

DESIGN AND FABRICATION OF HYDROELECTRIC FUEL CELL SYSTEM FOR HOUSEHOLD POWER PLANT

K. C. Nguyen.*, L T. Chung **,

Saigon Hi Tech Park Research Laboratories (SHTP LABS), Hochiminh City, Vietnam

** THLLC Joint Stock Company, Hanoi, Vietnam

ABSTRACT

In Viet Nam, there is a lot of electrical shutdown occurred at night time due to the shortage of electricity. Many people utilizes diesel oil power plant which generates a lot of pollutions such as noise and smelly toxic gas. In an effort to provide green energy source which is friendly to environment, we tried to develop a stand alone power plant providing 2000 watt. This power should be enough for cooking, air conditioner, lighting in a single home. A compact hydroelectric fuel cell system is designed for household power plant which can connect to national electrical network in Vietnam.

The most expensive components are PEM if a TCP (Toray Carbon Paper gas diffusion layer); a Nafion proton transporter had to be used. In order to provide reasonable and acceptable cost, innovation had been made in the development of the replacement of TCP for gas diffusion material, the replacement of Nafion for PEM and the replacement of graphite for bipolar plates.

CONCEPTS

Fuel cell is an electrochemical device which can generate electricity by an oxidation of fuel (chemical reaction) into a proton (H⁺) and release free electron to the outside circuit. The ideal fuel cell system must provide plenty of electrons to generate high power electric efficiency in the practical level. The oxidation of fuel can occur by several mechanisms

a) Through an electro catalyst. This is the most long lasting energy providing system as the catalyst is not consumed in the process of generating free electron. When the fuel hits catalyst, it will be splitted into free electron and proton. Thus, there must be a proton transporter located right behind catalyst to avoid a recombination which can cause the electricity loss and proton transporter plays a key role here. Nafion products of Dupont, so far, are a key proton transporter even though it has revealed a lot of disadvantages including poor thermal stability, high cost.

b) Through a red ox reaction between fuel and reactor. The THLLC's fuel cell technologies are comprised of proton transport molecule, which is based on "liquid" coal. "Liquid" coal is surface and bulk modified carbon black with proton transport functional group SO₃H attached onto it. "Liquid" coal is actually a "liquid" nano coal as it exhibits nano scale in a suitable aqueous environment; the individual particle can be isolated and

showing particle size distribution in the range below 100nm. "Liquid" coal is a good proton transporter and tends to finely and stably dispersed in aqueous solvent. THLLC 's proton exchange membrane or polymer electrolyte membrane (PEM) is composed of "liquid" coal well encapsulated in polymer so that the PEM is not soluble and "liquid" coal still maintains nano scale in the polymer matrix. THLLC 's fuel cell technology using this PEM technology to gain high heat resistance, high bulk resistivity and thus high current density as well as high voltage. The "liquid" coal based PEM shows equivalent fuel cell performance with Nafion which is well known in the world.

However, THLLC's PEM is much more lower cost than Nafion.

c) For the fuel penetration material (FPM). TCP (Toray Carbon Paper) is a well known Trade Mark of fuel penetration materials (FPM). However, TCP is crispy and easily broken under high stress. TCP is also very high cost. Our FPM offers some advantages over TCP such as low cost, strong mechanical strength

d) PEM assembly: THLLC can also supply the entire custom made PEM with various size, thickness, voltage, current density

e) Electro catalysts: THLLC can provide low cost and stable catalytic materials for anode and cathode

f) Stack fuel cell: THLLC can provide good design for stack fuel cell based on liquid" coal electrolyte as above mentioned

Next, the energy system utilizes water to generate H₂ by the reduction agent contained in a replaceable cartridge. Regarding the hardware components, the system is composed of H₂ generator controller, PEM performance optimizing controller and electrical signals output controller. For the H₂ generation, the controller is composed of H₂ pump and H₂ regulator (regulator + pressure gauge). A heat and water vapor collector from the cathode reaction is equipped to enhance the PEM performance for example, electrochemically generated water can be used to control internal humidity required for proton transport. In order to control the out put electrical power, IC and Li-Po battery was used.

For the low cost approach, the hydroelectric fuel cell system utilizes new proton transport material which comprised of "liquid" nano coal (LC) embedded in a polymer forming nano composite as above mentioned.

The combination of LC PEM and replaceable reducer cartridge can made the hydroelectric fuel cell system compact and low cost for use in household power generator, electric bicycle, electric motorcycle, car and

power plant. In the present work, this is a true clean tech which is designed to demonstrate an output power from 2000W up to 20,000W for mini power plant for house hold.

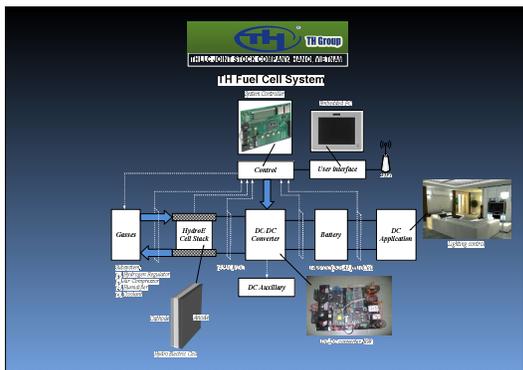


Fig.1 Structure of hydroelectric fuel cell system utilized in household power plant