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Reproduction And Imitation Of Proton Exchange Membrane Fuel Cell Performance At Dissimilar Porosity Of Diffusion Layer

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ABSTRACT

The nucleon exchange membrane electric cell is associate degree example of fresh energy. Recently, a three-dimensional, steady-state non-isotherm mathematical model for nucleon exchange membrane electric cell was developed for any exploration. This 3D model at the same time takes under consideration the mass, momentum, energy, species, charge conservation equation in addition as combines chemical science reaction within the electric cell. The simulation results reveals that it's straightforward to boost the electric cell performance for higher consistence within the diffusion layer by rushing up the gas diffusion, reducing the concentration grads of gas, depressing the ridge board consequence and falling current density grads.

1. INTRODUCTION

Proton exchange membrane fuel cells (PEMFCs) area unit promising inexperienced power sources for several applications. Simulation and experimental analysis on PEMFC is vital for each internal transport phenomena exploration and structural style optimisation [1-2]. Water behavior is one among the key factors influencing electric cell performance, thus analysis on water management problems area unit very talked-about in recent years. the new topics of those studies were water transportation within the nucleon exchange membrane [3-9] and within the gas diffusion layer [10-15]. At identical time, many researchers thought of the water transport on the gas flow channels [16-17]. A three-dimensional, steady-state non-isotherm mathematical model for nucleon exchange membrane electric cell is developed during this paper. The model takes into accounts at the same time the mass, momentum, energy, species, charge conservation equation and combines chemical science reaction within the cell.

2. MATHEMATICAL MODEL

The essential suppositions of the model: one. the operation setting of the cell at steady state and non-isotherm. 2. The diffusion layer and therefore the catalyst layer area unit pore media. three there's solely streamline flow within the electric cell flow field. The model is calculated by the FLUENT six.3 software system [18].

2.1 Physical model

The physical model of a nucleon exchange membrane electric cell is developed, which has nucleon exchange membrane, catalyst layer of anode and cathode, gas diffusion layer of anode and cathode, gas channel of anode and cathode, current collector of anode and cathode. this is often typical straight channel flow field and used generally.

3.RESULTS AND DISCUSSION

3.1 The performance

The simulation results displays that the cell's performance at higher consistence is healthier than at lower consistence once the cell is at higher current density. it's opposite once the cell is at lower current density. The cell with a consistence of zero.2 has nearly identical current density at the lower current density with the consistence of zero.8 once it's at zero.8V. The fuel cell's polarization curves departs the one-dimensionality relation with the voltage attenuates speedily with the lower consistence once the cell at lower voltage section (e.g. under 0.7V), that place up large concentration distinction polarization particularly once the cell at the consistence of zero.6V. The electric cell has best performance at the consistence of zero.8 whereas the worst at zero.2. the explanation is that the chemical concentration of the conductor surface begins to alter once the fuel is consumed. for instance, the cell unharness current at identical time consumes chemical element once chemical element is provided to the cell's cathode, that ends up in the chemical element falling across resistance whereas being transferred. There area unit 2 troubles once the mass is been transferred. One is that the house resistance, the second is flooding. The house resistance is principally aroused by the mass transmission and reaction distinction between the flow channel and therefore the ridge a part of the flow flied board. The liquid state water bring that the millipore within the diffusion layer happens to jam that influences the traditional gas diffusion.

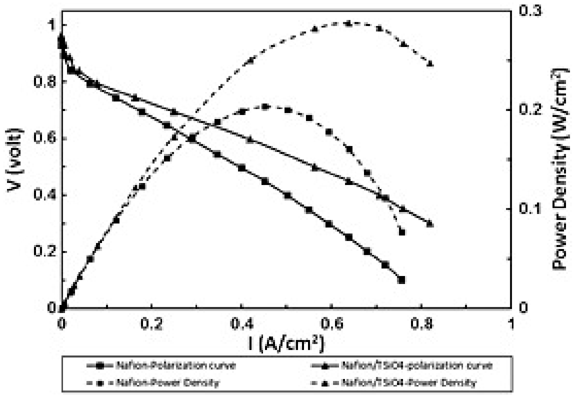

Figure1. Performance of proton exchange membrane fuel cell

3.2 the present density distribution

The highest current density region is that the osculant district of the ridge a part of the bi-polar board and therefore the diffusion layer, which might be seen within the red zone from Fig.3. this is often simply the world that has the shortest gas and negatron transport path. the present density higher than the flow channel is incredibly little. it's troublesome for chemical element to diffuse into the catalyst layer below the ridge portion at lower consistence of zero.2.

3.3 Distribution of gas concentration

Fig.4 displays the chemical element and chemical element gas mass concentration distribution at the Y=0m section of XZ once the cell discharge potential of zero.6V with the diffusion layer consistence is zero.2, 0.4, 0.6 and 0.8. It may be seen that the chemical element gas within the gas channel of the anode distributing uniformity with the mass fraction worth of zero.8105 once the consistence is zero.2. otherwise, the chemical element gas distribution grads area unit larger than this, decline from zero.77 to 0.65.

This situation are going to be relaxed once the consistence is zero.8, all the gas distribution grads is smaller than that at zero.2. Another result's that the chemical element gas distribution grads area unit smaller than the chemical element gas distribution grads. there's some relationship with the molecule volume. Therefore, the upper the diffusion layer consistence is, the smaller the gas concentration grads of the diffusion are going to be. it's profit for gas transport with high consistence, reducing the chemical element gas concentration grads and ridge half impact, particularly once the chemical element gas diffuses from flow channel right down to the ridge portion of the bi-polar board. The cell performance may well be exaggerated consequently.

3.4 Water distribution

The water mass fraction distribution of the electric cell with the cell discharge potential of 0.6V is shown in Fig.5. The chemical element is humidified before coming into the flow channel within the cathode of the cell, so water from the gas channel and therefore the gas diffusion layer root within the building from reaction and transferring through the nucleon exchange membrane from the anode aspect to cathode aspect. The water mass fraction of the gas diffusion layer is often 0.95 once the consistence of the diffusion layer is 0.2.

The water mass fraction distribution is from zero.1068 to 0.3 at the water slice face, and from 0.3 to 0.6 on the gas channel direction within the slice face at X=2×10-3 m, severally. lastly, the water mass fraction distribution minish from the gas diffusion layer to the gas channel in any XZ slice face, and will increase on the direction of the gas channel. the upper the consistence is, the smaller the water mass fraction distribution grads are going to be, that explains that higher consistence is propitious to water transfer within the diffusion layer.

The different within the anode is that the water mass fraction distribution grads within the diffusion layer on the gas channel direction aren't pretty much as good as that within the cathode. the most distinction area unit that water mass fraction will increase the gas channel on the channel direction within the cathode aspect, whereas depressed within the anode aspect, though the depress extent is little. this is often principally as a result of internet flux of water within the nucleon exchange membrane falls down from cathode to anode aspect, which suggests that the water concentration increasing within the diffusion layer of the anode aspect so diffuse to the gas channel. nonetheless the gas concentration falls down close to the outlet, that ends up in the water building from reaction decrease. The water of the gas channel transfer to the diffusion layer so as to avoid the membrane drying at the anode aspect.

4. CONCLUSIONS

(1) The water brings the millipore within the diffusion layer happens to jam, that influences the traditional gas diffusion. The lower of the consistence, the more severe jam are going to be occurred of the diffusion millipore, and with a lot of rapidness of the voltage.

(2) the best current density region is that the osculant district of the ridge a part of bi-polar plate and therefore the diffusion layer. This happens to be the world that has the comparatively shortest gas transport path and negatron transport path. the present density higher than the flow channel is incredibly little. it's troublesome for chemical element to diffusion into the catalyst layer below the ridge portion once at lower consistence.

(3) the upper the consistence of the diffusion layer is, the smaller the gas concentration grads of the diffusion are going to be. it's profit for gas transport with high consistence, reducing the chemical element gas concentration grads and ridge half impact, particularly once the chemical element gas diffuses from flow channel right down to the ridge portion of the bi-polar board. The cell performance may well be exaggerated consequently.

(4) The water mass fraction distribution monishes from the gas diffusion layer to the gas channel in any XZ slice face, and will increase on the gas channel direction. the upper the consistence is, the smaller the water mass fraction distribution grads are going to be, that explains that higher consistence is propitious to water transfer within the diffusion layer.

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