E2-25: Electro-reduction of Pb^{2+}(aq), Sn^{2+}(aq) and Ni^{2+}(aq) on Pt-disc electrode

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Electro-reduction of metal ions has attracted much attention world wide owing to the possibilities offered by the method for the removal of potential pollutants from the aquatic environment. It also serves as a powerful analytical technique for the determination of ionic species even at extremely low levels, which cannot be analysed by conventional methods. In this communication, electroreduction of Pb^{2+}(aq), Sn^{2+}(aq) and Ni^{2+}(aq) on a Pt-disc electrode immersed in a deoxygenated solution containing 0.1 mol dm^{-3} $NaClO_4$ are reported. Cyclic voltammetry and sampled current voltammetry were used as analytical techniques. Substrates were used in micromolar and millimolar levels.

Results showed that the cyclic voltammogram of 0.001 mol dm^{-3} Pb^{2+} on Pt-disc electrode in the above electrolyte was well-behaved with two reduction peaks centred at - 0.620 V and - 0.680 V with respect to a saturated calomel electrode. These peaks were assigned to 1-e reduction of Pb^{2+} to Pb^{+} and further 1-e reduction to Pb respectively. However, the corresponding oxidation peaks were not resolved and only one peak centred at +0.450 V was observed. The peak height (I_p) varied linearly with the bulk concentration of Pb^{2+} at both milli- and micro-molar level, indicating that the peak height was a measure of the amount of Pb^{2+} present in the system. Electroreduction of Sn^{2+} (aq) behaves similar to that of Pb^{2+}(aq) although the values of peak positions and currents of the former are different from the latter.

The electrode kinetics of Ni^{2+}(aq) reduction was unusual. The cyclic voltammogram revealed no information on the redox behaviour of Ni^{2+}(aq). A sampled current voltammetric technique was thus used for this system. Current voltage curves were found to be broad and featureless. Tafel plots were linear at both large and positive and large and negative ends of overpotential (n). Both straight lines were extrapolated to a common point (0, -2.95) on the $\ln|j|$ vs n plot; where j is the current density at the overpotential n. Thus, exchange current density for the electro-reduction of Ni^{2+}(aq) on Pt-disc electrode from the above background electrolyte was calculated to be $5*10^{-6}$ A cm^{-2}. The gradients of these straight lines gave the value of 0.7 for the transfer coefficient.