EFFECTS OF OPERATING CONDITIONS ON ELECTRODIALYTIC CONCENTRATION OF SILVER FROM PHOTO-PROCESSING EFFLUENTS

By

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DECLARATION

I certify that this dissertation does not incorporate without acknowledgement of any material previously submitted for a Degree or Diploma in any University and to the best of my knowledge and belief it does not contain any material previously published or written or orally communicated by another person except, where due references is made in the text.

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ABSTRACT

Electrodialysis is now recognized as a cleaner technology for reclaiming waste chemical solutions including industrial effluents contaminated with heavy metals. Compared with the conventional separation methods (chemical precipitation, filtration, evaporation, electrolysis, etc.), electrodialysis offers remarkable advantages such as less area requirement, ability to incorporate into the production process itself, avoidance of the generation of hazardous chemical sludge and many more. In this study, Electrodialytic recovery of Silver (Ag) from photo-processing effluents was investigated with the aim of understanding the possible effects of various operating conditions on the process.

In this study a laboratory fabricated four-membrane, five-compartment, Electrodialysis cell was used with the cationic and anionic selective ion exchange membranes Asahi Kasei K501SB and A501SB, respectively, which are originally used for seawater desalination. The removal efficiency of Ag^+ at different current densities was studied, using synthetically prepared metal ion solutions and actual industrial effluents containing Silver (photo processing effluents). Time dependent sampling was done and analyzed with a flame atomic absorption spectrophotometer (GBC 932).

According to the experimental results, very significant removal efficiencies were observed in the range of current densities studied. At low current densities of 2 and 4 mA/cm^2, removal percentages observed were 36 and 53.5, respectively. However at high current densities of 8 and 10 mA/cm^2, removal percentages increased up to 85 and 96 respectively (for an initial feed concentration of 1000 mg/L). However at those high current densities, ion exchange membranes were found to be damaged due to high heat dissipation. It was also noticed that at low concentrations of feed solution (i.e. 300 and 100 mg/L), the removal efficiencies were reduced remarkably. Considering these results Electrodialysis with the aid of desalination ion exchange membranes could be recognized as an efficient and locally made sustainable technology for treating silver containing effluents having a sufficiently high contamination level, while reclaiming the metal silver for reuse. However the necessity of a final smoothing treatment stage such as metal replacement, ion exchange or adsorption is stressed to obtain higher quality water.

Few experimental trials on Electrowinning were also conducted at a single electrical potential (5V), in order to compare the power consumption of the two processes. Results revealed that

the power consumption for electrodialysis is comparatively lower than electrowinning (i.e. by only considering the power consumption of the reactor, without accessories).

Necessity of the construction of pilot scale reactors is recognized for a full economical review of the two process schemes. On the other hand experiments must be carried out on the synthesis of ion exchange membranes having good permselectivity towards multivalent cations, so that the Electrodialysis process could be applicable on treating other industrial effluents contaminated with multivalent metal cations.

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ABBREVIATIONS

AAS	-	Atomic Absorption Spectrophotometer
AEM	-	Anion Exchange Membrane
BPM	-	Bipolar Membranes
c.d	-	Current Density
CEM	-	Cation Exchange Membrane
DC	-	Direct Current
ED	-	Electrodialysis
EDI	-	Electrodeionization
EDR	-	Electrodialysis Reversal
EDTA	-	Ethylenediaminetetraacetic acid
EN	-	Electroless Nickel
HSA	-	High Surface Area
HMT	-	High Mass Transfer
HDPE	-	High Density Polyethylene
IEC	-	Ion Exchange Capacity
OSHA	-	US Occupational Safety and Health Administration
SS	-	Stainless Steel
USEPA	-	United States Environmental Protection Agency