Fuel cell control based on the maximum power using neural networks

Zolykha tedadi
Department of Electrical Engineering Ahar Branch , Islamic Azad University , Ahar Iran
Email: **Sh.teadadi@gmail.com**

Abstract

Increase power consumption on the one hand, and fossil energy problems such as environmental pollution, increase their prices, and.... On the other hand, increased production of renewable energy is dissipated in the system and especially a fuel cell different types of renewable energy. Increasing is day by day. fuel cells different one of types, which is one of the most important types of various types, fuel cell with a proton exchange membrane (PEM) which is one of the major problems of this type of fuel cell, dependence it is load on. In the absence of an system load increase it will reduce the load voltage and if the load reduces voltage is increase. Output voltage control for controllers must be designed in this paper neural network controller that could change in pressure katd and anode gases input for load changes the output voltage is fixed. To search for. And Controller voltage to reduce error and increase the power quality of the design

Keywords: *Fuel cell, neural networks, hydrogen, neural network controller, fuel cell maximum power*

1- Introduction

The energy crisis is one of the issues that concern today's society is ever to provide the bulk of fossil fuel energy are required human resources Banners decaying hand, consumer systems that are burned with low return this system, in addition Bratlaf fuel sources, the most important sources of environmental pollution are therefore energy use systems energy conversion efficiency, low pollution, such as fuel cells, is much needed and necessary. [1].environmental reasons the use of fossil fuels associated with over the years a steady increase in demand for new technology systems for the production of energy without emissions. In this context fuel cells as an alternative to the very good reasons, such as efficiency high, loss low to medium dynamic response is excellent ,reliability superior resistant space applications still fused[2]. System fuel cell overall electrical efficiencynet40 to 60 percent, is that almost all energy conversion systems more. [3] Fuel cell electric power generation is a new device that directly convert chemical energy of hydrogen and oxygen in a chemical reaction in the presence of an electrolyte-free burning with the help of electrodes is converted into electrical energy. [4]

2- Power control

Oxygen fuel cell mass control system to prevent voltage drop mass, high efficiency and lifetime as well as a big deal. Here's a new control method for oxygen control system (breathing) the mass of the fuel cell on the basis of a combination of state space equations the neural network model is proposed. The main goal of sending control system sufficient air to the masses and maximum net power of the masses.

Polymer membrane fuel cell process with state space equations and mass output voltage with a neural network including an input layer, a middle layer and an adaptive neural controller. Then the output shown to control breathing fuel cell system is designed based on combined model.

Neural model successfully in many applications including chemical processes, biochemical, image processing is used. That all available information is that the process of process parameters using artificial neural network model are unknown**.**

2.1 state space model

State space model nonlinear model based on the equations of state 9 modes:

m_{o2} m_{h2} m_{n2} m_{sm} $m_{w,an}$

Wcp $m_{w,ca}$ p_{sm} p_{rm}

LTI system analysis in the subject line of the model used for the linear model

U voltage the compressor Vcm is.

2.2 neural network model

Weather in fuel cell voltage is very important. Some empirical research methods or models to calculate the fuel cell voltage developed but non-linear models or parameters. In this paper, a lot of artificial neural networks to calculate the fuel cell voltage is applied to the topology shown below is.

State space model nonlinear model based on the equations of state 9 modes:

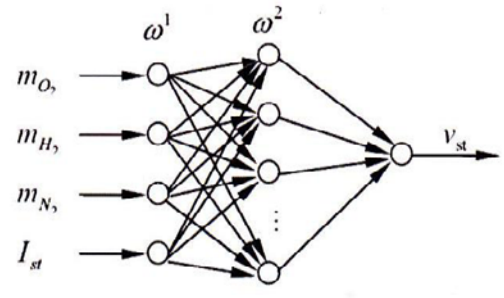

Fig.1. tvpvlvzhy neural network for the voltage

Network input oxygen mass, the mass of hydrogen, nitrogen mass, cell output current and output voltage of the fuel cell is a neural network. This here with minimizing a quadratic loss function of the output error is made the error of comparing the output value with the desired output is achieved. Many optimization techniques are able to do so.

Block diagram of the control system by using a combination of equations of state-space model with the fuel cell process neural network shown.

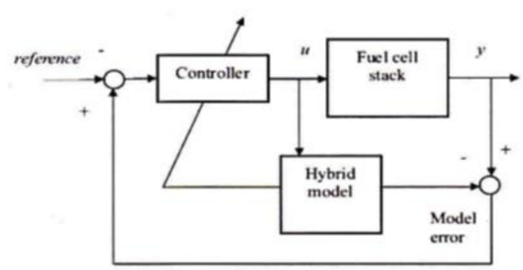

Fig.2 System Control output power

Add considered as a parameter of oxygen that cells need oxygen in the show

$$\lambda_{o2} = \frac{w_{o2,in}(x)}{w_{o2,rct}(x, I_{St})} \qquad (1)$$

The oxygen flow rate entering the mass flow rate of oxygen reaction shows direct Lyon cell flow

Affected, λ_{o2} leading to a drop $W_{o2,rct}$ in the moment, in other words the proportion of added oxygen λ_{o2} compressor driving voltage, impact. There is there for λ_{o2} much we can improve oxygen partial pressure that needs to get more power from the compressor .mtghyyrs that λ_{o2} affect the performance of the control input (voltage compressor) and the flow cell.

The purpose of adding the control system to keep oxygen in the amount $\lambda_{o2}^{ref} = 2$ of the lump sum is the maximum power with minimum cost function is below the output voltage and Q are mass values of their weight.

$$J = Q_1(I_{St}v_{st})^2 + Q_2(v_{st} - y)^2 + Q_3(\lambda_{o2} - \lambda_{o2}^{ref})^2 \qquad (2)$$

V_{st} The neural network is calculated. [5]

3- Fuel Cell Model

To evaluate the control approach, this work has considered the fuel cell model proposed in [6]. The voltage

Model contains an equation to calculate the FC voltage E_{FC} That is based on the FC temperature, pressure reactant gas Partial pressures and membrane humidity and is described as

$$E_{fc} = 1.229 - 0.85.10^{-3}(T_{fc} - 298.15) + 4.3085.10^{-5}T_{fc}[\ln p_{H2} - Lnp_{o2}] \qquad (3)$$

The FC should give a fast response providing the maximum net power, that is, it should achieve the lowest losses caused by the compressor according to the following equation

$$P_{net} = P_{fc} - P_{com} \qquad (4)$$

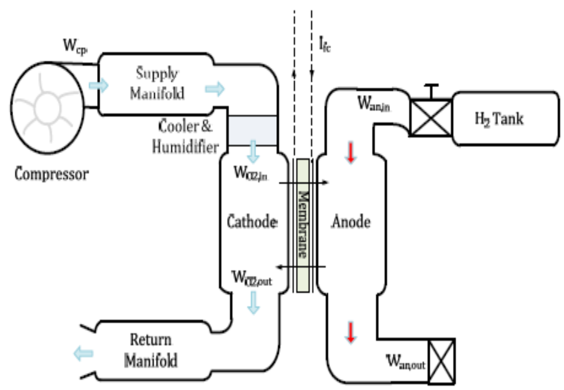

***Fig.3.**.Schematic diagram of the FC system*

Where P_{comp} is the motor compressor consumption which

Is derived from the FC model, and P_{fc} is the power supplied by the fuel cell stack, which is given by

$$P_{fc} = I_{fc}E_{fc} \qquad (5)$$

4- Results and Discussion

According to the results, provided neural network control system for quickly controlling the fuel cell terminal voltage and improving system performance. In addition, less energy consumption, reduced system complexity and the neural network controller are able to change hydrogen stream to control the real power to change time the error signal between the actual plant output and the reference model output trains the neural network

In this study, the NN identification model is first generated to emulate the forward model of the system of PEM fuel cells which is used under various conditions of active and reactive power plant. This model is then placed in series with the NN controller to track the reference model as shown. The tuning of the PEM fuel cell dynamic neural network controller

Is now convenient through the NNC model.

Thus, from Figs. 4and 5it is easy to observe that the use of neural network controller gives best results.

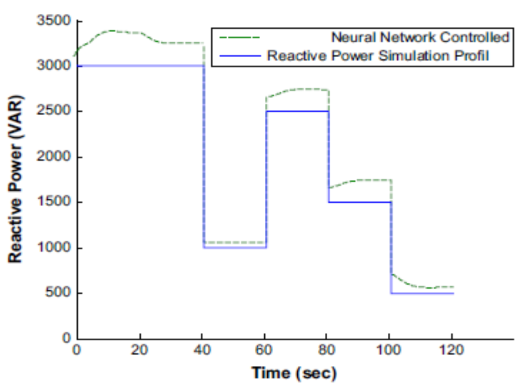

Fig.4.Reactive power network control Controlled

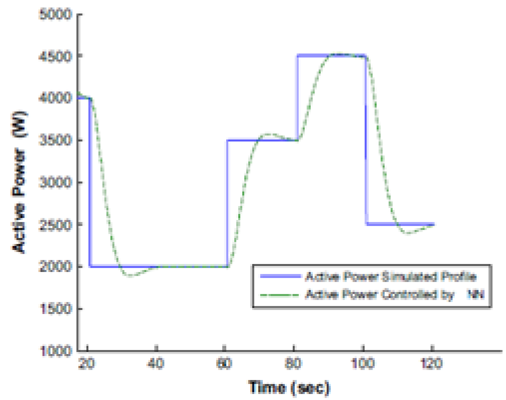

Fig.5.active power network control.

References

[1] M.Samavati, et al, 1388,"report on the conceptual design of the project design and fuel cell CHP systems 5KW",fuel cell groups, Research Center of Engineering Esfahan.

[2] c.panos,K.I.Kouramas,M.C.Georgiadis, E.N.Pistikopoulos,"Modelling and explicit model predictive control for PEM fuel cell systems"Chemical Engineering Science 67(2012)15-2

[3] Suns.J.Yan, G.Y.Cao, X.J.Zhu,"Modeling and control PEMFC Using Fuzzy Neural Networks, "Journal of Zhejiang University SCIENCE, VOL.6, 2005, PP.1084-1089

[4] Y.Tian, X.Zhu, and teal, "An Adaptive fuzzy Control Strategy of Movable Power Sources of Proton Exchange Membrance Fuel Cells", IEEE Conference, VOL.2, 2005.

[5] L.Zhang, M.pan, S.Quan, Q.Chen, Y.Shi,"Adaptive Neural Control Based On PEMFC Hybrid Modeling", IEEE Conference, VOL.2, 2006, PP.8319-8323.

[6] J. T. Pukrushpan, "Modelling and control of fuel cell systems and fuel processors", Doctoral thesis, 2004.