Research Paper Engineering

Molten Carbonate Fuel Cells (MCFCs) Alternative Sources of Energy Generation in the Future

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ABSTRACT

The present paper intends to increase the application of high temperature fuel cell e.g. Molten Carbonate Fuel Cell (MCFC). Molten carbonate fuel cells are currently being developed for natural gas, biogas (produced as a result of anaerobic digestion or biomass gasification), and coal-based power plants for electrical utility, industrial, and military applications. That can be maximize the energetic yield from alternative energy sources like, Biomass gasifire. Another alternative Molten Carbonate Fuel cell operates high temperature are requires start- up significant time to reach running conditions and responds slowly to changing power demands, these characteristics makes MCFC more suitable for constant power application.

Keywords : MCFC, Gasifire, Energy, Modeling

Introduction:

Rising fossil fuels costs and climatic changes alternative where power is produce locally form e-waste, biomass, sun, water & wind etc., and utilization locally. Biomass as alternative continues to be the main fuel for primary energy generation in India for both thermal/ electrical energy either by direct combustion or by gasification. Currently, bio-fuels from waste and biomass are mainly used in engines and turbines with fairly low efficiencies and generate significant amounts of regulated pollutants (NOx, SOx and particulates). Replacement of these conventional fuels with MCFCs in gasifier would lead to better environmental with higher efficiency. The scope of the work, combining these resources with fuel cell applications would provide a significant contribution to environment friendly efficient energy use in the future. MCFCs are high-temperature fuel cells that use an electrolyte composed of a molten carbonate salt mixture suspended in a porous, chemically inert ceramic matrix of beta-alumina solid electrolyte (BASE). Since they operate at extremely high temperatures of 650°C (roughly 1,200°F) and above, non-precious metals can be used as catalysts at the anode and cathode, reducing costs. Higher operating temperature allows them to use natural gas directly without the need for a fuel processor and have also been used with low-Btu fuel gas from industrial processes and other sources and fuels.

There are many processes in the fuel cell, including heat generation and transfer, mass transfer, oxidation, ionization, reformation and so on. Electro-chemical reaction can produce heat. Mean while there is mass -transfer between the gas of anode or cathode and the electrolyte, which forms a mass flow along with a heat flow. The thermal physical and electrochemical processes are interactive and interdependent in the fuel cell. The distribution of temperature has a great effect on the electrochemical reaction. The thermal analysis can be under-stand with the help of CFD analysis in the 3-D model of the MCFC [1].The the biomass gas distribution /concentration and thermal analysis in 2-D model of single cell MCFC can be understand [2].

2. Energy modeling of MCFC:

Last 12 years models of MCFC have been developed and their objective factions summarized here, modeling, and experimentation of scale-up process Bosio B et al.(1999),the effect of temperature on MCFC stack parameters analyzed J.H Koh et al. (2000). The effects of the reformer process to Mathematical Modeling, analysis has been done Park H. K et al. (2002). The three dimensional Parametric simulation and modeling of MCFC W.He.Q. Chen (2004), and Reduce the heat transfer losses in the stack of MCFC N. Woudstra (2006). The MCFC Couple with Gasifire system Ansaldo Ricerche (2006) and start-up, time and steady-state optimization process analysis have been done W. Wu et al. (2010). The Mathematical modeling of multiple cells, 150-cells in one stack, all cells are connected in a series, obtained average current density Sung-Yoon Lee, et.al. (2010). Mathematical Modeling of High power internal reforming Zhiwen et al.(2010), Fluid Distribution System in a Circular MCFC CFD, Optimal Design A. Sciacovelli et al.(2011). Modeling of Heat and Mass Transfer Energy transfer, Bengt Sundén et al.(2012), Analytical modeling of electrochemical mechanism in CO2 polarizations calculation Amal Elleuch et al (2012). Simulation and optimization of of single Cell Mathematical model of MCFC using MATLAB software s.k. dhakad et. al. (2012) has been done [3, 4]. Comparative analysis of future aspects of power generation through high temperature fuel cells (MCFCs) verses other fuel cells [7].

Using these developed models, simulated and optimized results were obtained, by using various optimization techniques, for the multiple objective functions. In the modeling analysis external and internal reforming (separation of hydrogen from methane) were considered. For the MCFC Static and Dynamic model were developed and used those models tried to improve the performance of fuel cell along with increase the cell life and reducing cell starting time. The practical utility of the models was limited, due to number of assumption and parametric constrains were considered in the analysis.

3. Energy modeling of Gasifire :

Energy balance analysis Equilibrium Model for Biomass Gasification Anil, K., Prasadet al.(2006),Thermodynamic Equilibrium Model, Downdraft Waste Gasifier Jarung et al.(2007). The model of woody biomass down draft gasifire has been

developed for the Fast Internally Circulating Fluidised Bed (FICFB) gasification processes. The work has been appeared in the previous paper. The goal of the present work is to develop modeling tool for aiding in the design of gasification plants and tries to maximize the energetic yield of gasification process.

4 MCFC model predictions through Feed Forward Neural Network (FFNN) base analysis.

The practical utility and validity of model results are key factor would lead to application in the development new model. The certain limitations in the developments of mathematical model of MCFC are overcome by neural network analysis. The modeling based on artificial neural networks is advanced; the feed forward neural network (FFNN) analysis can be use to prediction of the mathematical model. In the analysis given numbers of layers with given numbers of neurons in each layer is defined. Then the neural network trained for the input data for given number of epochs. Now get the approximate model of fuel cell in the term of neural network. Increasing the numbers of layers and neurons FFNN model better predict the simulated results [5, 6].

Conclusion: Unlike fossil fuels biomass does not add carbon dioxide to the atmosphere as it absorbs the same amount of carbon while growing and also cheapest, eco-friendly, renewable sources of energy. MCFC can be use as alternative source of energy in clean power generation for development country like India.

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