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TECHNOLOGIES FOR HYDROGEN AS AN ALTERANATIVE FUEL FOR USEFULL APPLICATIONS

VISHALA I L[1], SANJAY B[2]

Asst.Prof, Dept of ECE SJCIT, CHICKKBALLAPUR KARNATAKA[1]

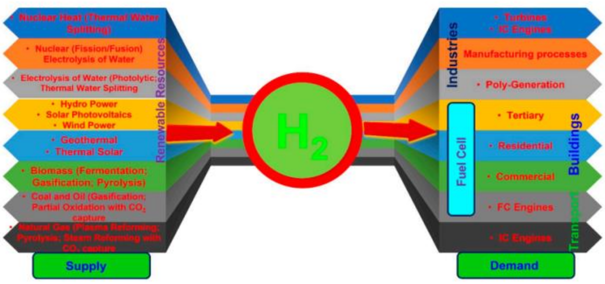
UG Student, Dept of ECE SJCIT, CHICKKBALLAPUR KARNATAKA[2]

Abstract: The general rise in environmental and anthropogenically induced greenhouse gas emissions is driven by worldwide population growth and a growing appetite for clean energy, industrial production and consumer consumption. Moreover, well-established, developed and emerging countries are looking for fossil fuel and petroleum resources to support their aviation, power utilities, industrial sectors and consumer processing needs. As emerging technological advances in clean energy technologies progress, there is a growing trend to overcome these challenging concerns and achieve the Paris Agreement priorities. Hydrogen is expected to be implemented in various manufacturing applications as a fundamental fuel in the development and production processes of future energy carrier materials. This paper summarizes recent developments and hydrogen technologies in fuel refining, hydrocarbon processing, materials manufacturing, pharmaceuticals, aircraft construction, electronics and other hydrogen applications. It highlights the existing industrialization scenario and describes expected innovations including theoretical scientific advances, production of green raw materials, potential exploration and renewable resource integration. Furthermore, this article discusses some of the future socioeconomic implications of hydrogen as a green resource.

INTRODUCTION

The global The global community regards sustainable development as a long-term issue because of the continuing challenges posed by dwindling fossil fuel supplies and deteriorating environmental conditions. The primary drivers of this fundamental change are rising energy demands, volatile fossil fuel prices, and massive greenhouse gas (GHG) emissions from fossil-fuel-powered vehicles and industries. With the global population expected to exceed 8 billion by 2030, energy demand is expected to rise simultaneously. Renewable energy sources such as wind, solar, hydro and geothermal have gained much attention in recent decades. This type of energy does not produce gaseous or liquid transportation fuels. Their irregular and sparse existence limits their applicability. Furthermore, invasive plants, food wastes (especially wood chips and agricultural crop waste) are also widely available for transformation into low-cost and clean energy production. Energy is an essential element of human life, social civilization and economic growth. For twenty decades, traditional fossil fuels such as coal, gasoline and natural gas have been used, leading to unsustainable oil consumption, uncontrolled exploitation and significant pollution. As a result, these non-renewable commodities are approaching degradation and exhaustion at an alarming rate. In particular, the continuous growth of global population and rapid economic change are continuously increasing energy consumption and exacerbating the energy crisis. Moreover, there has been negligible environmental pollution due to overuse and overuse of fossil fuels. As a result, most countries are eager to develop an alternative supply of renewable energy

SUPPLY AND DEMAND



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Industrialization in traditional oil upgrading sectors such as hydro-desulfurization hydrogenation and ammonia refining has recently experienced a dramatic increase in the demand for hydrogen. In industrial processing, most liquid-compressed hydrogen gas is produced commercially using the compression method due to its cost-effectiveness and readily available hydrogen supplies. However, hydrogen can be produced from renewable resources such as lignocellulosic biomass or water separation through solar energy. Hydrogen can be obtained in a variety of ways from different sources such as microorganisms, biofuels, petroleum-based liquids or electrolysis of water. An illustration of various hydrogen production methods is shown in Figure 2. Chemical thermal reforming is based on the catalysis of methane using steam to produce carbon dioxide and hydrogen. The formed CO then interacts with water vapor to produce H2 and CO2 via a water-gas shift reaction. Multiple hydrocarbon-based routes to hydrogen production include advanced alkaline reforming, thermal cracking modification, partial oxidation, and steam reforming.

HYDROGEN PRODUCTION TECHNOLOGIES

While hydrogen Although hydrogen has impressive power generation potential, only a limited fraction is utilized for such activities. Significant amounts of commercially produced hydrogen are used in a variety of fields, including metalworking, oil refining and recycling, fertilizers, and chemical processing. In the area of hydrogen processing and storage, several important research articles have been published. However, with the development of modern hydrogen industries, evidence of the availability of new hydrogen applications is limited, especially in the aerospace, marine and pharmaceutical industries. Since hydrogen does not exist naturally as a molecule, it is synthesized by converting some hydrogen-containing primary source, such as water or carbohydrate. Current estimates indicate that about 48%, 30%, and 18% of hydrogen is derived from natural gas, naphtha reforming, and coal gasification, respectively. Regrettably, most conventional methods of producing hydrogen from fossil fuels lead to significant emissions of greenhouse gases, increasing environmental pollution and high energy consumption. As a result, there is a greater focus on deploying emerging technology for hydrogen production from sustainable and nuclear sources, in conjunction with increasingly stringent and applicable environmental protection laws globally. These potentially transformative developments include water electrolysis, biomass, and nuclear/chemical conversion pathways. Despite these facts, hydrogen production can affect the ecosystem because any system that relies on current or new technology consumes a certain amount of raw chemicals and electricity, resulting in a net environmental loss. We cannot critically analyze the economic and environmental benefits of various hydrogen production technologies unless we have comprehensive knowledge of each aspect of the mechanical process. This research seeks to strengthen current research on the following hydrogen production technologies and their applications: refining of petrochemical/hydrocarbon fuels, additive manufacturing, hydrocarbon processing, fuel cells, materials synthesis, electronics, pharmaceuticals, ship and aircraft industry, and other hydrogen applications. The article summarizes the challenges and progress related to the use of hydrogen.

Preparation of Hydrogen by Laboratory Method

The laboratory preparation of hydrogen can be briefly described as follows.

This is a frequently used method of hydrogen production. Hydrogen is produced when granulated zinc reacts with dilute hydrochloric acid. We use this method for hydrogen production. Also, zinc can also produce hydrogen by reacting with aqueous alkali. The following response explains this by clarifying.

$Zn+2NaOH \rightarrow Na2ZnO2+H2$

Oxidation

Partial oxidation occurs when ethanol is saturated with oxygen and gives off hydrogen and carbon-monoxide.

$C2H5OH + (1/2)O2 \rightarrow 2CO + 3H2, \quad \Delta H0 = +14$ kJ/

Heat is generated in small quantity.

$CO + H2O \rightarrow CO2 + H2, \quad \Delta H0 = -41$ kJ/mol.

Preparation of Hydrogen by a Commercial Preparation Method

There are various methods of commercially producing hydrogen and this is another method of hydrogen production. Following are some generalized methods used.

1. Hydrogen is produced when acidified water is electrolysed using platinum electrodes.
2. To obtain high purity hydrogen, we can electrolyze a warm aqueous barium hydroxide solution between nickel electrodes.
3. Hydrogen is also formed when the stream reacts with hydrocarbons at particularly high temperatures in the presence of certain catalysts. For example, methane reacts with water at 1270K in the presence of nickel to produce carbon monoxide and water.

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CH4(g)+H2O(g)→CO(g)+3H2(g))
The mixture of carbon monoxide and water is popularly known as water gas. This water gas is used to synthesize methanol and many other hydrocarbons and hence is also known as 'syngas' or synthesis gas. This synthesis gas is made from sewage, scrap wood, sawdust and related materials. We can also make coal from coal, and this process is called 'coal gasification'. An increase in the production of hydrogen gas can be done by reacting the carbon monoxide stream of the synthesis gas in the presence of iron chromate as a catalyst at temperatures up to 673K.

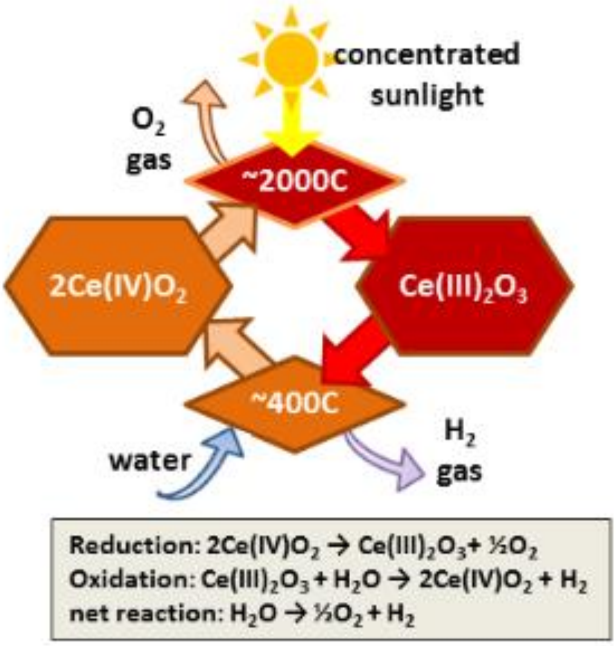
CO(g)+H2O(g)→CO2(g)+H2O(g)
The reaction given above is called water-gas shift reaction. Currently, the largest percentage of hydrogen gas is produced from petrochemicals, some from coal, and a small percentage from electrolysis of aqueous solutions.

Industrial Preparation of Hydrogen
An essential industrial method for hydrogen production is the catalytic steam-hydrocarbon process.

CnH2n+2+nH2O→nCO+(2n+1)H2

CnH2n+2+2nH2O→nCO2+(3n+1)H2

Thermolysis
Thermochemical water splitting processes use high-temperature heat (500°–2,000°C) to drive a series of chemical reactions that produce hydrogen. The chemicals used in the process are reused within each cycle, creating a closed loop that consumes only water and produces hydrogen and oxygen



DARK FERMENTATION
Dark fermentation is a type of biological production of hydrogen. Dark fermentation is carried out by obligate anaerobes and facultative anaerobes in the absence of light and oxygen.

In dark fermentation, bacteria act on the substrate and generate hydrogen. The substrate for the dark fermentation is lignocellulosic biomass, carbohydrate materials like wastewater from industry, sugar-containing crop residues, and municipal solid waste.

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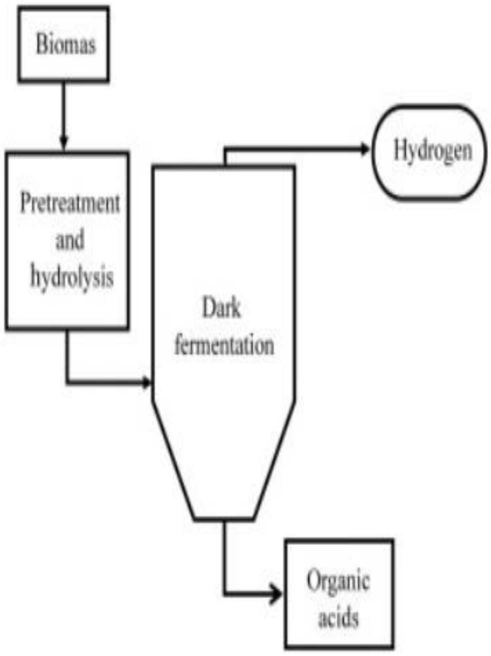
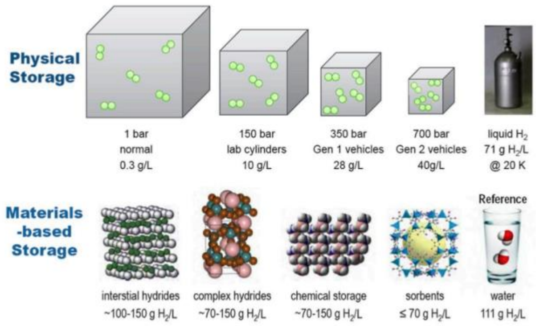


STORAGE OF HYDROGEN

STORAGE PROCESS

Considerable safety precautions are required to preserve hydrogen in a liquefied state at pressures above 100 MPa and at cryogenic temperatures of about −253 ◦C. Many researchers are interested in innovative hydrogen storage materials, such as carbon nanostructures, metal and recently discovered complex hydrides [50]. Hydrogen storage in solid form does not require high or significantly low cryogenic temperatures, making it a safer and more cost-effective method of hydrogen storage. Commercial deployment of hydrogen in industry requires efficient packaging, storage and transportation. Further investigation is needed to ensure that the material for H2 storage shown in Figure 5 is safe, reliable and affordable. The concept of hydrogen storage is recognized as challenging. Materials used must not actively interact with hydrogen or any other process. Additionally, conventional storage methods using high-pressure gas cylinders (compressed hydrogen) and liquid hydrogen; Physical adsorption of H2 on materials with significant variables such as large specific surface area; and complex hydrides leading to hydrogen intercalation in metals and H2 deposition in metals are thoroughly reviewed.



GREEN HYDROGEN ECONOMY ON MOVE

The first element in the periodic table is Hydrogen and it cannot be subdivided into other elements through chemical reactions. Hydrogen is unique in that it is the most basic and abundant natural element, and is designated by the letter H. Hydrogen is very important in the world of chemistry. In fact, it is so reactive that when mixed with other elements it always forms a single entity (substance). Compounds are made up of two or more elements of the same or different atoms that form when hydrogen forms a bond with another element.

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ADVANTAGES

- No vehicle emissions other than water vapor.
- Fuel economy equivalent to about twice that of gasoline vehicles.
- Hydrogen is abundant, and can be made from renewable energy.
- Pollution free.

FUTURE RESEARCH

Hydrogen is a viable alternative energy source that emits no carbon. Hydrogen is an excellent choice for a carbon-free society and to aid in the hydrogenation process (using hydrogen as the main energy source). Each hydrogen production method has its own unique requirements and activities to overcome these limitations. Many alternative hydrogen production methods are employed for various purposes. No single technology can achieve all objectives to reach the goal of optimal, reliable, cheap, clean and efficient hydrogen production.

CONCLUSION

The main objective of this paper is to propose solutions to specific problems related to the importance of hydrogen in futuristic energy systems, its conceivable implementations and widespread use of hydrogen energy systems.The development of hydrogen energy systems is increasing as evidenced by the historical change in fuel consumption. As industrialization phased out wood-burning technologies, the content of hydrogen as a fuel continued to increase rapidly. Coal was replaced by lighter fossil fuels such as oil and subsequently natural gas. The ultimate objective is to reduce GHG emissions by eliminating the overall carbon content of fuels.Currently, more than 90 percent of worldwide hydrogen production is derived from fossil fuels for energy and raw materials. This amount should be reduced as much as possible to eliminate or reduce fossil-fuel-related GHG emissions. Hydrogen-powered ammonia production is currently a major industry. Hydrogen is consumed in significant quantities by the chemical and processing sectors. By developing the full range of hydrogen energy systems, including production, distribution and consumption, and public acceptance, the energy sector of the hydrogen industry is predicted to become its most important component in the near future.

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