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HYDROGEN AS AN ALTERNATIVE RENEWABLE ENERGY PERSPECTIVE: A CONCISE REVIEW

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Abstract
Our fossil fuel-dependent economy can transition to a hydrogen economy using hydrogen as an energy carrier, which might then supply an emissions-free source of transportation fuel. The two primary research approaches were independent research and literature reviews. Due to the distinctive low density of hydrogen, storage and transportation of hydrogen are topics of significant investigation. The issue of anthropogenically induced climate change and its unbreakable connection to the current and future energy requirements of our global society are possibly the greatest threat to our planet. With its ability to help with issues of environmental emissions, sustainability, and energy security, hydrogen is now widely recognised as one important component of a potential energy solution for the twenty-first century. With minimal to no negative environmental effects both locally and internationally, hydrogen has the potential to be used as a source of energy for transportation, distributed heat and power generation, and energy storage systems.

Keywords: *Hydrogen, Energy, Production, Storage, Resources.*

Introduction

Hydrogen is a diatomic gas with the chemical formula H_2 that is harmless, non-metallic, tasteless, colourless, and highly flammable at standard temperature and pressure. An appealing alternative fuel is hydrogen. However, hydrogen is not a primary energy source like coal, gas, or oil. As a secondary "energy carrier," it is more like electricity in that it must first be created using energy from another source before being delivered to a location where its latent chemical energy can be fully realised. Diverse resources, both renewable (hydro, wind, wave, sun, biomass, and geothermal), can be used to produce hydrogen (coal, natural gas and nuclear). The only by product at the time of use is water, and it can be stored as a fuel and used in distributed heat and power generation systems, fuel cells, internal combustion engines, and turbines [Crabtree at el. 2017].

Due to the quick development of fuel cell technology over the past ten years, the significance of hydrogen as a possible energy carrier has substantially increased. Fuel cells that run on hydrogen or fuels rich in hydrogen have the potential to play a significant role in accelerating the transition to a sustainable energy system with low carbon dioxide emissions in the future. The eventual establishment of a hydrogen-based economy has the potential to bring about significant economic and environmental gains as well as increased energy supply security. The potential to significantly lower carbon emissions globally is perhaps the strongest argument in favour of a sustainable hydrogen economy [Dorian at el. 2012; Ewan 2005]. However, there are considerable scientific, technological, and socioeconomic challenges to the adoption of hydrogen as the clean energy in the transition from a carbon-based (fossil fuel) energy system to a hydrogen-based economy. But any switch from a carbon-based (fossil fuel) to a hydrogen-based economy is fraught with formidable scientific, technological, and social obstacles. This succinct paper seeks to explain the reasons behind the rising demand for hydrogen energy around the world and looks at some of the key concerns affecting how hydrogen will evolve as an energy source in the future.

Hydrogen production and distribution

The third most common chemical element in the crust of the Earth is hydrogen, but it is almost always found in chemical combinations with other elements. It must consequently be created using energy, like as heat or electricity, from other sources that include hydrogen.

At present, hydrogen is produced in large quantities from fossil fuels by Steam Reforming of natural gas and partial oxidation of coal or heavy hydrocarbons. These processes are now the least expensive and most well-established for the large-scale production of hydrogen and can benefit from economies of scale. There are two steps to the entire process. The hydrocarbon raw material is combined with steam and supplied into a tubular catalytic reactor in the first stage. With less CO_2 present, syngas (a combination of H_2 and CO gas) is created during this process. When a portion of the raw material (heated gas) inside the reactor is burned, oxygen or air is added to raise the reaction temperature as needed. The second stage involves feeding the CO catalytic converter with the cooled product gas, where carbon monoxide is largely transformed by steam into carbon dioxide and hydrogen. (As shown in Figure 1)

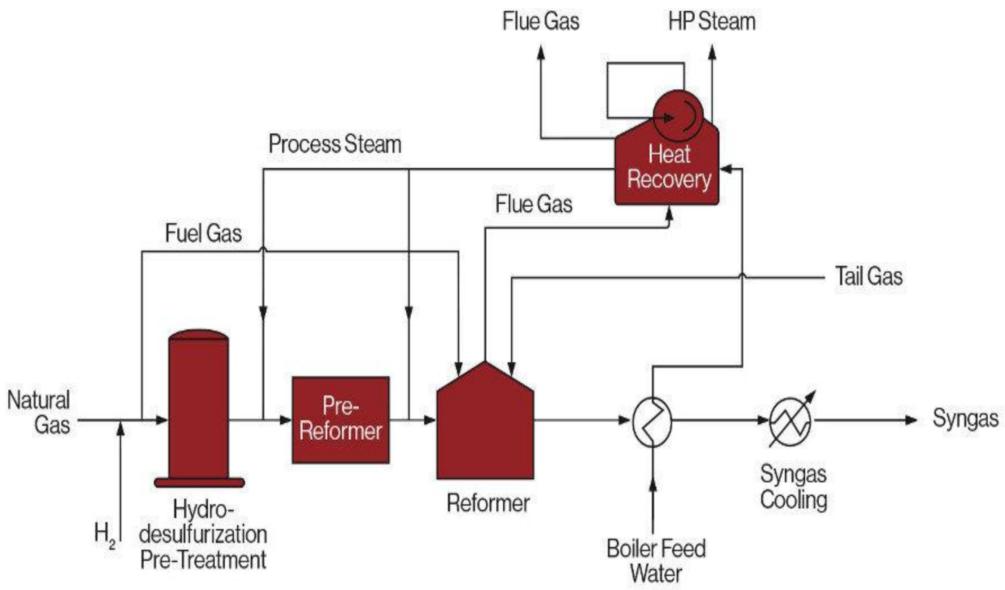

Figure.1. Schematic diagram of steam reforming process

However, it is evident that we must transition to a situation where hydrogen is produced from non-fossil resources, chief among them being water, in order to reap the benefits of a truly sustainable hydrogen energy system [Sherif et al. 2005; Penner 2018]. Water can be divided into hydrogen and oxygen through a number of methods, including photo-electrolysis, high-temperature decomposition, electrolysis, and photo-biological water splitting. Although the commercial electrolysis of water produces hydrogen with a 75% efficiency, the price of hydrogen is now far greater than that of hydrogen derived from fossil fuels [Dutton 2002; Ewan & Allen 2005; International Energy Agency 2006].

If one could actually show that such a technique could be employed to produce the necessary enormous volumes of hydrogen, the biological reformation of biomass utilising microorganisms and fermentation is plainly appealing. This process emits carbon dioxide, but additional biomass can grow to recycle it. The photocatalytic technique, which uses solar energy to split water straight into its component parts, hydrogen and oxygen, without the usage of power, will be the holy grail of hydrogen production. In order to divide water from our seas, this optimal manufacturing route therefore harnesses "solar hydrogen," the power of the Sun. According to a recent US Department of Energy (DoE) research, solar photodecomposition of water is most likely the only significant, long-term solution to a CO_2-free route for the mass generation of the enormous volumes of H2 required for the development of the hydrogen economy [US Department of Energy, Office of Science 2003]. The development of novel materials, emerging physical phenomena, and unique methods are required for low-cost and effective solar energy production of hydrogen.

Hydrogen storage

Many people believe that one of the most important and technically difficult obstacles to the widespread use of hydrogen as a reliable energy carrier is the availability of viable hydrogen storage (Crabtree et al. 2017; Harris et al. 2004). In terms of energy per unit of weight, hydrogen is the most energetic substance. Unfortunately, it also has a very low energy density per unit volume because it is the periodic table's lightest chemical element. Two different kinds of hydrogen storage systems—one for stationary uses and the other for transportation—will be necessary for the hydrogen economy. Both have unique demands and limitations. In the coming hydrogen economy, the transportation industry is anticipated to be the first large-scale user of hydrogen. In comparison to stationary uses, hydrogen storage requirements for transportation applications are much stricter.

Currently, the two main types of hydrogen storage are cryogenically chilled (liquefied) fluid hydrogen and high-pressure gas containers. Traditional steel cylinders have a gravimetric density of about 1 wt% and can store hydrogen at 200 bar. With a gravimetric hydrogen density of up to 10%, recently created ultra-high density composite cylinders composed of high-grade carbon fibre can store hydrogen at pressures in the range of 700–1000 bar.

The family of ionic-covalent hydrides generated by light elements including lithium, boron, sodium, magnesium, and aluminium are the most promising hydrogen storage materials. With the exception of $NaAlH_4$, which can act as a reversible store with the right catalysts, high-temperature solid-phase transitions are often involved in the hydrogen absorption or desorption in these materials. Recently, fresh, promising hydrogen storage materials have been ffound [Chater et al. 2006], and new chemical pathways have been devised for triggering hydrogen uptake/release under benign conditions [Johnson 2005]. To satisfy the needs for hydrogen storage, however, much more fundamental study is needed to comprehend the physical and chemical processes driving hydrogen storage and release as well as to enhance the features of hydrogen absorption and desorption in this class of materials.

Hydrogen utilization

One of the most alluring paths to a sustainable energy future is the synergistic complementarity of hydrogen and electricity, and fuel cells offer, arguably, the most effective means of turning hydrogen and other hydrogen-bearing fuels into power. Similar to a battery that is constantly being recharged, a fuel cell produces electricity through the electrochemical reaction of hydrogen and oxygen from the air.

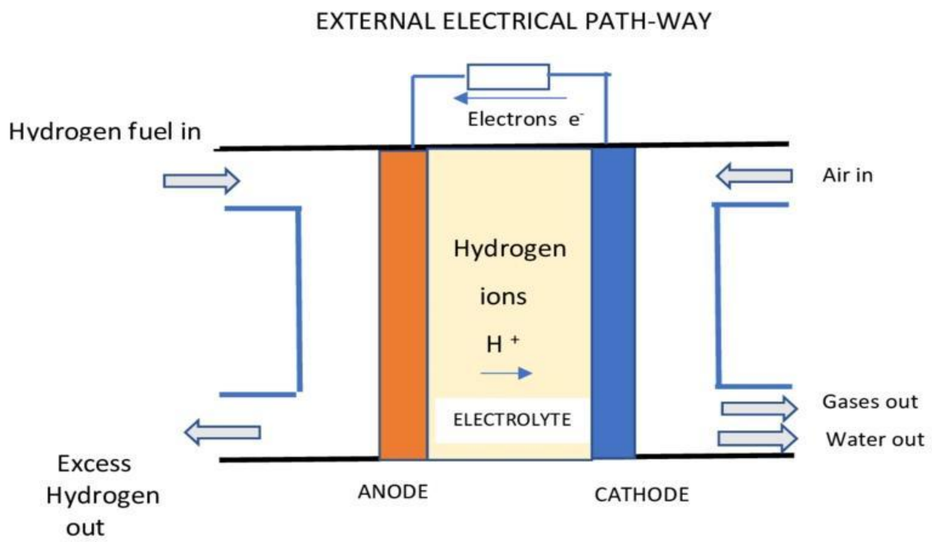

Figure.2. Schematic diagram of hydrogen fuel cell

In the future, fuel cells could replace more harmful internal combustion engines in stationary and mobile distributed energy applications. Because hydrogen fuel cells operate in the 60 to 120°C temperature range, which is significantly lower than the typical operating temperature of internal combustion engines, they generate just water and almost no other pollutants, including nitrogen oxides [Winter & Brodd 2004]. If hydrogen fuel could be obtained from renewable sources, hydrogen-powered fuel cell vehicles might theoretically provide a path to actual (i.e., whole life cycle) zero emissions.

There is a very real possibility that much of the existing energy systems will be replaced by fuel cells. They provide a very alluring technological development path that will result in large efficiency improvements over the commercially accessible hydrocarbon fuels of today and high efficiency when hydrogen is used as an alternative energy source in the future. However, a number of significant technological obstacles still need to be cleared before fuel cells can successfully compete with traditional energy conversion technologies. Cost reduction and better component and material durability are the main scientific and technical problems facing fuel cells.

Conclusions

Hydrogen has a remarkable potential to play a significant role in accelerating the shift from our current carbon-based global energy economy to one that is clean, renewable, and sustainable. In order to address growing concerns about carbon emissions and climate change, as well as the future availability and security of energy supply, the development of hydrogen generation, storage, and usage technologies is expected to play a key role. In many nations, hydrogen and fuel cells are regarded as significant alternative energy sources and essential technologies for upcoming sustainable energy systems in the stationary power, transportation, industrial, and residential sectors. The problems of developing a new energy economy, one that is not dependent on carbon fuels, are tremendous, however, and call for significant technology advancements, as well as scientific breakthroughs.

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