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Introductory Chapter: An Overview of PEM Fuel Cell Technology

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1. Introduction

Proton exchange membrane (PEM) fuel cells revive a significant state in the energy industry and others. Enhancement fuel cell design will solve many problems for the energy issues. However, some issues are waiting to be solved. Solving issues of the fuel cells will lead to enhance other new technologies. Thus, enhancement of alternative technologies can reply to human poverty. As a result, fuel cells and types were discovered since in the 1970s, institutions, scientists and industries executed many enhancements. These enhancements involve proton exchange membrane (PEM) and other fuel cells.

These developments have not finished yet because of some known issues. NASA and similar organizations provide support to fuel cells with the contribution of several organizations in Europe and the World. Parallel to targeted efforts aimed at solving fuel cell durability, energy and wastewater.

This book intends to provide the reader with a comprehensive overview of the fuel cells for an alternative energy results in the enhancement of the fuel cells as well as its use by finding solutions to these problems.

2. Brief of PEM fuel cell

Prior to the PEM fuel cell book chapters, brief technical information of PEM fuel cell has been given in this chapter. In addition, it is necessary to explain the working principle by defining what the PEM fuel cell means.

The hydrogen activated to form the proton ion with the catalyst is injected in the Proton exchange membrane fuel cell (PEMFC). When the electron is forced to flow out, the proton passes through the membrane and produces electric energy. The electron interferes with the oxygen as the electron returns back to the cathode. The proton ion turns into water. **Figure 1** shows chemical reactions in every electrode [1, 2].

The reaction of anode can be activated in Eq. 1 as below:



The reaction of cathode can be activated in Eq. 2 as below:



Overall the reaction can be determined in Eq. 3 as below:



Furthermore, PEMFC's advantages and disadvantages should be figured out according to the literature. PEM fuel cell's advantages are mentioned such as the heat and water waste management, the reaction of electrode kinetics, a power with high density, an alternative catalyst and a low study temperature [3–9].

Proton exchange membrane fuel cell's disadvantages are also mentioned such as a very high sensitivity, too expensive material, a gas diffusion layer (GDL) and flow field layer, catalyst issue, degradation and difficulties of production of membrane electrode assembly (MEA) [2–4, 10–12].

PEMFC's advantages and disadvantages should be known very well because of enhancement of alternative energy resources.

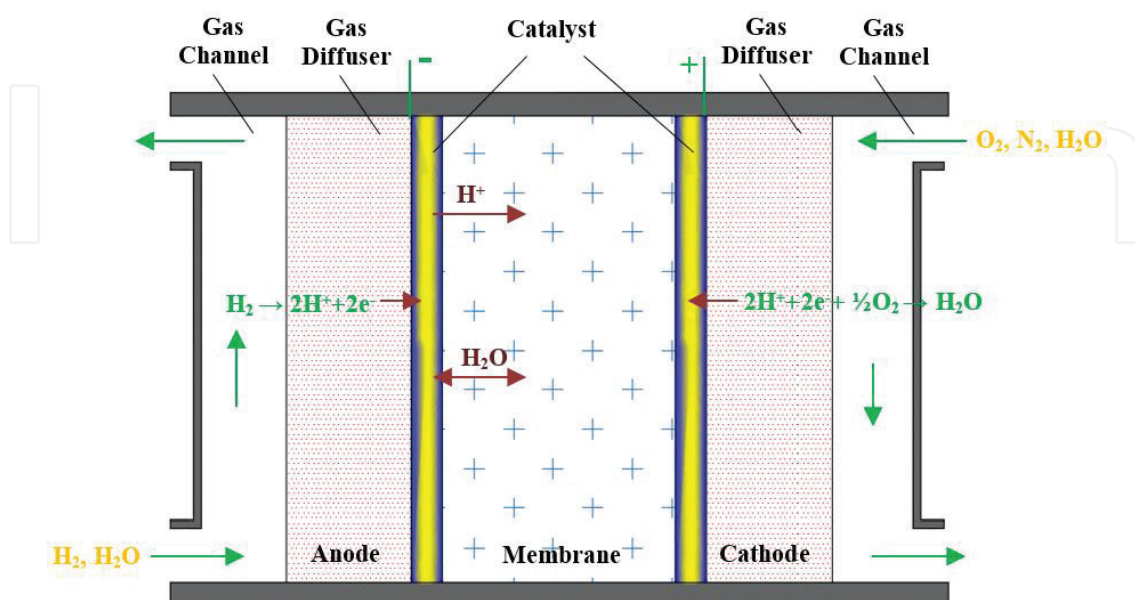


Figure 1. A general schematic drawn of PEMFC [1, 2].

In addition, a mass transport and water management is a very significant issue to be solved [13–16]. When mass transport and water management issues are solved, PEMFC will become an alternative energy resource in the future.

3. Conclusion

Alternative energy options have gained importance owing to the depletion of fossil fuels. These options require considerable experimental and prototyping efforts for realizing new energy resources. The enhancement of modeling and simulation of PEMFC are invented to find new alternative remedies. Therefore, PEM fuel cells might be investigated for enhancements of PEM fuel cell modeling and simulations. PEM fuel cell voltage, current, temperature, pressure, thickness and other parameters depend on the experimental run time. PEMFC with anodic or cathodic plates, which can be produced as a part of the cell's membrane electrode assembly (MEA), can take O₂ gas directly from the air by natural convection.

Its cathodic or anodic plates determine the performance of PEMFC. Due to these similar experiment study measurements, the effects of hydrogen feeding and performance-based optimizations were figured out by optimization of experimental works. The observed voltage, temperature, pressure, layer, current and other parameters are characterized all of similar experimental works. This study presents performance and efficiency enhancement methods for PEM fuel cells and developments related to the management of waste water in the fuel cell.

This book poses proton exchange membrane fuel cell and technology in terms of enhancement with new technologies. The main idea of this study is to scrutinize the performance efficiency and enhancement of modeling and simulations of fuel cells. Besides, the research of fuel cell performance can figure out many critical issues for an alternative resource of energy. Furthermore, compared to all types of fuel cells, advantage and disadvantage aspects of PEMFCs are also investigated. This book may be a model for future similar work because of the durability of PEM fuel cell, by discussing the energy production, waste water problems and the propose of solution.

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References

- [1] Larminie J, Dicks A. Fuel Cell Systems Explained. 2nd ed. West Sussex: Wiley; 2003. pp. 1-24

- [2] Taner T. Alternative energy of the future: A technical note of PEM fuel cell water. *Fundamentals of Renewable Energy and Applications*. 2015;**5**(3):1-4/1000163. DOI: 10.4172/20904541.1000163
- [3] Andujar JM, Segura F. Fuel cells: History and updating. A walk along two centuries. *Renewable and Sustainable Energy Reviews*. 2009;**13**:2309-2322. DOI: 10.1016/j.rser.2009.03.015
- [4] Chandan A, Hattenberger M, El-kharouf A, Du S, Dhir A, Self V, Pollet BG, Ingram A, Bujalski W. High temperature (HT) polymer electrolyte membrane fuel cells (PEMFC) – A review. *Journal of Power Sources*. 2013;**231**:264-278. DOI: 10.1016/j.jpowsour.2012.11.126
- [5] Li J, Wang J, Chen X, Lv Z, Chen T, Wang T. A highly conductive proton exchange membrane for high temperature fuel cells based on poly(5-vinyl tetrazole) and sulfonated polystyrene. *Solid State Ionics*. 2014;**255**:128-134. DOI: 10.1016/j.ssi.2013.12.014
- [6] Rikukawa M, Sanui K. Proton-conducting polymer electrolyte membranes based on hydrocarbon polymers. *Progress in Polymer Science*. 2000;**25**:1463-1502. DOI: 10.1016/S0079-6700(00)00032-0
- [7] Asensio JA, Sanchez EM, Gomez-Romero P. Proton-conducting membranes based on Benzimidazole polymers for high-temperature PEM fuel cells. *Chemical Society Reviews*. 2010;**39**:3210-3239. DOI: 10.1039/B922650H
- [8] Neelakandan S, Rana D, Matsuura T, Muthumeenal A, Kanagaraj P, Nagendran A. Fabrication and electrochemical properties of surface modified sulfonated poly (vinylidene fluoride-co-hexafluoropropylene) membranes for DMFC application. *Solid State Ionics*. 2014;**268**:35-41. DOI: 10.1016/j.ssi.2014.09.027
- [9] Devanathan R. Recent developments in proton exchange membranes for fuel cells. *Energy & Environmental Science*. 2008;**1**:101-119. DOI: 10.1039/b808149m
- [10] Oh HS, Oh JG, Roh B, Hwang I, Kim H. Development of highly active and stable non-precious oxygen reduction catalysts for PEM fuel cells using polypyrrole and a chelating agent. *Electrochemistry Communications*. 2011;**13**:879-881. DOI: 10.1016/j.elecom.2011.05.027
- [11] Li Q, He R, Jensen JO, Bjerrum NJ. Approaches and recent development of polymer electrolyte membranes for fuel cells operating above 100°C. *Chemistry of Materials*. 2003;**15**:4896-4915. DOI: 10.1021/cm0310519
- [12] Villers D, Jacques-Bedard X, Dodelet JP. Fe-based catalysts for oxygen reduction in PEM fuel cells pretreatment of the carbon support. *Journal of the Electrochemical Society*. 2004;**151**:A1507-A1515. DOI: 10.1149/1.1781611
- [13] Arbabi F, Roshandel R, Karimi MG. Numerical modeling of an innovative bipolar plate design based on the leaf venation patterns for PEM fuel cells. *IJE Transactions C: Aspects*. 2012;**25**(3):177-186

- [14] Emery M, Frey M, Guerra M, Haugen G, Hintzer K, Lochhaas KH, Pham P, Pierpont D, Schaberg M, Thaler A, Yandratis M, Hamrock S. Proton exchange membrane fuel cell 7: The development of new membranes for proton exchange membrane fuel cell. *ESC Transactions*. 2007;**11**(1):3-14
- [15] Gimba ID, Abdulkareem AS, Jimoh A, Afolabi AS. Theoretical energy and exergy analyses of proton exchange membrane fuel cell by computer simulation. *Journal of Applied Chemistry*. 2016;**2016**:1-15
- [16] Rezaee V, Houshmand A. Energy and exergy analysis of a combined power generation system using PEM fuel cell and Kalina Cycle System 11. *Periodica Polytechnica Chemical Engineering*. 2016;**60**(2):98-105

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