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作品編號 030027

參展科別 化學

作品名稱 **H.E.L.P. Heart Empowers Lifelong
Pacemaker**

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EXPERIMENT 1---The effect of NaCl and Glucose Concentration on the efficiency of the cell

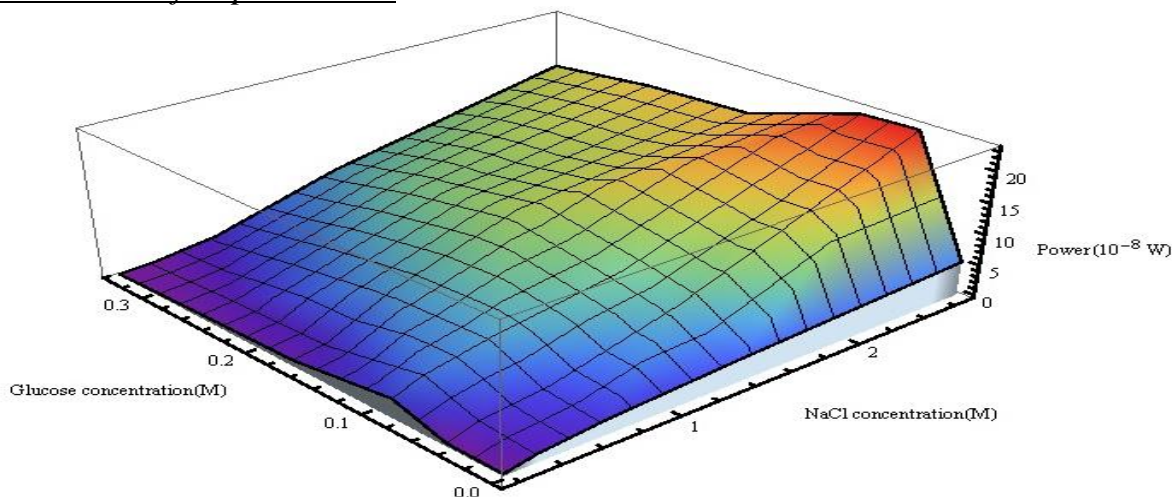
I. Introduction

Experiment on different concentrations of standard glucose solution (ranged from 0.125 M to 1.000 M) and standard sodium chloride solution (ranged from 0.250 M to 4.000 M) were done. We investigated the full concentration effect, which included both concentration of glucose solution and sodium chloride solution on the fuel cell's output voltage, current and power.

II. Procedures

1. Add 25.0 cm³ of Glucose solution of the tested concentration to the beaker representing the anode, and add 25.0 cm³ of distilled water to the beaker representing the cathode.
2. Add 50.0 cm³ of 0.250 M NaCl (aq) to both beakers representatively.
3. Fold a piece of filter paper and soak in fully into NaCl (aq) at cathode.
4. Clean and place the silver wires into the beakers representatively, and connect the air pump to the cathode.
5. Connect the cell to two multi-meters, each acting as a voltmeter and an ammeter respectively
6. Take the readings of multi-meters after 30 seconds.
7. Repeat steps 1 to 6 twice for the second and third reading of the cell.
8. Take average value among three values as the final reading of the cell.
9. Repeat steps 1 to 8 by replacing the NaCl (aq) with concentrations of 0.000 M, 0.500 M, 1.000 M, 2.000 M and 4.000 M, and the standard glucose solution with concentrations of 0.000 M, 0.125 M, 0.250 M, 0.500 M, 0.750 M and 1.000 M.

III. Result of Experiment 1



When glucose concentration is increased from 0.000 M to 0.250 M, the output power increases, it is found that power generated is maximized at glucose concentrations between 0.125 M and 0.250 M. However, with further increase in glucose concentration from 0.250 M to 1.000 M, the power generated decreases. This shows that high concentration of glucose inhibits the generation of electricity, while higher concentration of sodium chloride solution can increase the output.

EXPERIMENT 2---The effect of temperature on the efficiency of the cell

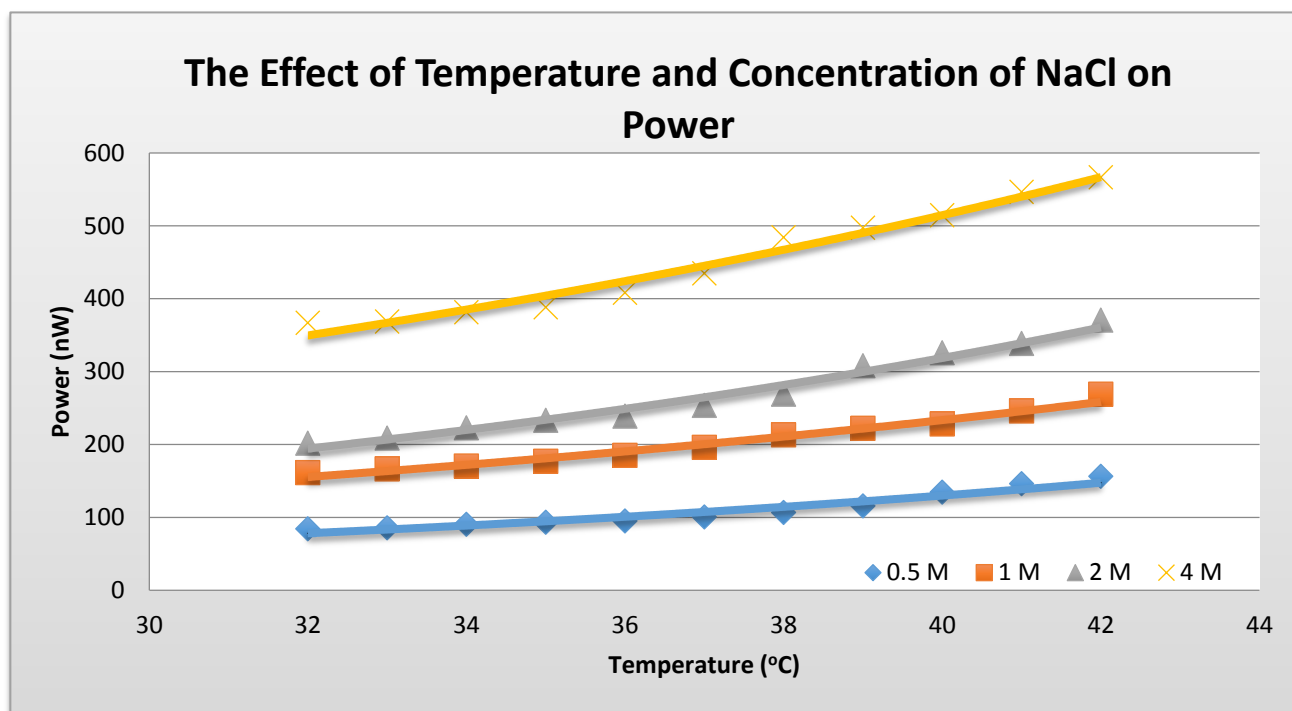
I. Introduction

In this experiment, the second effect - temperature on the fuel cell's output voltage, current and power was investigated. In order to get a significant result, the effect of temperature on these measures with fixed 0.250 M glucose solution and sodium chloride solution concentrations varied from 0.500 M to 4.000 M had been investigated.

II. Procedures

1. Add 25.0 cm³ of Glucose solution of the tested concentration (0.25 M) to the beaker representing the anode, and add 25.0 cm³ of distilled water to the beaker representing the cathode.
2. Add 50.0 cm³ of 0.500 M NaCl (aq) to both beakers representatively.
3. Fold a piece of filter paper and soak in fully into NaCl (aq) at cathode.
4. Clean and place the silver wires into the beakers respectively, and connect the air pump to the cathode.
5. Connect the cell to two multi-meters, each acting as a voltmeter and an ammeter respectively
6. Take the readings of multi-meters after 30 seconds.
7. Repeat steps 1 to 6 twice for the second and third reading of the cell.
8. Take average value among three values as the final reading of the cell.
9. Repeat steps 1 to 8 by varying the temperature from 42°C to 32°C.
10. Repeat steps 1 to 9 by replacing the NaCl solution of 0.000 M, 1.000 M, 2.000 M, and 4.000 M respectively.

III. Result of Experiment 2



The results showed a consistent trend and relationship of the effect of temperature on the output current, voltage and power of the fuel cell for 4 different concentrations of sodium chloride solution with fixed 0.25 M glucose solution. Generally, the results showed that the output power increases with temperature.

EXPERIMENT 3---The effect of dialysis tubing and Nafion 117 on the efficiency of the cell

I. Introduction

Semi-permeable membrane separating glucose and oxygen, ensure the glucose oxidation only occurs at the anode, and preventing glucose oxidation occurs at the cathode, responds to maximize power output. Experimental study on two kinds of membranes, dialysis membranes and Nafion 117 films were done, by studying their fuel cell output voltage, current and power effects.

Previous experiments showed that the optimal output of the battery is at 0.250 M glucose solution, Therefore, experimental conditions for glucose concentration is fixed on 0.250 M and sodium chloride solution concentration varies from 0.500 to 4.000 M.

II. Procedures

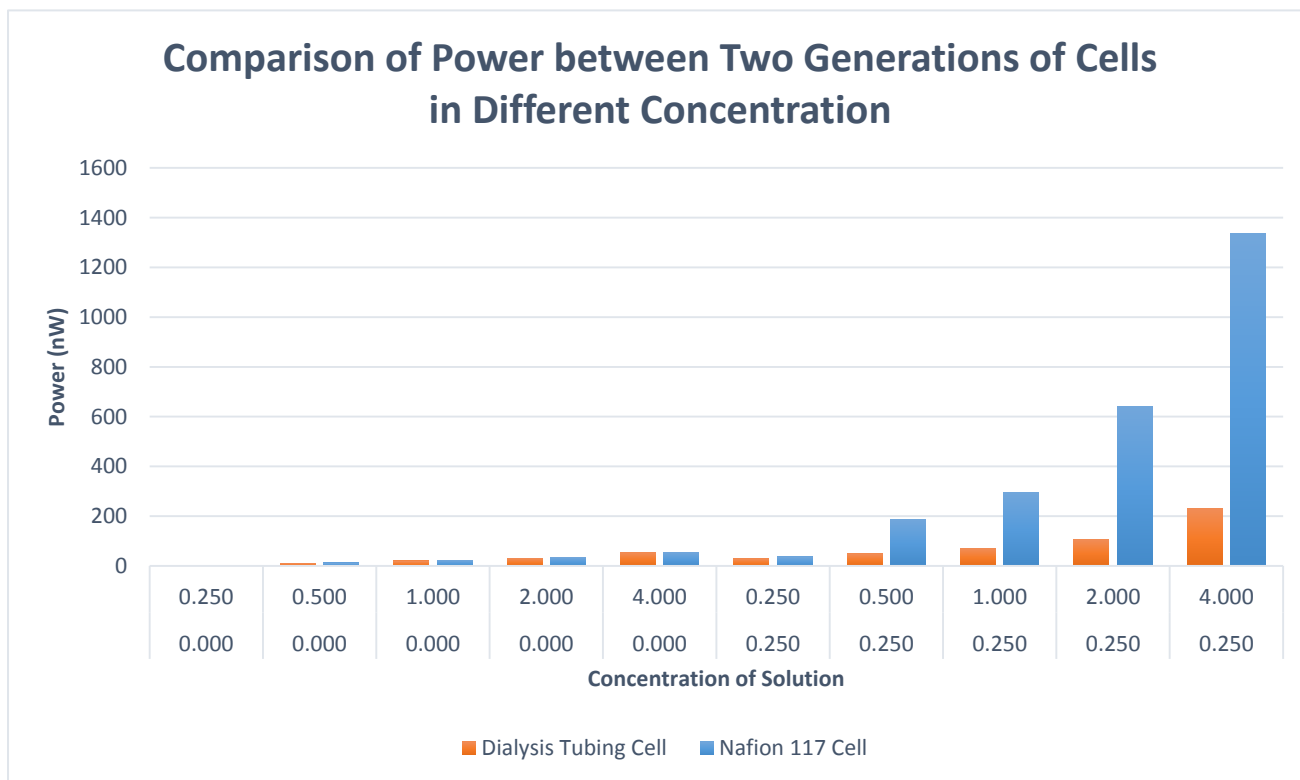
The Effect of Dialysis Tubing on voltage and current of the fuel cell

1. Pour 50 cm³ 1.000 M NaCl (aq) to each compartment of the beaker separated by dialysis tubing.
2. Pour 0.250 M Glucose Solution into the compartment representing anode.
3. Connect the cell to two multimeters, which act as a voltmeter and ammeter respectively
4. Take the reading of the multimeters after 30 seconds
5. Repeat steps 1 to 4 twice for the second and third reading of the cell.
6. Take average value among three values as the final reading of the cell.
7. Repeat steps 1 to 6 with NaCl (aq) with concentration of 0.000 M, 0.250 M, 0.500 M, 2.000 M and 4.000 M to obtain the remaining data.

The Effect of Nafion 117 on voltage and current of the fuel cell

1. Add 50 cm³ 1.000 M NaCl (aq) and 50 cm³ of 0.250 M of glucose solution to the beaker.
2. Add 1.000 M NaCl (aq) to the Nafion 117 membrane pouch, and silver plate was put inside to become the anode.
3. Connect the cell to two multimeters, which act as a voltmeter and ammeter respectively
4. Take the reading of the multimeters after 30 seconds
5. Repeat steps 1 to 4 twice for the second and third reading of the cell.
6. Take average value among three values as the final reading of the cell.
7. Repeat steps 1 to 6 with NaCl (aq) with concentration of 0.000 M, 0.250 M, 0.500 M, 2.000 M and 4.000 M to obtain the remaining data.

III. Result of Experiment 3



The result had shown that when the solution does not contain glucose (i.e. Glucose concentration equals to 0.000 M), Nafion 117 Membrane Cells have similar power outputs compared to the dialysis tubing cells. However, in 0.250 M glucose solution, the output of Nafion 117 membrane cell is about 1 to 5 times more compared to that of dialysis tubing cell. According to the experiment results, it was found out that the power output was maximized when the concentration of glucose solution and NaCl (aq) are 0.250 M and 4.000 M respectively. Under this concentration, the out of Nafion 117 membrane cell was 1336.68 nW which was 5 times higher than that of dialysis tubing cell. Hence, adopting Nafion 117 as the selectively membrane can greatly enhance the output of cell.

It is believed that the special structure of Nafion 117 has limited the movement of glucose molecules, and prevented their oxidation at cathode. This has enhanced the oxidation of glucose at anode, and thus increased the power output of the cell.

【評語】 030027

The proposed design of bio-compatible fuel cell on a pacemaker is impressive. The current prototype still have a long way to go to reach it's final applicable state. However the well-thought developing stages make the future promising. The size-down design of IC and all other parts proven the work is backed up by good support. The prototype has been tested in pig blood successfully. The stepwise resolution of all the problems encountered shows the good logic behind the work.