- **1999 – Europe's first hydrogen** fueling stations were opened in the German cities of Hamburg and Munich. The Royal Dutch/Shell Company committed to a hydrogen future by forming a hydrogen division. Also, a consortium of Icelandic institutions, headed by the financial group New Business Venture Fund, partnered with Royal Dutch/Shell Group, DaimlerChrysler (a merger of Daimler Benz and Chrysler) Norsk Hydro to form the Icelandic Hydrogen and Fuel Cell Company, Ltd. to further the hydrogen economy in Iceland.

Examples of the use of Hydrogen in the world:

- **1991 – Georgetown University in Washington, D.C. begins** development of three 30-foot Fuel Cell Test Bed Buses (TBB) as part of their Generation I Bus Program. In 2001, Georgetown finished their second Generation II bus, which uses hydrogen from methanol to power a 100kW fuel cell "engine."
- The **European Union**, for example, is engaged in fuel cell bus trials in several cities and foresees that 20% of transport fuel will come from hydrogen by 2020. Japan has a demonstration programme with 60 vehicles and 10 refueling stations and has plans to commercialize five million fuel cell vehicles by 2020.
- The **United States** is undertaking research and development leading to specific performance targets and a commercialization decision in 2015. Over 100 vehicles and 17 fuelling stations are being tested in the state of California alone.

Conclusion:

- Even though hydrogen is very expensive to produce and to store, it is pollution-free and creates drinkable water.
- In the end result the usage of hydrogen and fuel cell technologies can enhance and improve different aspects of our lives if its through economical, social and especially in environmental aspects.
- As seen from the example, given above, the usage of hydrogen for transportation use is grown and developing through the usage of technologies, making a clear environment to live in.

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