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Short communication

Assessment of the performance of a PEMFC in the presence of CO

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Abstract

Carbon monoxide is a conventional contaminant in the fuel obtained from reforming processes with an important influence on the performance of a proton exchange membrane fuel cell (PEMFC). The studies of transient and continuous injection of CO presented here give information about poisoning and recovery processes, and recommend strategies for fuel cell operation. Pulsing study shows that up to 100 ppm CO, has no significant effect on the performance. Constant current demand experiments show an oscillatory effect due to CO electro-oxidation at high over-potentials. In continuous poisoning process, kinetic and mass transfer affect the rate of CO removal. To recover the performance for continuous fuel cell operation, we propose cyclic feeding of hydrogen containing traces of CO (i.e. supplied by a reforming process) and pure hydrogen streams.

Keywords: PEMFC; CO poisoning; CO removal; CO oxidation

1. Introduction

Hydrogen produced from hydrocarbon or alcohol reforming processes contains trace components (carbon monoxide, sulphur, ammonia, etc.) that may damage the electrode during a proton exchange membrane fuel cell (PEMFC) operation. One of them, carbon monoxide, when is adsorbed on the Pt anode, inhibits the dissociation of hydrogen to protons and electrons. The impact of CO on power output of a PEMFC that uses Pt as electrocatalyst increases with the concentration and this behaviour is more accentuated at the lower operating temperatures [1].

Overcoming the CO poisoning problem is of paramount interest and needs to be addressed in order to make reformate gas a viable fuel for PEM fuel cells. Even after a preferential oxidation (PrOx) reactor, the outlet CO concentration is about 50 ppm, although programmed targets for steady state and transient CO concentrations are 10 and 100 ppm, respectively [2]. Los Alamos National Laboratory (LANL) has developed both PrOx catalyst and reaction system and they can achieve low concentrations of CO (10–20 ppm) in a multistage reactor over a Pt/Al_2O_3 or Ru/Al_2O_3 catalyst [3]. In another study on low temperature PrOx reactors [4], up to 100 ppm CO in the effluent was obtained with the best catalyst studied.

Other methods to remove CO from the fuel cell are the mixing of the fuel feed with small amounts of air or oxygen ("air bleeding") between 1 and 5% content in the gas [5,6]. This stimulates the oxidation of CO over the catalyst. This method requires an extensive control system since the air content has to be closely monitored. The addition of hydrogen peroxide to the fuel stream has also been investigated as a method to minimise the CO contamination [7,8]. A method for operating PEM fuel cells using hydrogen from a reformate process, with reduced requirements for gas cleaning, is to apply electrical pulses while fuel cell is in operation. The pulses increase the anode potential to values at which the CO is oxidised to CO_2. In this way, the catalyst surface is continuously cleaned and the loss of cell voltage is minimised [9].

Springer et al. [10] tested PEMFC performance with CO concentrations between 10 and 100 ppm as impurity and de-

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