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Department	Chemical Engineering
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Thesis Title	Removal of Cadmium from Wastewater by Electro-Deposition on Stainless Steel Concentric Tubes Bundle
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Abstract	<p>1- Mass transfer of Cd+2 ions to a smooth stainless steel rotating cylinder electrode was studied by measuring the limiting current for the cathodic reduction of Cd+2 in 0.5 M sodium sulphate supporting electrolyte by three electrodes cell with stainless steel rotating cylinder electrode working in hydrodynamic voltammetry mode. The studied parameters were electrolyte pH (4, 5, 6 and 7), initial Cd+2 concentrations (50, 100, 200, 300 and 400 ppm) and rotation rates (100, 150, 200 and 250 rpm). Cadmium ions' reduction potential for mass transfer control conditions was found to be -0.13 V. Diffusion coefficient was determined and correlated with the bulk concentration of Cd+2 in sodium sulphate solution. The increase in pH was found to enhance the mass transfer coefficient and this effect diminishes nearly at pH=7, and the experimental data were well fitted by an empirical dimensionless correlation among the Sherwood number, Reynolds number and Schmidt number. The obtained correlation was:</p> $Sh=0.047 [Re]^{0.769} [Sc]^{0.356}$ <p>For $(8015.519 < Re < 20587.07)$</p> <p>Reduction potential obtained via the voltammograms constructed by the rotating cylinder cell was applied for the two pilot scale units in order to keep the process under mass transfer control conditions. Parameters studied in these units are: initial cadmium concentration, pH, and electrolyte flow rate. The first pilot scale unit was an electrochemical reactor with smooth stainless steel concentric tubes, and the second one was an electrochemical reactor with stainless steel mesh concentric cylinders.</p> <p>2- For the stainless steel smooth concentric tubes cathode, mass transfer coefficient was calculated and correlated with initial concentration .</p> <p>Effect of pH on mass transfer coefficient was studied and correlated, and it was found that the effect of pH was found to be completely negligible at pH=7.</p> <p>On the other hand, effect of flow rate on mass transfer coefficient was studied and correlated.</p> <p>Performance of the reactor was analyzed by introducing figures of merit for fractional conversion, specific energy</p>

	<p>consumption, space time yield and normalizes space velocity. The experimental data were correlated in a dimensionless expression as follows:</p> $Sh=0.804[Re]^{0.632} [Sc]^{(1/3)}$ <p>For $254 < Re < 1018$</p> <p>3- For the stainless steel mesh concentric cylinders was adjusted to work under mass transfer control conditions by applying the reduction potential obtained in hydrodynamic voltammetry experiments.</p> <p>Effect of initial cadmium concentration, pH and solution flow rate was studied and analyzed. Mass transfer coefficient was correlated with these studied parameters.</p> <p>Similar to smooth cathode, the mesh cathode showed a negligible response to pH at pH=7.</p> <p>Noticeable enhancement in mass transfer coefficient was investigated by the action of flow rate, and the mass transfer coefficient was correlated with the solution flow rate.</p> <p>The mesh cathode showed a higher conversion than that adopted by the smooth cathode, and showed lower cumulative current efficiency than that of smooth cathode.</p> <p>Mesh cathode showed specific energy consumption, space time yield and normalized space velocity higher than that for the smooth cathode.</p> <p>Experimental data for the mesh reactor were correlated in a dimensionless relation as follows:</p> $Sh=1.898[Re]^{0.514} [Sc]^{(1/3)}$ <p>For $235 < Re < 943$</p> <p>Cadmium ions reduction reaction was found to follow a first order reaction with respect to Cd^{+2} concentration, and reaction rate constant was predicted under different operating conditions.</p>
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