Modelling and Control of NEXA Fuel Cell

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ABSTRACT

In this extended abstract the modeling and controller design of a Nexa PEM fuel cell are presented. In the modeling section, two neueal network algorithms are utlized to predict the performace of the fuel cell system. In sequel, an Intelligent controller has designed, developed and implemented in order to increase the efficiency of PEM Fuel Cells using soft computing. The experimental results demonstrate the effectivness of the proposed method.

1. INTRODUCTION

The past fifteen years has seen an emphasis in advancing fuel cell technology to enable decrease reliance on fossil fuels [1]. Toward this end, a significant amount of governmental and industrial resources have been focused on developing Proton Exchange Membrane fuel cells (PEMFC) as a "cleaner" more efficient alternative to existing power generation technologies. PEMFCs convert chemical energy directly to electrical energy with conversion efficiencies approaching 60% [2]-[3]. In addition, the only bi-product of reaction is water, which makes the PEM very attractive from an environmental standpoint. Foreseen applications of PEM fuel cells are widespread ranging from automotive, aviation, space, marine, military and stationary power production to name a few [1]-[5]. The technology is suited to provide for power demands from a few watts up to about 300kW [3]. Some of the major advantages of PEM fuel cell over other fuel cell technologies are the low operating temperatures and quick startup. In this paper, the modeling and controller design of Nexa Fuel cell are investigated as ongoing research as presented in[4]-[5].

2. Modelling of Nexa Fuel Cell

In this section, we investigate how well back-propagation and RBF networks can predict the performance of a fuel cell system. The 1.2 KW Nexa™ fuel cell is shown in figure 1. It can produce the unregulated DC power from a supply of hydrogen and air. The rated power at standard condition is 1200W with the voltage range 22V to 50 V and 26V at rated power. The unit is self-operated with a capability to collect the data from computer via Lab VIEW program.
The system consists of seven control signals and nine sensors to monitor the significant variables. The hydrogen pressure is regulated by regulator valve. The system controls air compressor for airflow, and cooling fan for stack temperature.

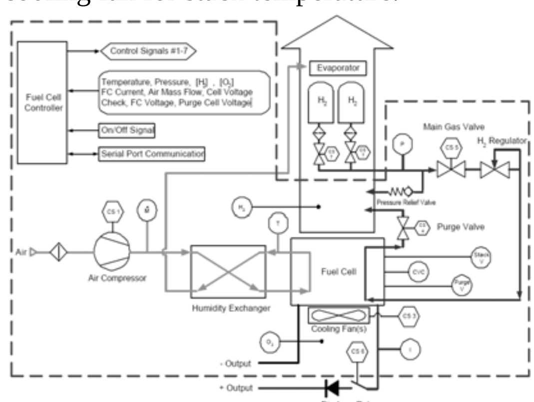


Figure 1: Block diagram of Ballard™ fuel cell

3. Controller Design

In this section, the experimental set up and the equipment utilized for the controller implementation are briefly explained. The system control implementation is shown in figure 2. In order to control the air mass flow rates according to the control algorithms, the controller will send the control output signals via analog output module (0-5VDC) of data acquisition (DAQ) to the mass flow controllers. The mass flow controllers will also send

the actual air mass flow rates to the computer via analog input module (0-5VDC). The load bank is varied and controlled by sending the digital outputs (DOs) to the op-amp circuit and the solid-state relays (SSRs).
The nominal power of the Nexa system is 1.2 kW.

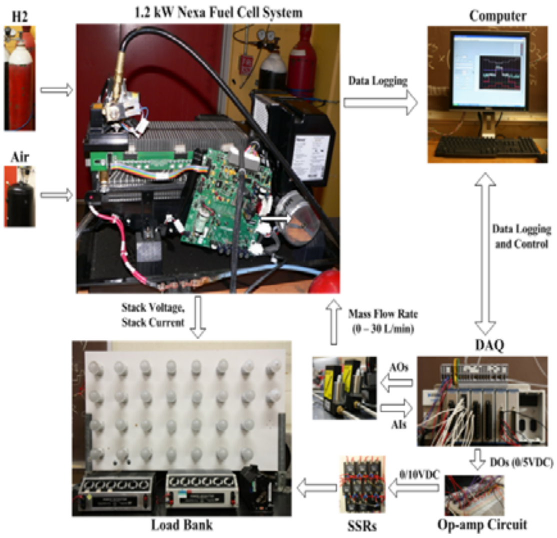


Figure 2: Block diagram of FC experimental set-up and controller implementation

The membership functions of the input (stack power error) and output (airflow rate adjustment) are selected appropriately.

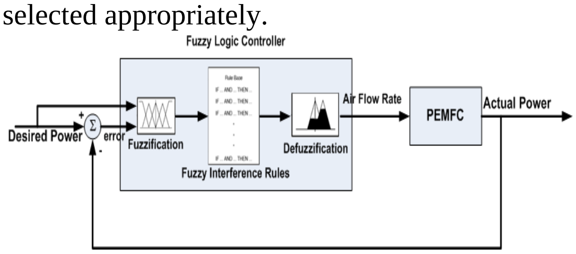
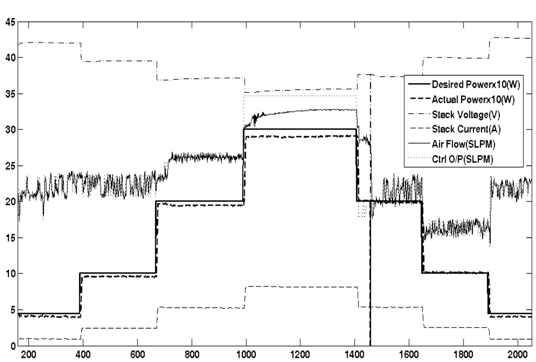


Figure 3: Blok Diagramo f Fuzzy Logic Controller



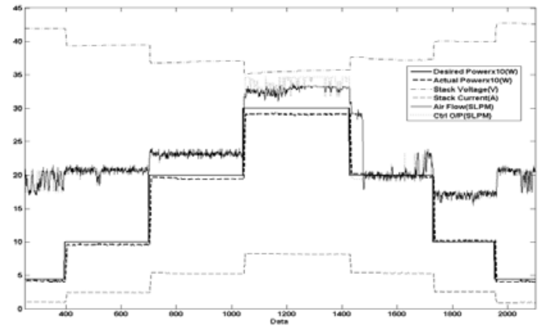


Figure 4: Actual & Desire Tracking of FC

As it is shown in Figures 4(a) & (b), the actual power track the desired power very closely using the fuzzy controller. The comparison of the result with fuzzy controller as shown demonstrates the effectiveness of the proposed method.

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