*International Journal of Advanced Computer Research (ISSN (print): 2249-7277 ISSN (online): 2277-7970)*
*Volume-3 Number-3 Issue-11 September-2013*

# The improves energetic yield of high temperature fuel cell (MCFC) using advance techniques in modeling and optimization analysis

**S. K. Dhakad[1], S.C.Soni[2], Pankaj Agarwal[3]**

## Abstract

***The present paper, deal with energy modeling and optimization of developed mathematical of high temperature fuel cell, e.g. Molten Carbonate Fuel Cell (MCFC). In the present work developed mathematical model of molten carbonate fuel [1]. Codes for the MCFC single cell stack model have been generated using the MATLAB software. Using the developed Mathematical model, various parameters of fuel cell have been optimized by two optimization techniques; that is Genetic and PSO Algorithm [1, 6]. Obtained simulated and optimized results have been compared with standards references [7,8,9] available open literature and also compare well with the Feed Forward Neural Network (FFNN) analysis [2,3].In the FFNN analysis tries to attempts the practical utility of the developed model [4]. The simulated and optimized results can be utilized in designing and improve the performances of MCFC single cell model. The results have been appeared in the previous papers, here summary and future scope of the work presented.***

## Keywords

***Energy, Modeling, Simulation, Optimization, FFNN analysis.***

## 1. Introduction

The present work on Energy modeling and Optimization of Molten Carbonate Fuel cells (MCFCs) in this section highlights the demand of global energy consumption and supply, which calls for increased use of renewable / non con conventional resources such as high temperature fuel cells (MCFCs) and biomass gasification. The gasification system integrated with high temperature fuel cells that play greater rolls in the commercial application of MCFCs. Review of literature has led to the present work on energy modeling and optimization of MCFCs. From available multiple sources like Journals, Research Papers, Articles and also internet resources helped to find the gap and this problem formation in the objective area [5].

## 2. Objective of present work

Present work attempts to maximize the energetic yield from alternative energy sources like gasifier, and approaching to minimize environmental impact in terms of polluting or $CO_2$ emissions, the coupling of Molten Carbonate Fuel Cells (MCFCs) to the fuel gas produced from these sources is an attractive option in the future.

## 3. Methodology has been used

Present work methodology has been used discuss briefly in this section. The analysis work has been done using MATLAB software's. The following models have been developed and analyzed.

1. Mathematical Modeling, simulation and optimization have been done of single cell MCFC model, by two optimization techniques, using MATLAB software.
2. The Feed Forward Neural Network (FFNN) base analysis has been done for developed mathematical single cell MCFC model, using MATLAB software.

## 4. Simulation and optimization of mathematical model of the MCFC

The analyses of single cell of the MCFC, Voltage Current (VI) Characteristic have been obtained at the various temperatures and pressures domains. Optimized efficiency and power density for the single cell of MCFC has been determine corresponding to maximum voltage at the temperature 900 $^{O}$K results have been appeared in previous work [1]. In the optimization two techniques has been used and obtained optimized results are compare well with each other [6] along with published work.

## 5. The Feed Forward Neural Network (FFNN) based model prediction of MCFC

The Feed Forward Neural Network (FFNN) based analysis also has been done, results have been appeared in the previous work [2, 3].The FFNN

analysis overcomes certain difficulties of developed mathematical model of MCFC. In this analysis data's (simulated & optimized results) collected using mathematical model have been arranged as input variables (i.e. temperature, pressure, current.etc) and one output such as Voltage/ Power. Then developed feed forward neural network based model for the selected numbers of layers and neurons in each layer is defined. Then the neural network trained for the input data and selected number of epochs now gets the approximate model of MCFC in the term of neural network. Using the FFNN approximate model, performance and evolution of the MCFC single cell have been obtained. In the analysis initially have been selected 4 layers along with 2:3:2 neurons and 5 layers and 2:3:2:4 neurons respectively. It has been analyzed that increasing the numbers of layers and neurons FFNN model better predict the simulated and optimized results, that obtained using the mathematical model of MCFC single cell.

## 6. Conclusions

[1] The present analysis, have been done for various parameters of single cell of MCFC and attempts to optimize the performances of the cell.
[2] The matrix/membrane thickness played a critical role in determining cell performance. Reducing the thickness improved the performance can be reducing the life of the cell.
[3] Using the Mathematical model of MCFC, the maximum efficiency a single cell has been determined.
[4] The optimized results can be utilized in designing multi cells of MCFCs.
[5] The complicated characteristics of MCFC such as high temperature, non-linear, and larger number of equations used in modeling, leads to certain limitations in the developed model.
[6] Neural network models represent an important tool of Artificial Intelligence for fuel cell performances analysis.
[7] Increasing the numbers of layers and neurons FFNN model better predict the simulated results.
[8] The FFNN trained results well compare to the simulated results along with standard references.

## 7. Future scope of the work

Fuel cell is old device but it application to the commercial purpose was very limited up to last ten years. In the future work will be require energy modeling to reduce the size of cells that is why it can be used for transportation purpose.

## 8. Results

The simulated and optimized results are shown here using two optimization techniques.

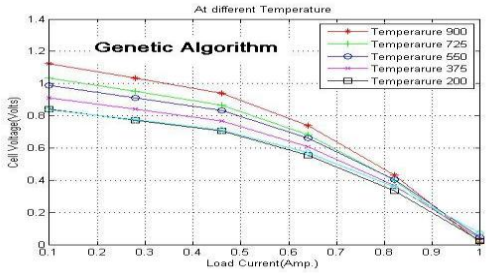


**Fig. 1: Cell Voltage Vs Load Current (VI Characteristic / Polarization curves) for the Temperature domain of the cell using Genetic algorithm**

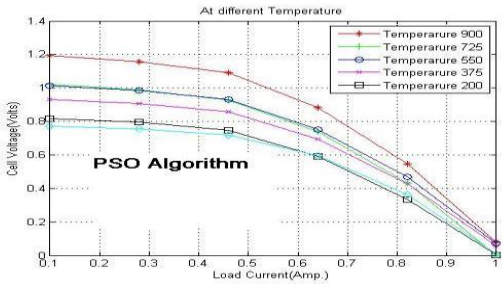


**Fig. 2: Cell Voltage Vs Load Current, (VI Characteristic / Polarization curves) for the temperature domain of the cell using PSO algorithm**

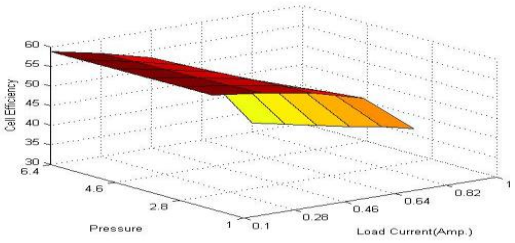


**Fig 3. Shown optimized efficiency of the cell at the different values of input variables, as load current & pressure**

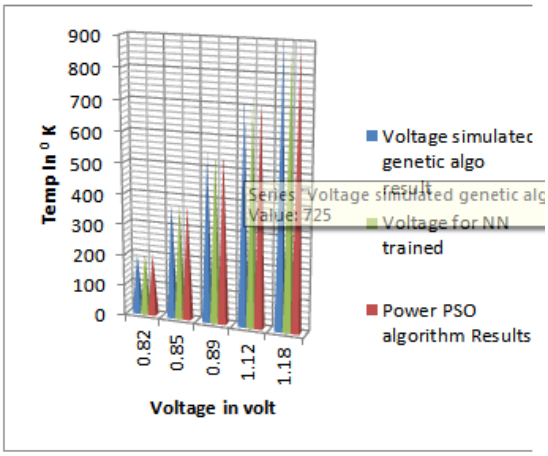


**Fig 4: Shown comparative analysis of voltage variation of the single cell of MCFC using the three different method of analysis at the input limits of the temperature**

The effect of temperature on VI Characteristics of the cell during the increase the load. The maximum voltage of the cell is corresponding to the temperature 900 $^{O}$K. The Simulated & Optimization Results are well compare to fuel cell hand book Edited by EG&G Technical Services, National Energy Technology laboratory Morgantown, West Virginia. 26507-0880 (2004) in chapter 6 p.p.18& 40 chapter 7 p.p. 31-41.

## References

[1] S.K. Dhakad, et.al. "Mathematical Modeling and Performance Simulation and Optimization of Molten Carbonate Fuel Cell(MCFCs)" Published in International Journal of Engineering Research and Industrial Application,(IJERIA) p.p. 299-311 Vol.5, No.3, August 2012.

[2] S.K. Dhakad et.al."The neural network analysis for the single cell of molten carbonate fuel cell (MCFC) Published in the International Journal of Engineering Research Vol. No.1, Issue.1 p.p.9-11, Nov.2012.

[3] S.K. Dhakad,et.al. l"The Feed Forward Neural Network (FFNN) based model prediction of Molten Carbonate Fuel cells, Indian Journal of applied Research, Vol.3,issue 2 Feb 2013.

[4] S.K. Dhakad, et.al. "The future aspect of power generation through high temperature fuel cells (MCFCs) verses other fuel cells "Publishedin International Journal Scientific Engineering and Technology (IJSET), p.p. 102-105 Issue no. 3, vol. 1, July 2012.

[5] S.K. Dhakad, et.al. "Review of work done in the field of commercial application of high temperature fuel cells (MCFCs) in stationary power generation" Published in International Journal of Industrial Engineering & Technology (IJIET), P.P 61-68,Vol.4 Number1, 2012.

[6] S.K. Dhakad, et.al."Cross validation of optimize results using Genetic and Particle Swarm Optimization (PSO) algorithms, for the single cell model of Molten Carbonate Fuel Cell (MCFC)" has been accepted in International Journal of Scientific Research (IJSR) Issue in the April -2013.

[7] Fuel Cell Handbook. Edited by EG&G Technical Services, National Energy Technology Laboratory Morgantown, West Virginia 26507-0880, 2004.

[8] Thermodynamic Analysisof Hybrid Molten Carbonate Fuel Cell Systems Ramin Rashidi University of Ontario Instituteof Technology 2008.

[9] Bengt SundénandJinliang Yuan , on Modeling of Heat and Mass Transfer and Other Transport phenomena in fuel cells, Frontiers in Heat and MassTransfer (FHMT) 1013008 (2010) Department of Energy Science Lund university Sweden.

[10] Piotr Tomczy kMCFC versus other fuel cell Charcteristics Techonologies and Prospects, Journal of Power Sources,Vol. (160), 2006, pp. 852-86.

[11] J.J. Ramirez and Martinez et.al. 'Basic design of a Fluidized Bed Gasifirefor the rice husk on a pilot scale' Latin American Applied Research Vol. 37, 2007, p.p.299-306.

**Dr. S. C. Soni** Presently working as Director BIRT Bhopal, M.P., Ex Director MANIT Bhopal, He has more than 30 years teaching experience. His area of interest is Design.

**Dr. Pankaj Agarwal** Presently working as Professor in the department of mechanical Engineering S.A.T.I. Engineering College Vidisha M.P. He has more than 18 years teaching experience. His areas of interest Thermal and Lean manufacturing .

**S.K. Dhakad** Presently working as Assistant Professor in the department of mechanical Engineering S.A.T.I. Engineering College Vidisha M.P. He has more than 10 years teaching experience. His area of interest is design.