Fuel Cell Voltage Control for Load Variations Using Neural Networks

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ABSTRACT

In the near future the use of distributed generation systems will play a big role in the production of electrical energy. One of the most common types of DG technologies , fuel cells , which can be connected to the national grid by power electronic converters or work alone Studies the dynamic behavior and stability of the power grid is of crucial importance. These studies need to know the exact model of dynamic elements. In this paper, a new method based on a neural network algorithm for controlling the fuel cell voltage is provided. The effects of load change the output voltage characteristic of the fuel cell unit is checked Simulations in MATLAB / SIMULINK. The results show that the prosecution is conducted in an appropriate manner Voltage Stabilization time.

KEYWORDS: Fuel cell, dynamic behavior, neural networks, hydrogen, neural network controller

1. INTRODUCTION

From the beginning of the human fossil fuels as a source of energy used, with problems such as environmental pollution, noise, low efficiency concerns, not far from the end of this resource has been stuck underground ,so for about a century, mankind has been looking for an alternative to replace the power supply. Electricity production from renewable energy sources such as solar hydrogen gas, a notion that has been developed in a number of countries has led to research and development in this area. Electricity and heat produced by the reaction between hydrogen as fuel and air as the oxidant in the presence of an electro... Suitable for PEM fuel cells is possible. In this process, such as pure hydrogen fuel, Hydrocarbons Alkaline, Methanol and... (Depending on the type of fuel cell) Used at the end of the process, water and electrical energy will emerge as the major product [1]. Currently over 85% of world energy demand by fossil fuels, coal, Oil and natural gas supplied. On the other hand, because of the increase in world population and increasing need for energy in developing countries to improve their standard of living, Energy demand is increasing. [2]

The basic design of a fuel cell by William Grove in 1839 was presented, but the first practical example of the fuel cell by the Space Research Organization of America (NASA) was created in 1955 with a capacity of 5 kW. As well as the tools to produce the required water aboard space shuttles used [3].

2. TYPES OF FUEL CELLS

Depending on the used electrolyte fuel cells can be divided into five categories that Include

1. The proton exchange membrane fuel cells or polymer (temperatures of 70'C to 90'C)
2. The alkaline fuel cells (temperatures of 60'C to 90'C)
3. The phosphoric acid fuel cell (temperature of 150'C to 200'C)
4. The molten carbonate fuel cell (temperature of 550'C to 700'C)
5. The solid oxide fuel cell (temperature of 800'C to 1000'C)

3. THE FUEL CELL POLYMERIC

The origin of these cells is related to 1960 America during the investigation and study on the sources of power were to travel to other planets and until mid-1980 failed to progress quickly As a source of clean and high efficiency study and research on polymeric membrane fuel cells by 1990 in developed countries such as America, Italy, and Japan began Today, it is widely used in cell electric vehicles , naval ships , batteries, portable light , variable power sources , distributed generation spacecraft systems tested Polymeric membrane fuel cell is the fifth- generation fuel cell Where oxygen and hydrogen react with water, heat , and electricity produced When a fuel cell is working Hydrogen at the anode and the cathode, oxygen is injected. The reaction that occurs at the anode and cathode of the fuel cell.

$$H_2(g) \xrightarrow{pt} 2H^+ + 2e^- \quad (1)$$

Cathode reaction

$$2H^+ + 2e^- + \frac{1}{2}o_2 \xrightarrow{pt} H_2O + heat \quad (2)$$

The overall cell reaction is shown below

$$H_2 + \frac{1}{2}O_2 \rightarrow H_2O + heat + electricalenergy \quad (3)$$

4. ARTIFICIAL NERVOUS NETWORK MODEL

An artificial neural network is a kind of artificial intelligence techniques is that the human brain has the same behavior. AI can be either linear or nonlinear function approximation to a good cause. A feed forward neural network with supervised training was used in this study. The structure is a three-layer feed forward. The network consists of an input layer, a hidden layer and an output layer is W. Transfer function for the hidden layer is a sigmoid function. The form is given by:

$$F(u) = \frac{1}{1+e^{-(d.u)}} \quad (4)$$

Where d is the slope parameter. The input hidden layer can be obtained from the following equation:

$$\mathrm{u} = \sum_{i}^{n} (\mathrm{w_{ij}x_i} + \mathrm{b_i}) \quad (5)$$

Where J weight wij xj input to the i- th hidden layer neurons, and bi is the bias if the output layer is linear. Equation model for the entire network can be expressed as follows:

$$y_k = \sum_{j=1}^{N} w^o{}_{ij} f\left(\sum_{j=1}^{N} \left(w_{ij} x_i + b_i\right)\right) \qquad (6)$$

Where the output signal yk KTH and the output neurons output, weight shape Neurons in the output layer in this study, the weights and measures bias ANN according to the gradient descent algorithm intended movement. The update is the best learning algorithms for ANN. linear transfer function in the output layer is used. The following figure shows the architecture of the neural network developed ANN network having an input layer with three) Hydrogen partial pressure PH2 Oxygen PO2 Current fuel cell ISTACK.

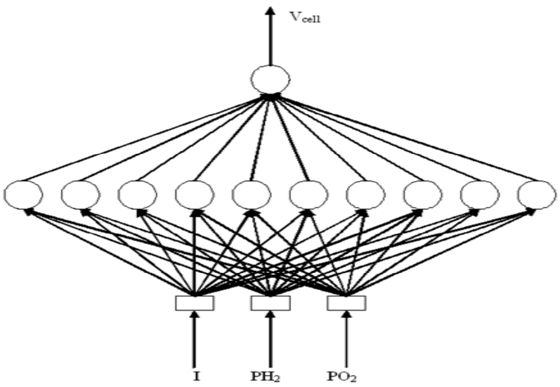

Fig.1.Model of fuel cell NNT

A hidden layer with 10 neurons and an output layer with one output Cell voltage MATLAB (PEMFC Thule box neural networks ANN models were used to build and Sigmoid function of hidden layers and neurons could be enough to sign a functional relationship between the input and output

5. RESULTS AND DISCUSSION

In Figure 3 we have the best solution to stabilize the load controller errors in the initial moments but total control nntc compared with other controller input has given us the answer to prosecute which can increase the number of iterations of the algorithm shifts other elements in meeting the established time we load reduction.

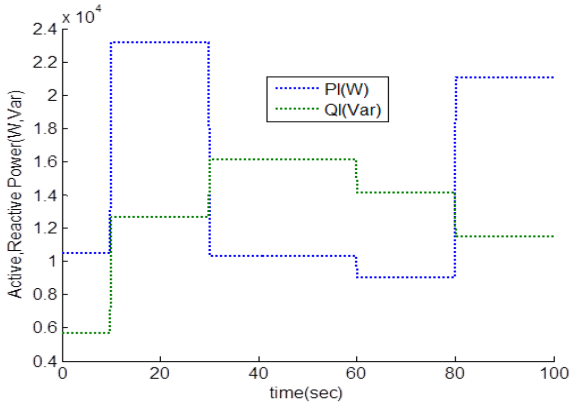

Fig.2. Step bar

Figure 3 changes the active power output Figure (4) which controls the hydrogen inlet valve moment changes can have an impact on power and voltage ramps so you can figure out regardless

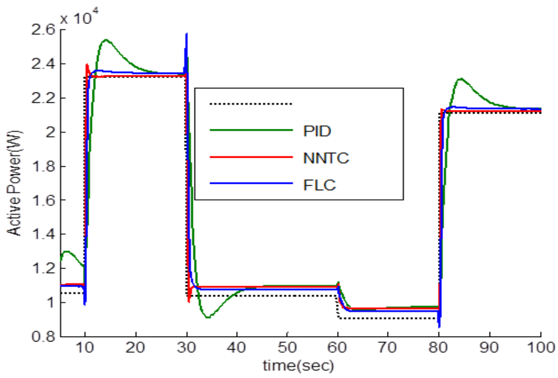

Fig.3 Changes in the active power

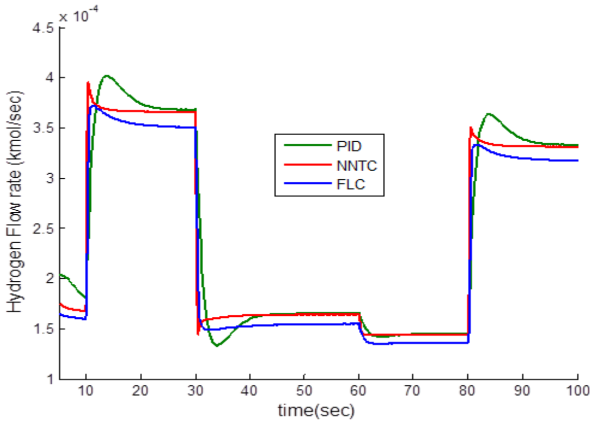

Fig.4. Changes in the flow rate of hydrogen

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