International Journal of Technology Research and Management
ISSN (Online): 2348-9006
Vol 4 Issue 4 April 2017

A Review Article of Enhancement Three Phase Power Generate Through Solid Oxide Fuel Cell

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Abstract: *Fuel cell technology is a relatively new energy-saving technology that has the potential to compete with the conventional existing generation facilities. Among the various Distributed Generation or onsite generation or localized generation technologies available, fuel cells are being considered as a potential source of electricity because they have no geographic limitations and can be placed anywhere on a distribution system. Fuel cells have numerous benefits which make them superior compared to the other technologies. The integration of the fuel cell system is to provide the continuous power supply to the load as per the demand. In this paper, design and modeling of Solid Oxide Fuel cell (SOFC) is discussed for the distributed generation applications. Modeling and simulations are carried out in MATLAB Simulink platform. Solid oxide fuel cells operate at temperatures near l0000C these are highly efficient combined heat and electric power. Modeling of SOFC is done by using by using Nernst equation. In that the output power of the fuel cell can be controlled by controlling the flow rate of the fuels used in the process. The fuel cell source is integrated with the DC – DC boost converter to stabilize the voltage from the fuel cell. CUK converter is used for Power Factor Pre-regulators in discontinuous Conduction Mode. The output of the CUK type boost converter is then fed to the three phase PWM inverter to get the suitable form three phase output voltages for the grid connected applications.*

1. INTRODUCTION

Distributed generation is referred in general to small generators, starting from a few kW up to 10 MW, whether connected to the utility grid or used as stand-alone at an isolated site. Normally small DGs, in the 5-250 kW range serve households to large buildings (either in isolated or grid-connected configuration). DG technologies can be categorized to renewable and nonrenewable DGs. Renewable energy technologies are in general sustainable (i.e., their energy source will not run out) and cause little or no environmental damage; they include: Solar photovoltaic, Solar thermal, Wind, Geothermal, Tidal, Low-head (small) hydro, Biomass and biogas and Hydrogen fuel cells (hydrogen generated from renewable resources). Nonrenewable energy technologies are referred to those that use some type of fossil fuel such as gasoline, diesel, oil, propane, methane, natural gas, or coal as their energy source. Fossil fuel-based DGs are not considered sustainable power generation sources as their energy source will not renew. They include: Internal combustion engine (ICE), Combustion turbine, Gas turbine, Micro turbine and Fuel cells (using some type of fossil fuel, e.g. natural gas to generate hydrogen). Both types of DGs (renewable and nonrenewable) are popular and widely used around the world. The downside of renewable resource DGs is the intermittent nature of their renewable energy source; and the disadvantage of fossil fuel-based DGs is that they generate environmentally polluting, and in some cases poisonous exhaust gases, such as SO2 and NOx, which are similar to the pollutants from conventional centralized power plants. However, considering the increasing need for electricity, the benefits of the nonrenewable DG technologies with low emission of polluting gasses exceed their disadvantages and are expected to be used in the foreseeable future.

- **FUEL CELL:**

The first references to hydrogen fuel cells appeared in 1838. In a letter dated October 1838 but published in the December 1838 edition of The London and Edinburgh Philosophical Magazine and Journal of Science, Welsh physicist and barrister William Grove wrote about the development of his first crude fuel cells. He used a combination of sheet iron, copper and porcelain plates, and a solution of sulphate of copper and dilute acid. In a letter to the same publication written in December 1838 but published in June 1839, German physicist Christian discussed the first crude fuel cell that he had invented. His letter discussed current generated from hydrogen and oxygen dissolved in water.

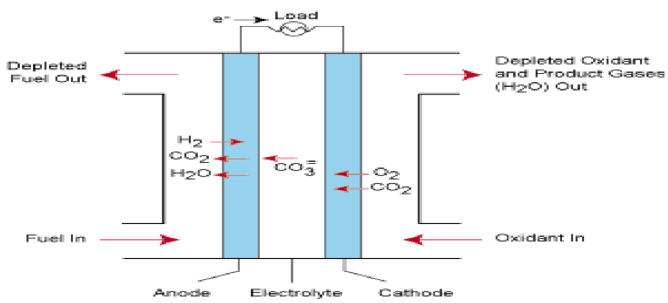


Figure (1) Fuel cell Internal Structure

- **FUEL CELL TYPE**

Fuel cells come in many varieties; however, they all work in the same general manner. They are made up of three adjacent segments: the anode, the electrolyte, and the cathode. Two chemical reactions occur at the interfaces of the three different segments. The net result of the two reactions is that fuel is consumed, water or carbon dioxide is created, and an electric current is created, which can be used to power electrical devices, normally referred to as the load.

1. Proton exchange membrane fuel cells (PEMFCs)
2. Phosphoric acid fuel cell (PAFC)
3. Solid acid fuel cell (SAFC)
4. Alkaline fuel cell (AFC)
5. High-temperature fuel cells

- **EFFICIENCY OF LEADING FUEL CELL TYPES:**

1. Anode: The electrode at which oxidation (a loss of electrons) takes place. For fuel cells and other galvanic cells, the anode is the negative terminal; for electrolytic cells (where electrolysis occurs), the anode is the positive terminal.

2. Aqueous solution: a: of, relating to, or resembling water b : made from, with, or by water.

3. Catalyst: A chemical substance that increases the rate of a reaction without being consumed; after the reaction, it can potentially be recovered from the reaction mixture and is chemically unchanged. The catalyst lowers the activation energy required, allowing the reaction to proceed more quickly or at a lower temperature. In a fuel cell, the catalyst facilitates the reaction of oxygen and hydrogen. It is usually made of platinum powder very thinly coated onto carbon paper or cloth. The catalyst is rough and porous so the maximum surface area of the platinum can be exposed to the hydrogen or oxygen. The platinum-coated side of the catalyst faces the membrane in the fuel cell.

2. ISSUES OF OLD ARTICLE

Y. Raju Babu [1] Electrification of daily life causes growing electricity consumption; rising number of sensitive/critical loads demand for high-quality electricity, the energy efficiency of the grid is desired to be improved1, 2. The outputs from the fuel cells are obtained by electrochemical reaction between H2 and oxygen. Generally, the fuel cell stacks are obtained by series connection of several individual fuel cells, which are equivalent to series connection of general voltage sources, with its internal impedance.

Inderjeet Singh [2]: Dynamic modeling of solid-oxide fuel cell with three phase inverter has been performed to analyze its load behavior as distributed generator in a grid connected power system. The response of the system to step changes in load demand are presented along with the analysis of the simulated results. It has been observed that the fluctuations in the output voltages in the power system due to load variations are taken care of by the SOFC very closely. An efficient dynamic model of Solid Oxide Fuel Cell has also been developed which can supply active power maintaining inverter voltage as desired.

Jin Woo Jung [3]: This dissertation presents circuit models and control algorithms of fuel cell based distributed generation systems (DGS) for two DGS topologies. In the first topology, each DGS unit utilizes a battery in parallel to the fuel cell in a standalone AC power plant and a grid-interconnection. In the second topology, a Z-source converter, which employs both the L and C passive components and shoot-through zero vectors instead of the conventional DC/DC boost power converter in order to step up the DC-link voltage, is adopted for a standalone AC power supply. In Topology 1, two applications are studied: a standalone power generation (Single DGS Unit and Two DGS Units) and a grid-interconnection.

Professor Donald G. Kasten [4]: This dissertation studies the circuit models and control strategies for two topologies of the fuel cell powered distributed generation systems. In Topology 1, each DGS unit positions the battery in parallel to the fuel cell for a standalone AC power plant and a grid-interconnection. In Topology 2, a Z-source converter, which uses L and C components and shoot-through zero vectors without a DC to DC power converter to boost the DC-link bus voltage, is adopted for a standalone AC power generation.

Design 3-Ø Inverter System

A Inverter power circuit has to Convert DC to 3 phase AC voltage. Inverter requed two power supply for Inverter power circuit. SMPS power supply input DC requirement. Inputpower supply for Drive and protection circuit Consisting of 12-0-12 transformer/ used (IN 4007,1.5A,240V) diode bridge rectifier. Circuit and 470uf 25v capacitor we required but we have used fixe 12v dc supply so I have used voltage controller IC LM 78012.In protection circuit also used 12-0-12 transformer, 1.5 amper and (IN 4001, 1A, 50V) diode module, 220uf,16v capacitor used and variable 12volt dc to convert (voltage controller IC LM7812) fix 12 volt. A power circuit in Inverter I have requered 110 volt DC supply for convert three phase AC supply [8], [9]. We have required smps supply for some practicat experiment results. A power circuit is 3 phase bridge inverter using IGBTs. LCL filter with load or grid current is 2 Ampere and supply voltage is 440 volt.

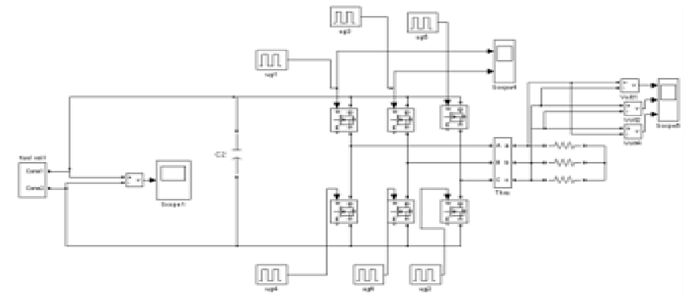
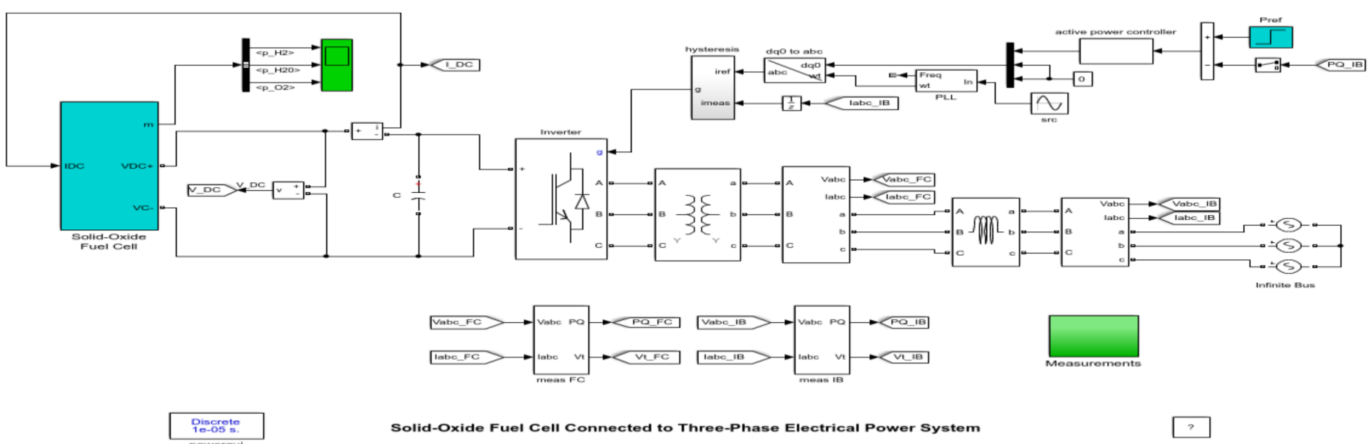


Figure (2) Model of matlab

3. MODELING SYSTEM IN MATLAB

The modeling of SOFC is carries out based on the assumptions made that the fuel cell temperature is made to be constant; the fuel cell gasses are ideal and the Nernst's equation applicable to the cell. By Nernst's equation output fuel cell dc voltage Vfc across stack of the fuel cell at current I is given by the Simulink Models of Fuel Cell System The fuel system designed in this work for distributed generated grid connected applications consists of the solid oxide fuel cell, CUK converter, three phase inverter and the load. The three phase inverter is selected because most of the loads are three phases in general. The overall simulink model diagram is shown in figure 4 and followed by the model Designs of the individual blocks of SOFC, converters. Now we design and this fuel cell used in our power system modal and find all wave forms in figure in shown in Figure 5 and Figure 6, Figure 7.and Figure 8 is final Our MATLAB Modal results for current and voltage in grid systems.



From the above simulation results it can be identified to meet the load changes in the power system can be effectively be controlled by incorporating the FC system as they are fed constant output voltages. The FC output can be controlled by controlling the internal parameters of the fuel cell.

4. CONCLUSION

Dynamic modeling of solid-oxide fuel cell with three phase inverter has been performed to analyze its load behavior as distributed generator in a grid connected power system. The response of the system to step changes in load demand are presented along with the analysis of the simulated results. It has been observed that the fluctuations in the output voltages in the power system due to load variations are taken care of by the SOFC very closely. An efficient dynamic model of Solid Oxide Fuel Cell has also been developed which can supply active power maintaining inverter voltage as desired. The combined system reduces the cost of power generation as well as the level of pollution reducing the fuel consumption enables comprehensive quantitative and qualitative analysis.

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