STUDY OF AN OBLIQUE ROTATING BARREL ELECTROCHEMICAL REACTOR FOR REMOVAL OF COPPER IONS FROM WASTEWATER

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An experimental study was performed using an oblique rotating barrel cathode to recover copper from wastewater, which initially contained 100 parts per million (ppm) of cupric ions. The barrel was a perforated cylindrical polypropylene basket having eight axial fins on its exterior surface. It was partially filled with copper Raschig rings and was partially submerged in the wastewater at a tilted angle from the horizontal position. During the operation, the barrel was slowly rotating in the water and the copper rings were made as the cathode by connecting them to a DC power supply through a dangler contact. The movement of exterior fins and tumbling motion of copper rings provided a high mass transfer rate and a large cathode area for copper electrodeposition reaction.

The cupric ion concentration in the wastewater was reduced to less than 1.0 ppm permitting discharge of the treated wastewater to the drain system. With an operating cell voltage of 2.5 to 5.0 V, the overall current efficiency for copper electrodeposition reaction was 20 to 53%, and the electric energy requirement was 4 to 21 kWh per kilogram of copper recovered from the wastewater. An apparent first order reaction rate constant for copper electrodeposition reaction on the Raschig rings, was measured as a function of process variables including cell voltage, barrel rotational speed, percent barrel loading, barrel tilt angle and percent barrel immersion. The reaction rate constant was found to increase with increasing cell voltage, barrel rotational speed (figure 1) and percent barrel immersion in the test solution, and to decrease with increasing percent barrel loading and barrel tilt angle (figure 2) from the horizontal position. Cathode passivation was observed at high cell voltages with the formation of black coatings that drastically reduced the values of apparent reaction rate constants on copper rings.

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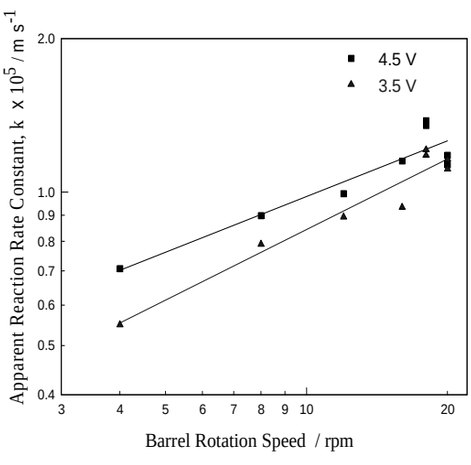

Figure 1. A log-log plot of the apparent reaction rate constant versus barrel rotating speed at 3.5 & 4.5 volts. The other operation condition were kept constant 50% barrel load and 45^{o} barrel tilt angle.

Figure 2. Effect of barrel immersion angle on the apparent reaction rate constant at a cell voltage of 4.5 V, 50% barrel load, 50% barrel immersion and 18 rpm barrel rotational speed.