International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 10 (2018) pp. 8377-8381

Design Fabrication and Dynamic Characteristics of PEM Fuel Cell

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Abstract

The proton exchange membrane fuel cell uses a water-based, acidic polymer layer as its electrolyte, with platinum-based terminals. PEMFC cells work at by and large low temperatures (underneath 100 degrees Celsius) and can tailor electrical respect meet dynamic power necessities. On account of the by and large low temperatures and the usage of significant metal-based anodes, these cells must work on unadulterated hydrogen. PEMFC cells are at the present time the fundamental advancement for light commitment vehicles and materials dealing with vehicles, and to a lesser degree for stationary and distinctive applications. The PEMFC vitality unit is in like manner sometimes called a polymer electrolyte layer control gadget

Hydrogen fuel is set up at the anode where electrons are detached from protons on the surface of a platinum-based force. The protons experience the layer to the cathode side of the cell while the electrons go in an outside circuit, delivering the electrical yield of the phone. On the cathode side, another significant metal anode unites the protons and electrons with oxygen to make water, which is expelled as the principle squander thing; oxygen can be given in a cleansed outline, or expelled at the terminal particularly from the air.

A variety of the PEMFC which works at lifted temperatures is known as the high temperature PEMFC (HT PEMFC). By changing the electrolyte from being water-based to a mineral destructive based structure, HT PEMFCs can work up to 200 degrees Celsius. These annihilations a bit of the present imprisonments as to fuel ethicalness with HT PEMFCs prepared to process reformate containing little measures of Carbon Monoxide (CO). The change of plant can similarly be unraveled through transfer of the humidifier.

Watchwords: PEMFC, Membrane, polymer, temperature, electrolyte.

INTRODUCTION:

Worldwide interest for new and sustainable power source has prompted a few elective vitality assets and innovation. One of them is power module (FC) which changes over synthetic vitality of hydrogen and oxygen (or air) straightforwardly to electrical vitality. There are numerous sort of energy unit innovation, for example, soluble FC (AFC), proton trade film FC (PEMFC), phosphoric corrosive FC (PAFC), liquid carbonate FC (MCFC), and strong oxide FC (SOFC)

Proton trade layer FC (PEMFC) is a promising innovation because of its powerful thickness, low working temperatures, low nearby discharges, calm task and quick start up-shutdown. One of PEMFC application is as smaller than expected/convenient power supply. For this reason, the PEMFC is normally amassed as a pile of numerous cells. Examination of PEMFC execution was led by amassing 1, 3, 5 and 7 cells, at that point assessed the polarization bends yielded by power module test gadget.

EXPERIMENTAL STUDY:

Segments of PEMFC stacks comprised of film terminal get together (MEA), aluminum end-plates, gold covered copper current authorities, silicon elastic gaskets (sheet thickness 0.5mm), FU4369 graphite bipolar plates and different adornments (Swagelok tubing fitting, bars, stainless steel stray pieces, ring, warm safe's shells, silicone tubing). MEA comprised of Nafion 117 film, gas dispersion anodes (GDE) with 0.5 mg/cm2 Pt stacking of 60% Pt/C and 5 wt. % Nation 117 arrangements. The reactant gases were hydrogen UHP (99.99% immaculateness) and oxygen, with nitrogen as cleansing gas. In this gathering, the reactant gases stream arrangement was Z write.

FABRICATION OF STACK COMPONENT:

The bipolar plates were power device review FU 4369 graphite bipolar plates, measurement of 62 mm x 95 mm x 5 mm, with a 6-direct serpentine example in the hydrogen stream field and in oxygen stream field. Profundity and width of the channels were 1mm, and width of the rib was 0.8 mm (Figure 2). The present gatherer plates were gold covered (0.2 µm)- copper plates, measurement of 62mm x 120 mm x 1.0

mm). The aluminum end-plates had measurement of 80 mm x 115 mm x 16 mm.

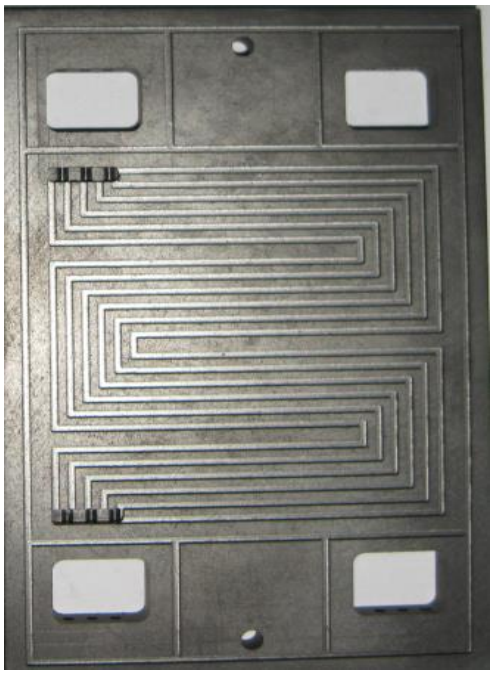


Figure 2: Bipolar plates outline

ARRANGEMENT OF MEMBRANE ELECTRODE ASSEMBLY:

The layer terminal gatherings (MEAs) utilized for the examination were set up by hot-squeezing of two business gas dispersion cathode (GDE) (60 wt% Pt/Vulcan XC72 on carbon material, Pt stacking 0.5 mg/cm2) on either side of a DuPont™ Nafion 117 film at 120oC, 20 kgf for 1 min. For powerful contact between the GDE and the film, the Nafion 117 arrangement (5% arrangement of 1.0 mg cm-2(Neuroflash PTE Ltd)) was connected on impetus surfaces of two GDE by screen printed strategy. Nafion 117 layer was beforehand treated with 3% hydrogen peroxide (H2O2) at 70-80oC for 1 h to expel natural polluting influences. To get completely H-frame, the layer was bubbled at 70-80 oC for 1 min 0.5 M H2SO4 , after that the film was washed twice more than once with refined water at 70-80 oC for 1 h to expel H2SO4 that stay on the film surface.

ASSEMBLING OF SINGLE CELL:

The PEMFC stack comprises of single cell, 3-cells, 5-cells and 7-cells with dynamic region of 25 cm2. The MEAs, gasket, two mono polar plates (for hydrogen and oxygen stream), bipolar plates and current authorities were sandwiched between two aluminum end plates with eight strung stainless steel bars, fasteners and nuts. The gaskets are put between electrolyte film and bipolar-plate which ought to have great flexibility, toughness and consumption safe. Amid the stack amassing, two situating poles were utilized for arrangement. All segments were adjusted and stacked one by one. The sizes of SS 316 jolts are M6 x 0.8 mm with 58mm, 70mm, 90mm and 100mm length for the single cell.

PERFORMANCE OF PEMFC:

In the cell testing, high virtue hydrogen (99.99%) and oxygen gases were utilized as fuel and oxidant, separately. Smart2 PEM/DM half and half power device test framework (WonATech Co., Ltd.Korea) was utilized to test the execution of the stacks. The test station comprised of two principle frameworks: a gas nourishing and a controlling framework. A gas sustaining framework provided and treated the fuel and oxidant gases encouraged to the cell, while the controlling framework estimated and controlled the task states of the FC stack. The back weight of the energy component could be changed with the assistance of mechanical valves in the test station, for every reactant.

Figure 3: Estimating execution

Figure 5: Test setup

Changing gas stream rate for single cell:

At initial step, number of cell was kept steady at single cell. Gas stream rate variety was connected, and after that every one of its exhibitions was assessed. As expansion, back weight was likewise connected to demonstrate its impact.

RESULT AND DISCUSSION:

Figure demonstrated that for single cell, the best execution was accomplished by state of 100/100 with back weight, trailed by 100/100, 100/140, and 60/140, separately. To start with, it demonstrated that back weight have beneficial outcome on power module execution, as effectively affirmed by numerous logical books and diary papers. Second, it demonstrated that 100/100 mL/min not just demonstrated the immersed stream rate for the single cell, yet additionally showed that 1: 1 proportion is the best stoichiometry proportion for these reactants. Hypothetically, the mole proportion of hydrogen and oxygen gases for water arrangement is 2: 1. The inconsistency between the exploratory and hypothetical proportions should be examined at additionally inquire about.

Fig 7 demonstrates that open circuit voltage esteems were typical for every cell, as it was anticipated from hypothetical examination and affirmed by numerous exploration papers. Operational voltage was controlled by definition. The aftereffects of operational current thickness were fairly unforeseen. The 7-cells demonstrated a come up short or broken condition on task/testing. It is typical if the normal esteems for Jop were same or comparable for the greater part of the 4 mix. In any case, the outcomes were extraordinary. This prompt unpredictable example for operational power thickness Pop. There are numerous components that could add to this surprising outcome, from the nature of MEA amassing (hot-squeezing), spillage of reactant gases, and so forth. The danger of deformity is expanded as number of cells expanding.

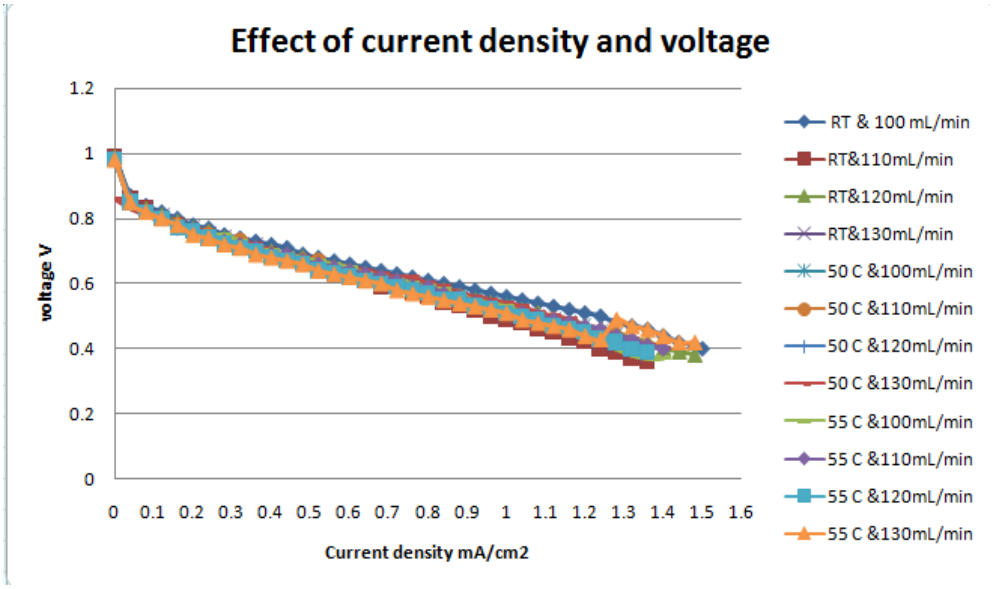


Figure 6: Polarization of Current thickness and voltage

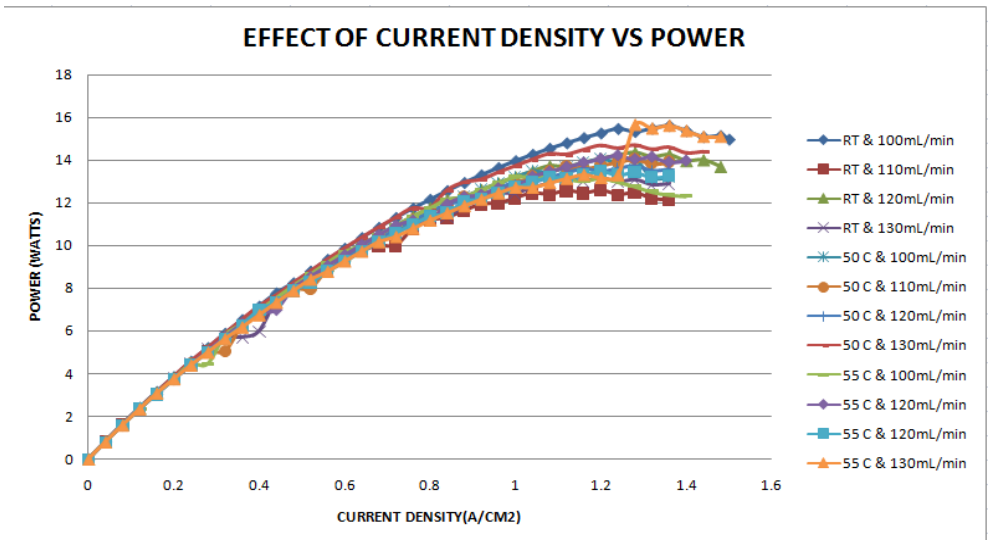
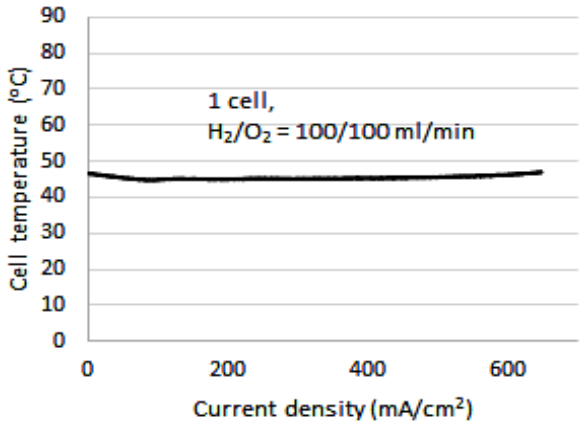
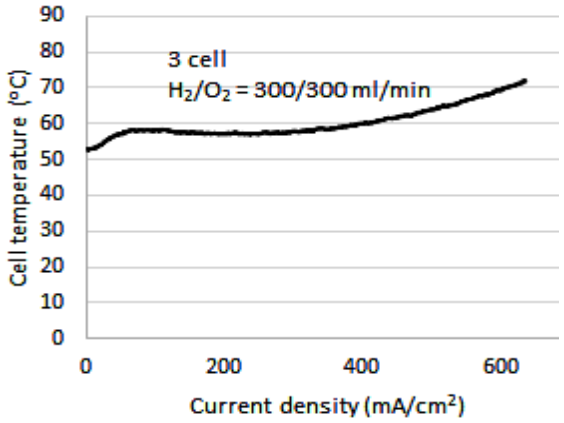


Figure 7: Current density vs. Power



(a)



(b)

Figure 8: Correlation of cell temperature and Jop, (a)1-cell, (b)3-cells

From Figure 8, plainly there exist a few patterns between cell temperature and current thickness. For 1-cell, the temperature was generally unfaltering at 45oC. For 3-cells and 5-cells, temperature increment das current thickness was growing up, yet not surpasses 90oC (typically known as temperature constrain for Nafion film). Rather, by achieving 70-80oC, the stack could enhance its execution, as this temperature run is the best esteems for Nafion execution. For 7-cells, the expanding temperature could surpass 80oC, if current thickness was over 400mA/cm2. This implies the stack needs a cooling framework to keep from probability of broken. On the opposite side, this outcomes recommended that there was a plausibility that the 7-cells temperature had surpassed 80oC, so activating of Nafiondefective amid testing.

CONCLUSION

The polarization bends demonstrated that before electronic stacking, the OCV of every cell have typical esteems. This implies all stack worked regularly at begin point. As present thickness was expanding, a portion of the cells were going underperformance. A few contemplations could be taken, for example, hot-squeezing that in light of decided dividing (thickness) as opposed to weight measure, cooling framework for expanded number of cells, changing benefit of clasping torque, and so forth. The danger of come up short is expanded as number of cell is expanding.

More number of the cells and higher current thickness had effect on the expanding of cell temperatures. Then again, this expanding temperature could add to higher execution of the stack if could be kept up between 70-80oC.

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