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HYDROGEN PRODUCTION WITH THE HELP OF WATER ELECTROLYSIS

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ABSTRACT: Water electrolysis is a quite an old technology started around two centuries back, but promising technology for hydrogen production. This work reviewed the event, crisis and significance, past, present and way forward for the various water electrolysis techniques. In this work thermodynamics, energy requirement and efficiencies of electrolysis processes are reviewed. Alkaline water electrolysis, polymer electrolysis membrane (PEM) and High temperature electrolysis are reviewed and compared. Low share of water electrolysis for hydrogen production is thanks to cost ineffective, high maintenance, low durability and stability and low efficiency compare to other available technologies. Current technology and knowledge of water electrolysis are studied and reviewed for where the modifications and development required for hydrogen production. This review paper analyzes the energy requirement, practical cell voltage, efficiency of process, temperature and pressure effects on potential kinetics of hydrogen production and effect of electrode materials on the conventional water electrolysis for Alkaline electrolysis, PEM electrolysis and heat Electrolysis .

KEYWORDS: Hydrogen Production, Water electrolysis, Electrolyte, Electrode, Electro catalyst, PEM.

INTRODUCTION

The atmosphere is polluted by many greenhouse gases; SOx, NOx, CO2 and CO from hydrogen production by hydrocarbon source that are fuel sources which can affect seriously the ecosystem. Hence the clean technology is required for production of hydrogen which will be achieved if hydrogen is produced by renewable source like water electrolysis and no emission of SOx, NOx, CO2 and CO are going to be possible and to realize “hydrogen economy”[1]. There are many important non-fossil fuel based processes like Water electrolysis, photo catalysis processes and thermochemical cycles for hydrogen productions in practice. The utilization of solar power and wind energy are sustainable methods for hydrogen production by water electrolysis with high purity, simple and green process[2].

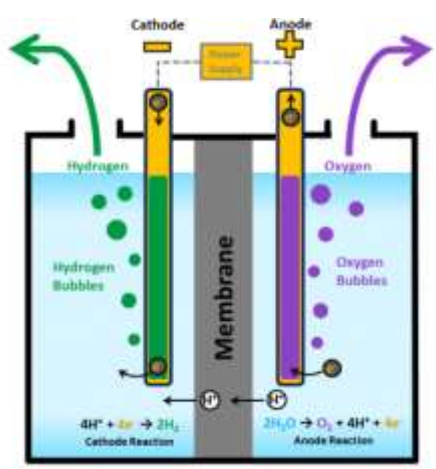

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Figure 1: Electrolysis[3]

A DC electrical force source is associated with two anodes, or two plates (regularly produced using some inactive metal, for example, platinum or iridium) which are set in the water. Hydrogen will show up at the cathode (where electrons enter the water), and oxygen will show up at the anode.[4] Assuming ideal faradaic productivity, the measure of hydrogen created is double the measure of oxygen, and both are relative to the all-out electrical charge directed by the solution.[5] However, in numerous cells contending side responses happen, bringing about various items and not exactly ideal faradaic effectiveness.

Electrolysis of unadulterated water requires overabundance energy as over potential to conquer different initiation boundaries. Without the overabundance energy, the electrolysis of unadulterated water happens gradually or not in the slightest degree. This is partially because of the restricted self-ionization of water. Unadulterated water has an electrical conductivity around one-millionth that of seawater. Numerous electrolytic cells may likewise come up short on the imperative electro catalysts. The productivity of electrolysis is expanded through the expansion of an electrolyte, (for example, a salt, a corrosive or a base) and the utilization of electro catalysts.

Presently the electrolytic cycle is once in a while utilized in mechanical applications since hydrogen can right now be delivered all the more reasonably from petroleum products. For hydrogen production, water electrolysis has its various merits like pollution free process if renewable energy sources use purity of high degree, very simple process and many of resources. Water electrolysis is an around 200 year old technology; around 1800 AD the principle demonstrated by experiment by J. W. Ritter in Germany. Within the same year William Nicholson and Anthony Carlise decompose water into hydrogen and oxygen in England. The appliance of this technology started to use after tens of year. The French military in 1890 AD constructed a water electrolysis unit to get hydrogen to be used in airships by Charles Renard. Around 1900 AD quite 400 industrial electrolyzers were operating worldwide. Around 1930 AD different sorts of alkaline electrolyzer were developed[4]. Within the 1970s AD, the development of the PEM electrolyzer offered several advantages over alkaline electrolyzers with limited use in small hydrogen and oxygen production capacities thanks to expensive materials and a limited lifetime. As hydrogen might be produced at lower cost by steam reforming, water electrolysis technology advanced only slowly.

The hydrogen production in total round the world is about 500 bill. Nm^3/year, mostly steam reforming[5]. Only 4 you look after hydrogen produced by water electrolysis as shown in figure 1. Thanks to low efficiency of production processes. Currently, the efficiency hydrogen production by water electrolysis is just too low to be economically competitive. The low gas evolution rate and high energy consumption are serious problems of water electrolysis. In average 4.5–5.0 kWh/m3H2 energy is needed for conventional industrial electrolyzer. In water electrolysis for hydrogen production processes the efficiency is a very important parameter. Many researchers in their work have done for analyzing the energy consumption, efficiency of hydrogen production systems[6]. The authors defined the energy, energy analysis, energy efficiencies, different driving energy inputs, definition of the efficiency, thermodynamic analysis, thermodynamic electrochemical characteristics, thermodynamic losses, system boundary and warmth flows across

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the method of a hydrogen production process in different electrolyzer plants. This review paper analyzes the energy requirement, practical cell voltage, efficiency of process, temperature and pressure effects on potential, bubble mechanics and effects , kinetics of hydrogen production and effect of electrode materials on the traditional water electrolysis for Alkaline electrolysis, PEM water electrolysis and heat electrolysis[7] .

CONCLUSION

Alkaline water electrolysis is easiest and simplest methods for hydrogen production. Less efficiency is one among the good disadvantages in order to widespread use of this system. Effort for development and research needed to over comes the disadvantages like energy consumption, cost and maintenances, durability, reliability and safety. The thermodynamic analysis shows the energy requirements theoretical and actual, resistances offered by system and also discussed different efficiencies, these parameters will help to identify the key problems in way to improvement. The kinetic analysis indicates the reaction rate in alkaline solution, ion transfer electrode surface activity and also effect of various electrolytes and additives on production. within the direction of improving this application the research have to consider significantly for reduce electrochemical reaction resistance, possibilities of low cost electrodes, electro catalysts, electrolytes and its additives to increase ionic mass transfer, corrosive resistive electrolytes and electrodes for durability of electrolyzer to scale back electrode physical phenomenon , electrode surface profile modifications and surface coatings, and more importantly, managing the gas bubble resistances. Improve the catalytic activity for HER and OER by using binary, ternary or quaternary alloys with an advanced design, improving the electrochemical active surface area, catalyst utilization, and stability against corrosions, development of highly conductive supportive catalyst, Understand and improve the triple-phase-boundary improve the proton transport across the catalytic layer, understand the water transport across the triple-phase boundary.

For the anode, find catalyst alternatives to exchange scarce iridium or unstable ruthenium are going to be considered an excellent achievement. New catalyst configurations or designed structures (e.g.: core-shells, BMGs, NTSFs, nanostructures, tuned alloys) could provide the necessary condition to decrease the quantity of iridium or stabilize the ruthenium dissolution over time. For the cathode, improve the catalyst stability (especially when supported on carbon materials), explore alternative supports other than carbon and investigate metal-free N-CNTs catalysts. Also important, is to explore the use of high surface area carbon materials (carbon blacks, CNTs, graphenes) with adjusted pore size, functional groups, grafted polymers and electrical conductivities for the aim of achieving higher activities and stability. Use innovative synthesis methods to supply new support materials, catalysts, and electrode systems.

Development of membrane alternatives to Nafion with advanced membrane synthesis methods, resulting in electrolytes with higher proton transport but providing at an equivalent time lower gas crossover and higher durability is required. This could be done by; using membrane composites or blends, adding inorganic or organic fillers, or introducing molecular barriers to the electrolyte. This review has also captured and documented in one place much of the varying jargon that has been used throughout the first development to today. Finally, we outlined our idea of the direction the future research should proceed in order to develop PEM electrolyzers as a reliable, cost

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effective solution to help solve the issues related with renewable energy. High-temperature alkaline electrolysis cell performances are tested at various current densities a wide selection of pressure and temperature with various anode and cathode materials are compared and showed an excellent deal of performance enhancement. Although the results are encouraging, further study is required to completely understand the explanations for the observed dramatic decrease in terminal potential, the possible effects of product mixing and/or electrode corrosion must be determined. The appliance of superheated steam to the cell for water replenishment, and other improvements required for long-term cell characterization. In summary, this review could help provide a basis for the development of a new generation of alkaline electrolysis systems based on very high temperature and pressure operation. Pressurized electrolysis required consistently smaller work and total (work and heat) energy inputs. Further, the percentage of labor composing total energy for pressurized electrolysis is greater; suggesting the prospects of integrating an electrolysis system with external thermal sources needs consider both operating temperature and product pressurization. Owing to the high efficiency of water decomposition at elevated temperatures, HT steam electrolysis might be an option within the future, but only within the long term. Since HT heat (e.g., from a nuclear or solar energy plant) and base-load operation are required, this technology would be favorable for centralized and large-scale hydrogen production plants. At the present, research and development work is focused mainly on the realization of long-lasting materials to extend both the lifetime and the performance of electrolysis stacks. Reduction in system complexity also remains a serious challenge.

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