



The Role Of Electrolysis In Hydrogen Production For Renewable Energy Application

¹Mr. Dilip Harishchandra Chavan, ²Mr. Suraj Shripal Bhagate,

¹Lecturer, ²Lecturer,

¹Science and Humanities Department,

¹DKTE'S Yashwantrao Chavan Polytechnic Ichalakaranji, India.

Abstract: The gradual depletion and burning of fossil fuels have brought huge pollution to the global ecological environment. Environmental governance and energy crisis have become double challenges faced by governments of many countries in the world. This paper explores the application of electrolysis water hydrogen production technology in the field of renewable energy power generation, in order to better promote the application and development of high temperature solid oxide electrolysis (TSOE) technology in the field of power generation. By investigating the changes in my country's hydrogen energy production and demand, this paper concludes that the average annual growth rate of my country's hydrogen production has continued to increase in recent years, and my country's hydrogen demand reached 19.8 million tons in 2018. It is estimated that by 2030, my country's hydrogen demand will reach 35 million tons, with a compound annual growth rate of 5.76%. Finally, when selecting large-scale hydrogen production technology from the high-TSOE hydrogen production technology in the field of power generation, the key problems to be solved and the renewable energy storage aspect are prospected for the application prospect of the electrolysis water hydrogen production technology in the field of power generation.

Keywords - Electrolysis of Water to Produce Hydrogen, Renewable Energy, Power Generation, High Temperature Solid Oxide Electrolysis, hydrogen production.

I. INTRODUCTION

With the transformation of domestic energy structure and the enhancement of social environmental awareness, hydrogen energy, as a clean and efficient energy source. Conventional hydrogen production (HP) routes are dominated by the production of hydrogen from traditional fossil energy, and the production of hydrogen from natural gas is mainly used worldwide. With the increasing demand of hydrogen energy in social development, HP, as the upstream of hydrogen industry chain, will also get rapid development. Selection of technical route of economic superiority, reduce the cost of HP is the key to the hydrogen use.

The purity of hydrogen and oxygen can generally reach 99.9%, making it the most potential large-scale HP technology. Among the existing HP technologies, using coal or natural gas to produce hydrogen has significant cost advantages, but it will produce new pollution. Use of HP by methanol and other chemical raw materials and industrial tail gas upstream production constraint difficult to form a stable and effective supply of hydrogen. So far, can support the future large hydrogen demand, stable raw material sources of HP methods for HP from electrolysis of water. Although at present, due to the high cost, electrolysis water HP and other methods do not have a competitive advantage. But compared with the passage of a massive to allocate renewable power transmission facilities construction, renewable energy power in HP, again through the pipeline, storage and transportation and highway, nearby given, should be closer to the market demand and solve measures to renewable energy given.

With the aggravation of environmental pollution, more and more researches focus on green and pollution-free energy, including clean, pollution-free, efficient and renewable hydrogen energy. In this paper, the application of high TSOE technology for HP in renewable energy power generation is discussed in order to promote the application and development of high TSOE technology in power generation.

II. RESEARCH METHODOLOGY

1.1 Electrolysis of Water to Produce Hydrogen

The positive and negative electrodes are inserted into water and direct current is applied. Hydrogen ions in the water undergo reduction reaction at the cathode to produce hydrogen, and hydroxide ions undergo oxidation reaction at the anode to produce oxygen. According to different electrolytes, it can be divided into alkaline electrolysis, proton membrane electrolysis and solid oxide electrolysis. The electrolysis water HP technology equipment is simple, the process flow is stable and reliable, and the generated hydrogen purity is extremely high, which can meet the demand of high purity hydrogen without pollution. Moreover, the scale is small, and the amount of hydrogen produced is generally less than 200m³/h. At present, the high cost of electrolysis is the most important reason restricting the promotion of the use of electrolysis water HP technology.

1.2 Solid Oxide Electrolysis

As a new type of high efficiency energy conversion device (700~900°C), solid oxide electrolysis can transform raw material H₂O into H₂ and O₂ through electrochemical reaction process at high temperature, realizing high efficiency transformation from electric energy and heat energy to chemical energy. The electrochemical process of hydrogen by solid oxide electrolysis at high temperature makes the electrolysis reaction more advantageous in thermodynamics and kinetics than low temperature electrolysis. Wide adaptability of raw materials, with the advantages of reversible operation, can be flexibly switched between the electrolytic cell and fuel cell mode. It can be used as an efficient HP or electrochemical energy storage device to convert electric energy into chemical energy (hydrogen energy). It can also operate in fuel cell mode and obtain electric energy through electrochemical reaction.

III. EXPERIMENT

Hydrogen energy has become more and more widely used in China and the market is expanding faster and faster. This article mainly adopts a variety of research methods including literature analysis and empirical analysis, investigation, experience summarization, and exploratory research. Through the collection and reading of some important documents such as policy texts, monographs, papers, web materials, conference proceedings, and integration of domestic and foreign scholars' research results on HP from electrolyzed water, sufficient literature and information are provided for the study of this article more authoritative data information.

IV. RESULTS AND DISCUSSION

A. Survey Results and Analysis

The industrial chain of hydrogen energy is relatively long, generally including HP, storage, transportation, hydrogenation, and terminal applications. It involves many fields such as chemical industry, electric power, transportation, and automobiles. China's hydrogen industry has developed rapidly and maintained its upward trend year by year. The average annual growth rate of HP has continued to increase, and the output and demand are the first in the world. The changes in China's hydrogen energy production and demand in recent years are shown in Table 1 and Figure

| Year | Output/10000t | Demand /10000t |
|------|---------------|----------------|
| 2014 | 1764 | 1760 |
| 2015 | 1850 | 1795 |
| 2016 | 1850 | 1844 |

Table 1. China's hydrogen energy production and demand changes

| | | |
|------|------|------|
| 2017 | 1915 | 1910 |
| 2018 | 1986 | 1980 |

Figure 1. China's hydrogen energy production and demand changes

According to market forecasts, the China Hydrogen Energy Alliance predicts that by 2030, my country's hydrogen demand will reach 35 million tons. In 2050, the national demand for hydrogen is close to 60 million tons. It can be seen that the application of hydrogen energy in China is becoming more and more extensive, and the market expansion speed is also getting faster and faster.

B. Application Prospects of High-Temperature Solid Oxide Electrolytic HP Technology in the Field of Power Generation

1) Large-scale Preparation of Hydrogen

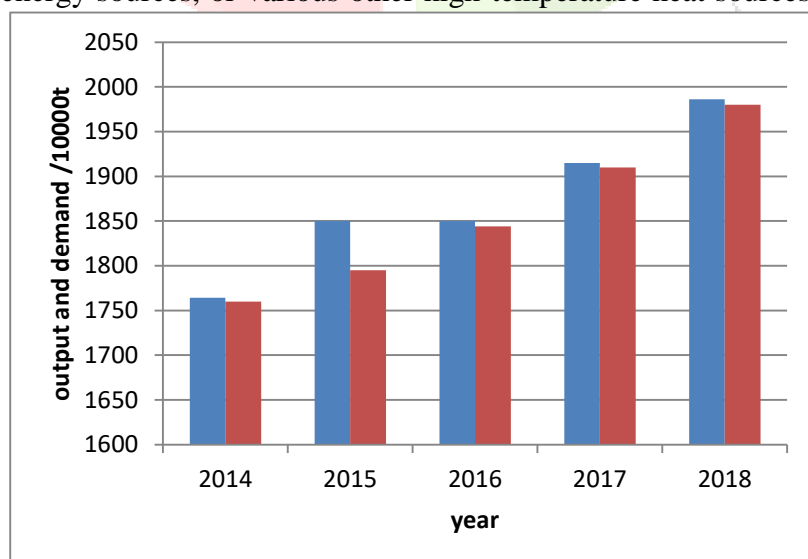
The solid oxide electrolysis method has a significant advantage in this respect. Since it operates at high temperature (700~9000C), the efficiency of electrolytic HP can approach 100%. The technical characteristics of the solid oxide electrolysis method determine that it is very suitable for coupling with a primary energy source that can provide both electrical and thermal energy to achieve large-scale and efficient preparation of hydrogen energy. The high-TSOE HP technology is suitable for the distributed power supply of cold, heat and power and large-scale stationary power stations. It is an indispensable green power generation technology in the future power market.

2) Renewable Energy Storage

The currently developed solid oxide electrolysis technology, which is applied to large-scale renewable energy power storage technology routes mainly includes: Power to gas (PtG) and Power to liquid (PtL), there are also technical routes that combine the two, Called Power to X (PtX). That is, through the solid oxide electrolysis technology, the power of renewable energy is efficiently converted into H₂ (or syngas) storage, and the prepared H₂ can enter the gas network or can be used for power generation; At the same time, the solid oxide electrolysis method can also communicate with the water network and the heating network to achieve efficient and optimal configuration of the entire energy network

The energy source of the solid oxide electrolysis method may be nuclear energy, various renewable energy sources, or various other high-temperature heat sources. Reduce carbon emissions and achieve clean

and efficient use of energy. A German company proposed the use of reversible SOC technology to prepare hydrogen for steelmaking. At the same time, the exhaust gas of the steel plant can also be used for fuel cell power generation. Reversible SOC technology can be used as a medium to achieve efficient and clean utilization of resources and energy. The high-TSOE method can be used as an energy network substance and energy exchange medium for electricity, heat, gas, etc., to connect these energy networks.



V. ACKNOWLEDGMENT

As a clean and efficient energy carrier, hydrogen energy can be obtained once and stored for a long time. It is also an important chemical raw material. The HP technology of electrolyzed water is mature and the equipment is simple. For example, combined with renewable energy generation, it can greatly reduce the cost of HP and solve the problem of renewable electricity consumption. It can be used as a stable source of future large-scale hydrogen energy demand. At the same time, the high-TSOE technology is efficient and flexible, can realize multi-energy symbiosis, and cross-complementation of electricity, heat, gas and other energy sources. It is expected to become an important part of my country's terminal energy system.

REFERENCES

- [1] Application of Electrolysis Water Hydrogen Production in the Field of Renewable Energy Power Generation : Tingjun Zhan et al 2020 IOP Conf. Ser.: Earth Environ. Sci. 598 012088
- [2] Kim S. Production of electrolyzed water for home-use based on electrodeposited macroporous platinum [J]. Journal of Mechanical Science & Technology, 2017, 31(4):1843-1849.
- [3] Islam M Z , Mele M A , Hussein K A , et al. Acidic electrolyzed water, hydrogen peroxide, ozone water and sodium hypochlorite influence quality, shelf life and antimicrobial efficacy of cherry tomatoes[J]. Research journal of biotechnology, 2018, 13(4):51-55.
- [4] Hussain M S , Kwon M , Tango C N , et al. Effect of Electrolyzed Water on the Disinfection of *Bacillus cereus* Biofilms: The Mechanism of Enhanced Resistance of Sessile Cells in the Biofilm Matrix[J]. Journal of food protection, 2018, 81(5):860-869.
- [5] Ju, Se-Young, Ko, Jin-Ju, Yoon, Hee-Sun, et al. Does electrolyzed water have different sanitizing effects than sodium hypochlorite on different vegetable types? [J]. British Food Journal, 2017, 119(2):342-356.
- [6] Zang Y, Li B, Zheng W, et al. Influence of droplet size and deposition on slightly acidic electrolyzed water spraying disinfection effect on livestock environment [J]. Nongye Gongcheng Xuebao/Transactions of the Chinese Society of Agricultural Engineering, 2017, 33(9):224-229.
- [7] You H S, Fadriquel A, Sajo M E J , et al. Wound Healing Effect of Slightly Acidic Electrolyzed Water on Cutaneous Wounds in Hairless Mice via Immune-Redox Modulation[J]. Biological & Pharmaceutical Bulletin, 2017, 40(9):1423-1431.