

OXIDATION OF METHANOL IN ALKALINE SOLUTIONS

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Abstract

Methanol oxidation in various alkaline solutions: hydroxide, carbonate and bicarbonate has been investigated. Cyclic voltammograms of methanol oxidation on platinised electrodes were carried out with various methanol concentrations, from 0.1 M up to 12 M, in various alkaline media: NaOH, Na₂CO₃ and NaHCO₃ with different concentrations, 0.1 M to 4 M.

Introduction.

Fuel cells have the potential to exceed the performance of batteries by a factor of at least ten for a wide range of military and civil applications. Proton-exchange membrane fuel cells (PEMFCs) offer the highest power densities and operate at modest temperatures. However, such membranes are not ideal due to their high cost, low fuel cell potential generated by the proton conduction reaction, the need for platinum catalysts, the sensitivity to fuel impurities, and the need for specialist high-cost materials as current collectors.

The development of fuel cell stacks is now well advanced for all applications. However, the significant performance advantage that the PEMFC has over the battery (rechargeable or non-rechargeable) will only be realised when a credible fuel source has been developed. The greatest performance advantages accrue when the cell uses hydrogen fuel. However, to store or generate hydrogen places a significant cost penalty on the system such that the whole life cost will be greater than for the rechargeable battery. The use of a liquid fuel such as methanol, which is directly oxidised at the fuel cell anode, offers a simpler logistics chain and a whole life cost which is competitive with the rechargeable battery, but at ten times the performance of an advanced battery.

Experimental Results and discussion.

Methanol oxidation in various alkaline solutions: hydroxide, carbonate and bicarbonate has been investigated. Cyclic voltammograms of methanol oxidation on platinised electrodes were carried out with various methanol concentrations, from 0.1M up to 12 M, in various alkaline media: NaOH, Na₂CO₃ and NaHCO₃ with different concentrations, 0.1 M to . The activity of methanol oxidation reaction for a certain concentration of methanol solution in alkaline solutions is directly related to the OH⁻ concentration and OH_{ads} on the electrode surface. A more active methanol oxidation reaction and higher reaction current can be achieved by increasing the concentration of alkaline solution. On the other hand, for certain concentration of methanol and alkaline solution, the highest activity of the methanol oxidation was obtained in NaOH solution and the lowest was in NaHCO₃ solution, i.e. the activity decreases in the order of: NaOH > Na₂CO₃ > NaHCO₃. The oxidation current in NaHCO₃ solution was only around 10% of that in NaOH solution.

The features of methanol oxidation in mixed alkaline solutions were also studied using the cyclic voltammograms for 6 M Methanol in the mixed solution of NaOH and Na₂CO₃ and NaOH and NaHCO₃, respectively. There is no significant difference observed from the CVs for methanol oxidation in NaOH and the mixture of NaOH and Na₂CO₃. However, the reaction current for methanol oxidation decreased severely in the mixture of NaOH and NaHCO₃ compared to that in NaOH. This suggests that the poisoning effect of CO species in alkaline solution is less significant and the HCO species could be the main poisoning species in methanol oxidation in alkaline solution.

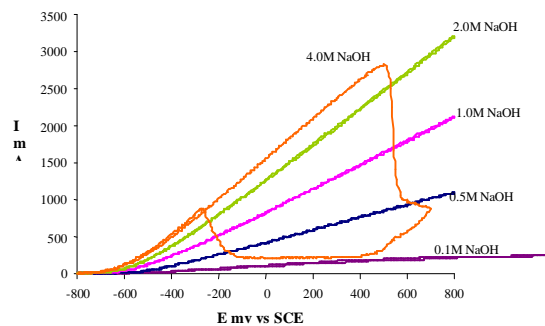


Fig. 1 Oxidation of 2.0 M methanol solution in various concentrations of sodium hydroxide.

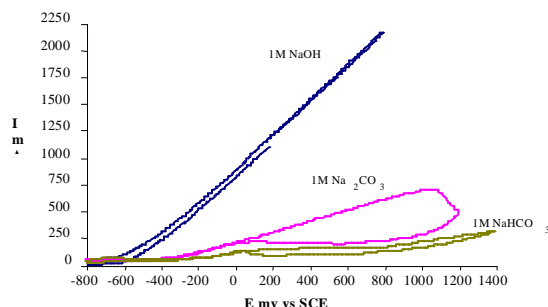


Fig. 2 Oxidation of 2.0 M methanol in sodium hydroxide, sodium carbonate and sodium bicarbonate.

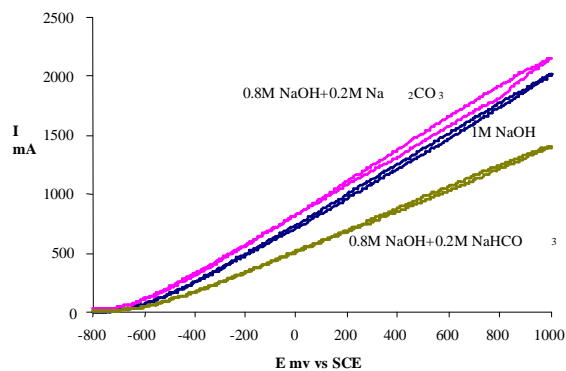


Fig. 3. Oxidation of 6.0 M methanol solution in mixed alkaline solutions.

