MFC was warped up in another larger container in which warm water flows from the bottom to the top for controlling the solution temperature of the MFC. The cathode chamber was one nonconductive polycarbonate plate (5 cm width by 5 cm length by 1 cm depth) having a square hole of total volume of 16 cm^3 (4 cm width 4 cm length 1 cm depth). There were two 3mm-diameter holes on the top of the chamber for air flow and electrical outlet. The anode electrode was a 4 cm x 4 cm piece of not wet-proofed plain carbon paper (Toray carbon paper, company). The cathode electrode was a 5 % wet proofed carbon paper (4 cm by 4 cm), and one side of the electrode contained Pt catalysts (0.5 mg/cm^2 with 20% pt). The Pt coated side was hot pressed with an electrolyte permeable membrane providing a membrane cathode assembly (Nafion 117, DuPont Company). Two membrane cathode assemblies were placed on both sides of the cathode chamber, and then the chamber was sealed with rubber gasket and stainless steel bolts and nuts.. All metal parts were covered using silicon glue. The distance of the anode and cathode electrode was approximately 3 cm in the reactor.

MFC operation:

[0068] The reactor was operated in batch mode at 30 °C controlled by warm water pumped from a water bath.. About 550 mL of wastewater was contained in a reactor and was purged with nitrogen gas for approximately 30 min prior to being tightly sealed inside an anaerobic glove box (Coy Company). Replacement of the wastewater in the MFC was performed in an anaerobic glove box all the times. The magnetic stirring bar was placed at the bottom of the reactor for mixing the solution at around 300 rpm. The air flow rate to the cathode chamber was about 10 mL/min in all experiments. The electric current between two electrodes was generally measured with a fixed resistor of 470Ω and 180Ω, except for the measurement with various loads using a resistance box..

Analysis and Calculations:

[0069] The wastewater strength was expressed as the average soluble COD (SCOD) based on duplicate samples. All samples were filtered through a 0.2 μm diameter syringe membrane, and in most cases the filtered samples were used immediately for the COD measurement except some samples were stored at a -80 °C refrigerator before the measurement. The determination of COD was performed using cell tests, and the readings were conducted by a photometer using standard methods. The electrolyte resistance between two electrodes was determined by an impedance spectroscopy instrument. The voltage difference between two electrodes was measured across a fixed load every 10 or 30 min., and the data were collected automatically by a data acquisition program and a personal computer. In some test, the external resistor was varied ranging 43 to 22 KΩ to determine the maximum power density and individual electrode potential as a function of different electric current. Current (I) was calculated as a resistance (R) from the voltage (V) by $I = I / V$ (Ohm's law), and current density, i (A/m^2), was calculated as $i=I/A$, where A is the projected surface area of the anode electrode. Power density, P (W/m^2), was calculated by multiplying the current density by voltage, $P = IV/A$. Coulombic efficiency (CE) was calculated based on $CE = C_G/C_T$ x 100%, where C_G is the total coulombs calculated by integrating the current generated over time, and C_T is the theoretical amount of coulombs available based on the measured COD removal in the MFC.

Results and discussion:

Voltage generation from the modified wastewater in a MFC:

[0070] Within 5 days of a start-up period after inoculation, the MFC generated voltage up to a maximum 492 mV with a fixed 470Ω resistor from modified wastewater containing acetate at a final concentration of 1.6 g/L . This result also suggested that domestic wastewater could support the medium and microorganisms for the power generation during the start up of the SMFC. After two more additional loadings, the MFC produced a stable voltage of 0.428 ± 0.003 V (± standard deviation, n =378) for 7 hrs (5 to 12 hr) from the acetatefed wastewater (SCOD = 1694 ± 20 mg/L; Figure 6). However, the voltage decreased down to 0.373V for about 4 hrs of operational time due to the failure of air supply to the cathode chamber as indicated in the Figure 6. This indicated that air supply is necessary for oxygen reduction for completing the electrical circuit. Restarting air supply to the cathode chamber increased the voltage up to average 0.406 ± 0.003 V over the next 31-hr period.

Cell voltage and power output as a function of current density:

[0071] At some experiment, voltage was measured by varying the loading size from 43 to 22 KΩ across a resistor between the anode and cathode electrodes of the SMFC. The voltage and power output were plotted as a function of current density as shown in Figure 6. An open circuit voltage (OCV, without a circuit load) of 0.720 V was first obtained with the wastewater of SCOD=1672 ± 6 mg/L. However, as current between the electrodes was allowed, the voltage decreased sharply down to 0.612 V (at around 96 mA/m^2) possibly showing the presence of a kinetic limitation at the lower current generation. At more current production, IR voltage drop (0.612 V to 0.217 V) was found until a current density of about 827 mA/m^2. This result indicated that the electrolyte resistance of a real wastewater medium still affected significantly the power output even though the anode and cathode was placed very closely. The significant effect of the