Estimating Parameters for Rates of CO Poisoning and Recovery in a PEMFC

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Introduction

Recently Springer et al.[1] showed equations to study both steady and transient coverage of CO on membrane and electrode assemblies (MEA) with platinum catalysts. These equations depend on a large number of thermodynamic and kinetic parameters for adsorption and electrochemical oxidation of both hydrogen and CO. They gave a set of parameters that fit their data and with these parameters and their equations they were able to obtain agreement with steady-state voltage-current data as a function of CO concentration and system pressure. They did not investigate the effect of temperature. Other studies[2] have shown that there is a significant change in cell performance due to a change in temperature at low CO concentrations (i.e., 20 ppm). In this paper we focus on the change in these parameters as a function of temperature and pressure for both steady state and transient behavior during exposure to CO in H2.

We are motivated by recent anodic polarization data that were reported for relatively high concentrations of CO/H_2 on a PRIMEA® MEA Series 55[3]. Current work in our laboratory is directed at the effect of temperature and pressure[4] on the steady-state and the rates of recovery and poisoning during exposure to concentrations of 500, 3000 and 10000 ppm CO/H_2. Specifically data were reported at 202 kPa for 70^oC and 90^oC in addition to the steady state results. Rates of poisoning and recovery for step changes in the CO levels in hydrogen were also reported. Examples of these transient data are shown in Figure 1 where the cell was operated at a fixed current density of 600 mA/cm^2 with initial stream or pure hydrogen. The decrease and increase in voltage resulted from changes in the CO concentration in the anode feed.

The objective of this study is to provide parameters for Springer's equations suitable for high performance MEA such as PRIMEA® MEA Series 55 as a function of temperature and pressure. With these high performance MEAs, the equations must be adjusted to include the effects of mass transfer through the gas diffusion layer. The sensitivity of the predictions to changes in the parameters will also be presented.

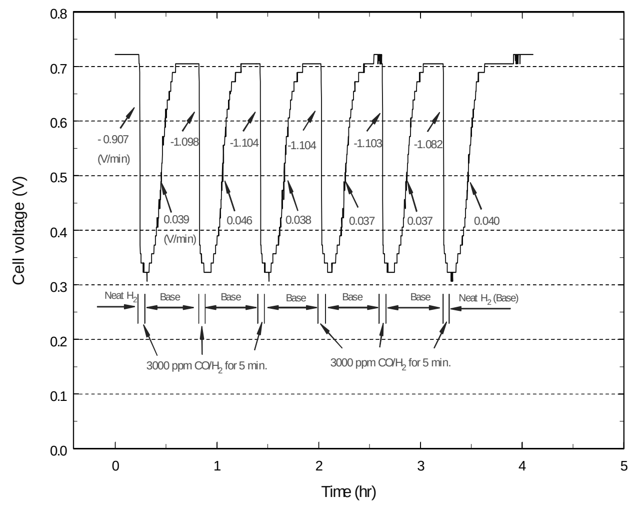

Figure 1. Transient performance with neat hydrogen and 3000 ppm CO at 600 mA/cm^2 with CARBEL™ CL GDM. (T_{cell} = 70^oC and P(A/C) = 15/15 psig)

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References

1. T.E. Springer, T. Rockward, T.A. Zawodzinski, and S. Gottesfeld, *Journal of the Electrochemical Society* **148** (1) A11-A23 (2001).
2. S.J. Lee, S. Mukerjee, E. A. Ticianelli, and J. McBreen, *Electrochemica Acta*, 44, 3283 (1999).
3. Mahesh Murthy, Manuel Esayian, Alex Hobson, Steve MacKenzie, Woo-kum Lee and J. W. Van Zee, *Journal of the Electrochemical Society*, **148** (10), A1147 2001.
4. M. Murthy, M. Esayian, A. Hobson, and S. MacKenzie, W-k. Lee and J. W. Van Zee, paper # 343 presented at the 2001 meeting of the Electrochemical Society, San Francisco, CA, Sept. 2001.