

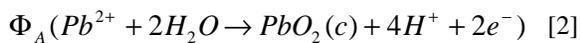
## Simultaneous Recovery of Lead and Lead Dioxide from Battery Effluents

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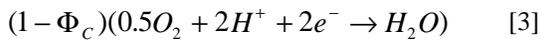
Reprocessing of lead acid batteries generates aqueous effluents containing low concentrations of Pb(II) species, which also arise from the chemical, electroplating, metal finishing, mineral processing industries. An electrochemical process will be described for lead recovery by simultaneous cathodic deposition of elemental lead (1) at e.g. graphite felt:



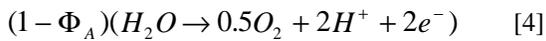
and anodic deposition of lead dioxide (2), also at graphite felt:



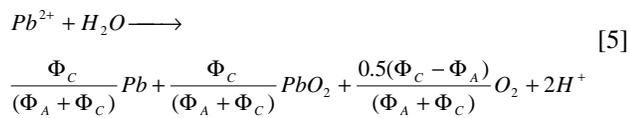
where  $\Phi_C$  and  $\Phi_A$  represent current efficiencies at cathode and anode, respectively. The loss reactions are primarily, at the cathode:



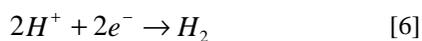
and at the anode:



Hence, the overall chemical change in the reactor is:



This neglects hydrogen evolution as a cathode loss reaction, as the exchange current density is so low on lead (3):



Potentially, such a process would be more elegant than the present industrial practice of treating lead effluents with lime to precipitate a mixture of lead sulfate, hydroxides and gypsum, which is then sent to a landfill site or smelter.

The feasibility has been demonstrated of depleting Pb(II) concentrations to below analytically detectable concentrations (< 10 ppb) using graphite felt electrodes. However, the process specific electrical energy consumption and hence its principal running costs, are critically dependent on the current efficiency losses due to reactions [3] and [4]. As both cathodic reactions [1] and [3] can be driven into mass transport control, the molar ratio of the dissolved oxygen and lead concentrations determines the cathodic current efficiency, and the latter concentration is sensitive to both pH and free sulfate activity, as shown in Fig. 1. However, loss reaction [4] at

anode is kinetically controlled and is the source of most of the dissolved oxygen, reduced by loss reaction [3]. As the reactor is operated such that PbO<sub>2</sub> deposition by reaction [2] is transport controlled, mass transport rates need to be as high as possible to maximise current efficiencies and minimise specific electrical energy consumptions.

Hence, a simplified model for predicting such current efficiencies will be presented, utilising both the thermodynamic information, such as shown in Fig. 2, and kinetic data from the literature. These predictions will be compared with experimental results.

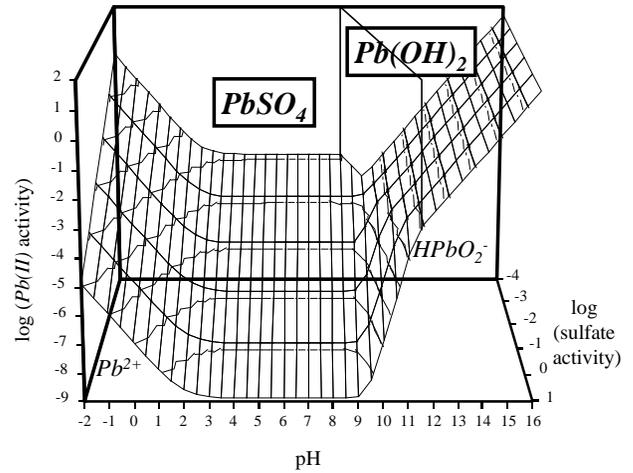


Fig. 1. Predicted effects of pH and sulfate activity on Pb(II) activity, calculated from thermodynamic data (4).

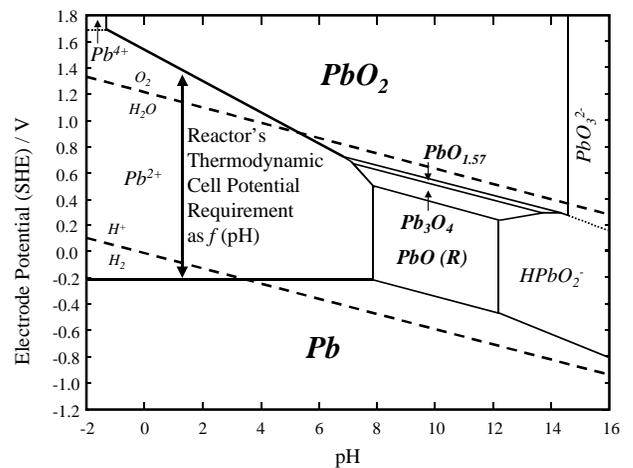


Fig. 2. Potential-pH diagram for the Pb-H<sub>2</sub>O system at 298 K and 0.1 MPa with dissolved lead activity = 10<sup>-3</sup>.

## REFERENCES

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