

DESIGN AND OPERATION OF AN ELECTROCHEMICAL METHANOL CONCENTRATION SENSOR FOR DIRECT METHANOL FUEL CELL SYSTEMS

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The development of a 150-Watt packaged power source based on liquid feed direct methanol fuel cells is being pursued currently at the Jet Propulsion Laboratory for defense applications. In our studies we find that the concentration of methanol in the fuel circulation loop affects the electrical performance and efficiency the direct methanol fuel cell systems significantly[1]. The practical operation of direct methanol fuel cell systems, therefore, requires accurate monitoring and control of methanol concentration. The present paper reports on the principle and demonstration of an in-house developed electrochemical sensor suitable for direct methanol fuel cell systems.

The sensing principle is based on the measurement of the diffusion-controlled current for the electro-oxidation of methanol in a polymer electrolyte membrane cell at a platinum-ruthenium electrode. Similar studies have been reported recently[2].

The dependence of the oxidation current on bulk concentration at 0.55 V is shown in Fig. 1. This data suggests that the oxidation current sustained at the methanol electrode under mass-transport-limited conditions could be used to devise a sensor for methanol concentration.

A sensor was thus designed, fabricated and tested. The sensing element consisted of Nafion[®] 117 membrane catalyzed with unsupported platinum-ruthenium catalyst on anode side and platinum black on the cathode side. The fixture in which the element is held renders the sensor highly suitable for in-line or "dip-type" integration into a fuel circulation loop. The overall device size is in about 2 cm³.

During sensor operation, the terminal voltage between the sensor electrodes was held

at a specified value in the range of 0.45-0.65 V with the platinum-ruthenium electrode being the positive electrode. The dependence of oxidation currents on temperature and the difference in sensitivity observed at different temperatures requires that temperature compensation be built into the calculation of concentration. The measured changes in current density are significant enough to allow monitoring of changes as small as 0.01M.

The sensor has been integrated with an automatic fuel feed system and has been operated for several tens of hours. The results demonstrate that the sensor is robust and sensitive to meet the concentration sensing and control demands of direct methanol fuel cell systems. Design and operational characteristics of this sensor will be described.

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References

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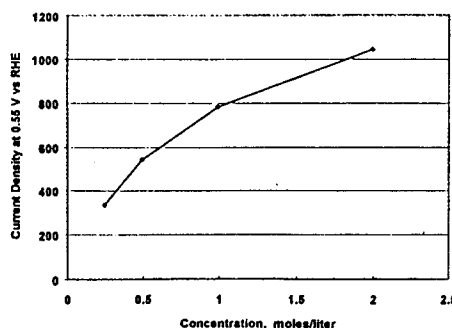


Figure 1. Dependence of diffusion-controlled oxidation current on concentration of methanol at 90°C