International Journal of Research and Review
www.gkpublication.in E-ISSN: 2349-9788; P-ISSN: 2454-2237

Review Article

A Review on Studies and Research on Fuel Cells

Sunil J. Kulkarni

Datta Meghe College of Engineering, Airoli, Navi Mumbai, Maharashtra, India.

Received: 16/01/2016 *Revised: 19/01/2016* *Accepted: 19/01/2016*

ABSTRACT

One of the most important factors that contribute to the cost of manufacturing sector is energy. Electricity and fossil fuels are most used energy resources. These sources are depleting day by day. The research in energy sector is concentrated on use of non conventional and novel energy sources. Also the efficient use of available energy is very important area of research. Fuel cells can be used for energy generation from biowaste and other materials. Many investigators have carried out research on different types of fuel cells with different materials. The current review summarizes studies and research carried out on fuel cells.

Key words: Energy, efficiency, microbial fuel cells, voltage**.**

INTRODUCTION

Energy is one of the most important cost factors in manufacturing sector. The efficient use of energy is required in order to reduce cost. Energy derived from fossil fuel and electricity is main source of energy in the industrial and domestic applications. Nowadays, non conventional sources such as wind energy, tidal energy and solar energy are being explored with more or less success. [1,2] Energy consumption in different plants can be reduced by applying different optimization methods.

Process intensification is one important objective behind optimization. Process intensification aims at reducing area or space, energy, cost and increasing the productivity. Techniques such as hydrotropy, nanotechnology can be employed for this purpose. [3-6] Reduction in frictional losses can save lot of energy. [7,8] Investigations have been carried out to reduce energy consumption in operation of energy intensive equipments like boilers, cooling towers, dryers, refrigerators and heat exchangers. [9-12] It is well known fact that yeast and bacteria can generate energy. Microbial fuel cells utilize the ability of microorganisms to synthesize energy. The current review summarizes studies and research carried out on fuel cells.

RESEARCH AND STUDIES ON FUEL CELLS

Barua and Deka carried out research on electricity generation from biowaste based microbial Fuel cells. [13] They established that voltage generated in a microbial fuel cell decreases linearly with respect to time. They found that the first order derivative of voltage generated with respect to time was a negative constant. They also observed that a mixture of biowastes can actually result in higher extractable current than any single component although this is not always true in general. They used potassium ferricyanide as the oxidizing agent. They used four different biowastes namely cow dung, drain waste water, rice washing

water, biogas plant slurry and some of their combinations. They observed that first three samples produced voltage less than 150 milivolt. In the next phase of their experiments, they added biomass samples to all three samples. A highly propagative concentration of micronutrients, essential for the survival of bacteria was main reason behind the use of biomass samples. They observed that voltage generated decreases linearly with time. Addition of biomass had positive effect while addition of vermicompost has a negative effect on current generation.

Sethuraman and Weidner carried out an investigation on sulfur poisoning on a proton exchange membrane (PEM) fuel cell electrode. [14] They quantified the extent of irreversible deactivation of Pt towards hydrogen oxidation reaction (HOR) due to sulfur adsorption and subsequent electrochemical oxidation in a functional PEM fuel cell. They observed that 6% of total Pt sites are deactivated per monolayer sulfur adsorption at open circuit potential of a PEM fuel cell followed by its removal. The deactivation was higher when the electrode was exposed to hydrogen sulphide. It was also found that adsorption potential influenced sulfur coverage of an electrode exposed to H_2S.

Vaghari et.al carried out studies about recent advances in application of chitosan in fuel cells. [15] They explained classification of fuel cells such as alkaline fuel cell, molten carbonate fuel cell, phosphoric acid fuel cell, proton exchange membrane fuel cell, solid oxide fuel cell, and biofuel cell. According to these studies, fuel cells offer many advantages such as high efficiency, high energy density, quiet operation, and environmental friendliness. According to them, pure hydrogen fuel is the appropriate choice for vehicle applications. We studied applications of proton exchange membrane fuel cell systems. [16] Proton exchange membrane fuel cells (PEMFCs), according to them faces many challenges. Technical data and information from a real PEMFC application test are two major factors for the commercialization of PEMFCs. They concluded that lightweight vehicles powered by PEMFC are the most promising applications. A stable supply of high-purity hydrogen and their associated economical system are essential for practical application. As this is not easily available, a PEMFC-based hybrid system should be used as the main substitution for traditional power sources in the near future due to their unique and relative advantages. He and Angenent reviewed application of bacterial biocathodes in microbial fuel cells. [17] They addressed the development and experimental progress of biocathodes in microbial fuel cells (MFCs). According to them, biocathodes are feasible in potentiostat-poised half cells. According to these studies it is important to understand the bacterial electron-transfer mechanisms in the cathode.

Yu et.al carried out studies on fuel cell power conditioning for electric power. [18] They introduced different types, electrical characteristics and power electronic requirements of fuel cells. Accordingly them, fuel cells are under consideration for almost every application including both residential and industrial power generation. They concluded that a power electronics interface must be incorporated between the fuel cell and output. Stambouli and Traversa discussed fuel cells as alternative for conventional resources. [19] They emphasized that energy security; economic growth and environmental protection are key factors which are driving the growth of non conventional energy sector. They reviewed the existing or emerging fuel cells technologies, their design and operation. Also they analyzed their limitations and benefits in connection with energy, environment and sustainable development relationship. According to these studies, electrical-generation efficiencies of 70% are possible along with a heat recovery possibility. Luna-Sandoval et.al provided a

new solution to apply hydrogen fuel cells as power supply for a public transport bus or vehicles. [20] Hydrogen is obtained by electrolysis from the water just if the bus engine is running. This water then passes through the fuel cell where the hydrogen is obtained, which is to be used as the bus engine fuel. When engine is turned off, instead of hydrogen, only water is stored as safety measure. They concluded that the main advantages of fuel cell are efficiency, simplicity, low emissions, silence, flexibility and wide application range. The main disadvantages are cost and hydrogen infrastructure.

CONCLUSION

Investigation on use of fuel cells for energy synthesis is widely studied area of investigation. Waste materials can be used in the fuel cells. It was observed by investigators that a mixture of biowastes can actually result in higher extractable current than any single component. Fuel cells are under consideration for almost every application including both residential and industrial power generation. Energy security, economic growth and environmental protection are key factors which are driving the growth of non conventional energy sector.

REFERENCES

1. Sunil Jayant Kulkarni**,** Tidal Energy: A Review, International Journal of Research (IJR), 2015, 2(1), 55-58.
2. Sunil Jayant Kulkarni, Solar Distillation: A Review, International Journal of Research (IJR), 2014, 1(11), 1171-1176.
3. Sunil Jayant Kulkarni, Ajaygiri Kamalgiri Goswami, Research on Application of Hydrotropy: A Review, International Journal of Science, Engineering and Technology Research (IJSETR), 2014, 3(10), 2617-2619.
4. Sunil Jayant Kulkarni, Process Intensification and Nanomaterials: A Short Review, International Journal of Research, 2014, 1(9), 392-394.
5. S.Thenesh Kumar, N.Nagendra Gandhi, Association Model Of Hydrotropy For The Effect Of Hydrotropes On Solubility And Mass Transfer Coefficient Of Acetylsalicylic Acid, Int J Pharm Pharm Sci, 2012, 4(3),600-605.
6. Anne Aimable, Tomasz Strachowski, Ewelina Wolska, Witold Lojkowski, Paul Bowen, Comparison Of Two Innovative Precipitation Systems For Zno And Al- Doped Zno Nanoparticle Synthesis, Processing And Application Of Ceramics, 2010, 4 [3], 107–114.
7. Sunil J. Kulkarni, Ajaygiri K. Goswami, Studies and Research on Friction, Friction Factor and Affecting Factors: A Review, International Journal of Engineering Sciences & Research Technology, 2014, 3(10), 355-359.
8. Ir. Peter Romeo Nyarko, Heat Load And Its Effects On Fluid Friction Factor In Corrugated Pipes, American Journal Of Scientific And Industrial Research, 2012, 3(4), 241-251.
9. Sunil J. Kulkarni, Ajaygiri K. Goswami, Studies and Research on Operation, Modeling and Simulation of Boilers: A Review, International Journal on Scientifiv Reearch in Science and Technology, 2015, (1)4, 59-61.
10. Sunil J. Kulkarni, Ajaygiri K. Goswami, Studies and Experimentation on Cooling Towers: A Review, International Research Journal of Engineering and Technology, 2015, 2(5), 279-283.
11. Sunil Jayant Kulkarni, Ajaygiri Kamalgiri Goswami, Application, Advancements and Research on Drying-A Review, International Journal for Research in Applied Science & Engineering Technology, 2015, 3(8), 403-407.
12. Sunil J. Kulkarni, Ajaygiri K. Goswami, Research and Reviews on Refrigeration–A Summery, International Journal of Modern Trends in Engineering and Research, 2015, 2(9), 65-69.
13. Pranab K. Barua, D. Deka, Electricity Generation from Biowaste Based Microbial Fuel Cells, International

Journal of Energy, Information and Communications, 2010, 1(1), 77-92.
14. Vijay A. Sethuraman, and John W. Weidner, Analysis of Sulfur Poisoning on a PEM Fuel Cell Electrode, Electrochimica Acta, 2010, 55(20), 5683-5694.
15. Hamideh Vaghari, Hoda Jafarizadeh-Malmiri, Aydin Berenjian and Navideh Anarjan, Recent advances in application of chitosan in fuel cells, Sustainable Chemical Processes, 2013, 1(16), 1-12.
16. Jung-Ho Wee, Applications of proton exchange membrane fuel cell systems, Renewable and Sustainable Energy Reviews, 2007, 11, 1720–1738.
17. Zhen He, Largus T. Angenent, Application of Bacterial Biocathodes in Microbial Fuel Cells, Electroanalysis, 2006, 18(19), 2009–2015.
18. X. Yu, M.R. Starke, L.M. Tolbert and B. Ozpineci, Fuel cell power conditioning for electric power applications: a summary, IET Electr. Power Appl., 2007, 1(5), 643–656.
19. A.Boudghene Stambouli, E. Traversa, Fuel Cells, an Alternative To Standard Sources Of Energy, Renewable and Sustainable Energy Reviews, 2002, 6, 297–306.
20. G. Luna-Sandoval, G. Urriolagoitia-C, L.H. Hernández, G. Urriolagoitia-S, E. Jiménez, Hydrogen Fuel Cell Design and Manufacturing Process Used for Public Transportation in Mexico City, Proceedings of the World Congress on Engineering, 2011 Vol III, WCE 2011, July 6-8, 2011, London, U.K.

How to cite this article: Kulkarni SJ. A review on studies and research on fuel cells. Int J Res Rev. 2016; 3(1):77-80.

****