

Hydrogen Energy: An Innovative Advancement for Energy and Environment

Mahendra Pratap Choudhary[#], Vaibhaw Garg^{*}

[#] Associate Professor, Department of Civil Engineering, University College of Engineering,
Rajasthan Technical University, Kota, Rajasthan, India

¹choudhary_mp@yahoo.co.in

^{*} Assistant Professor, Department of Civil Engineering, University College of Engineering,
Rajasthan Technical University, Kota, Rajasthan, India

²vaibhawgarg@rediffmail.com

Abstract — The economic development of countries with increasing energy needs, the depletion of the fossil fuels, world competition and volatility of prices, the struggle at ensuring the security of supply, concerns about emissions of greenhouse gases, rapid climate change and the reluctance of people to change their behaviour put energy as top priority among the most important and difficult problems before the countries in today's world.

Researchers, Scientists, and governments have been advocating alternative fuels for decades. In recent years, hydrogen has been and is widely mentioned as part of the solution to these problems. Hydrogen is an efficient fuel to use to generate electricity. It is available in great amount and does not put negative effects like emission of harmful gases or greenhouse effect. Studies have proved that hydrogen energy is the only alternative fuel that can reduce this world's dependence on oil with reduced greenhouse effect. In this way use of this renewable energy is playing an important role in reducing future climate impacts and energy supply concerns. However, hydrogen has both distinct advantages and disadvantages as a fuel. A brief review about the concept of hydrogen energy, its advantages and disadvantages has been made in this paper.

Keywords— hydrogen, energy carrier, fuel cells, greenhouse effect, environmental pollution

I. INTRODUCTION

Our universe is a combination of different components and each element plays an important role in composition of the world. Hydrogen, oxygen and nitrogen are considered as some of the most important elements and found abundantly. About 75% of this universe is composed of hydrogen and helps different other matters to sustain. Hydrogen is an environmentally attractive fuel. It burns without producing carbon dioxide. It is however not a primary source of energy on earth. It only occurs in nature in combination with others elements, mainly with oxygen in water. But like electricity it can be used as an energy carrier once it has been unbound from the other elements. To get energy from hydrogen gas, it is mixed with oxygen that creates a chemical reaction in air medium. This reaction forms energy that is called hydrogen energy.

Electricity is presently the only energy carrier which does not create an environmental impact when used. Hydrogen has the same advantage. It is now of the utmost importance to evaluate if the development of a new infrastructure based on hydrogen as an energy carrier is possible, useful or even inevitable. Hydrogen is not a source but a storage medium and an energy carrier. Like any other carrier it must be produced from a primary energy source. Currently more than 80% of the world energy supply comes from fossil fuels, resulting in strong ecological and environmental impacts. Besides the exhaustion of reserves and resources, air pollution and modification of the atmospheric composition, with their impacts on climate and on human health, are now of primary importance. Greenhouse gas emissions, especially CO₂ produced by the combustion of fossil fuels, are in the centre of our environmental concerns. The consequence is that global warming will most probably occur.

II. WHY HYDROGEN ENERGY?

Hydrogen is high in energy, yet an engine that burns pure hydrogen produces almost no pollution. NASA has used liquid hydrogen since the 1970s to propel the space shuttle and other rockets into orbit. Hydrogen fuel cells power the shuttle's electrical systems, producing a clean byproduct - pure water, which the crew drinks.

A fuel cell combines hydrogen and oxygen to produce electricity, heat, and water. Fuel cells are often compared to batteries. Both convert the energy produced by a chemical reaction into usable electric power. However, the fuel cell will produce electricity as long as fuel (hydrogen) is supplied, never losing its charge.

Fuel cells are a promising technology for use as a source of heat and electricity for buildings, and as an electrical power source for electric motors propelling vehicles. Fuel cells operate best on pure hydrogen. But fuels like natural gas, methanol, or even gasoline can be reformed to produce the hydrogen required for fuel cells. Some fuel cells even can be fueled directly with methanol, without using a reformer.

In the future, hydrogen could also join electricity as an important energy carrier. An energy carrier moves and delivers energy in a usable form to consumers. Renewable energy sources, like the sun and wind, can't produce energy all the time. But they could, for example, produce electric energy and hydrogen, which can be stored until it's needed. Hydrogen can also be transported (like electricity) to locations where it is needed.

Hence, the most important reasons to opt for hydrogen as a promising energy carrier are as follows:

The first one is the diversification of the energy sources and the reduction of dependency on fossil fuels. Since hydrogen can be produced from any primary source, it could improve the reliability of the energy supply and stabilize the energy market. It would make the utilization of energy more independent from the production and allow the economic exploitation of energy sources remote from the consumers.

The second reason is the reduction of the environmental impact of the energy system. Indeed most of the anthropogenic impacts on the environment come from the combustion of fossil fuels in the industrial, domestic and transport sectors. Using an energy carrier that is carbon free would reduce most of the related environmental problems. The fear of climate change is bound to make us decrease the emission of greenhouse gases.

The third reason is the control of acceptable costs and the hope of stable prices over time. The supply of energy at reasonable and stable prices is not ensured at all by the producers of crude oil or natural gas. Hydrogen facilitates the diversification of the sources and contributes to the reliability and security of the energy supplies that are needed to secure the world economy.

Hydrogen shows outstanding environmental characteristics at the point of utilization. It can be obtained from any primary source, often without recourse to electricity. It is very efficient to use but contains little energy per unit volume. While hydrogen is generally easier to store than electricity, its storage is in need of much improvement. No comparison between hydrogen and electricity as energy carriers has been performed as reliable and significant studies and data are presently lacking. Especially a comparison of transport costs, or the full analysis of the energy chain from the primary source to typical end users, was not made because the cost estimates and their forecast change too rapidly.

III. ADVANTAGES OF HYDROGEN ENERGY

1. The biggest advantage of using hydrogen energy for electricity generation is its pollution free nature. This renewable source of energy reduces pollution when used as fuel of fuel cell with electric

vehicles. Its usage neither leaves carbon footprint nor increases greenhouse effect.

2. Using hydrogen as fuel is another advantage associated with this renewable source. When hydrogen is used as fuel, it gives more sufficient results as compared to other fuels like gasoline or diesel. Using hydrogen is very cheap as well as compared to all other sources.
3. Use of hydrogen energy for security purposes is another benefit. It protects one country in situation of war in form of hydrogen bomb.
4. Maintenance of this energy source is very easy, as we never have to do a lot for its protection.

IV. DISADVANTAGES OF HYDROGEN ENERGY

1. Hydrogen power needs large budget. Cost factor affects efficiency of this source the most.
2. Hydrogen is found in many organic materials, but to get it for use from these materials process of water electrolysis is must. This process is also increasing cost of this energy.
3. Production, transportation, distribution and storage of hydrogen are difficult.
4. Fuel cells used with hydrogen power are large in size as compared to engines or batteries used with other renewable energy sources.

V. CONCLUSIONS

Although a drastic change of the energy system appears inevitable, the quantitative prediction of the role that hydrogen will play is most difficult. The competition between electricity and hydrogen as energy carriers will increase and debates on this topic will be numerous and lively. It is nevertheless possible that both solutions will coexist. Taking into account the economic, social and technological interests at stake, it is of primary importance to further evaluate the prospects of hydrogen as a new energy carrier and the synergies which will necessarily develop with electricity. For hydrogen as well as for electricity, major technological innovations will occur and will lead to the development of very large markets.

Therefore, the following points need to be considered for the hydrogen energy concept:

1. The governments should promote and support research and pilot projects for reducing greenhouse gases emissions.
2. The hydrogen energy concept should be introduced within the curricula of schools and universities.
3. As coal is likely to remain a permanent source of primary energy for many decades, studies on carbon

dioxide capture and storage should be enhanced to the benefit of both electricity generation and hydrogen production.

4. As nuclear energy is likely to remain a major source of primary energy, the nuclear expertise should be maintained and research fostered on new nuclear reactors for hydrogen production and / or electricity generation.
5. As reliable technical and economical data can only be obtained by practical experience, demonstration projects should be initiated, supported or enhanced in the various fields of hydrogen production, storage, transport and utilization.

REFERENCES

- [1] <http://money.usnews.com/money/personal-finance/articles/2008/01/11/the-pros-and-cons-of-8-green-fuels>
- [2] <http://www.eia.gov/totalenergy/data/annual/index.cfm>
- [3] <http://www.renewableenergyworld.com/rea/tech/hydrogen>
- [4] <http://www.alternative-energy-news.info/technology/hydrogen-fuel>
- [5] <http://www.nrel.gov/hydrogen>