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Electrodialysis as an alternative for treatment of nickel electroplating effluent: water and salts recovery

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Academic Work

Electroplating Processes

- Very large water consumption.
- Chemicals used are expensive and come from non-renewable sources.
- Large liquid wastewater volume, with harmful metal concentrations as Ni, Cr, Cu, Zn and other metals, organic additives and ions.
- **Nickel electroplating**: one of the most versatile surface-finishing.
  - Electrodeposited from sulfate or sulfamate electrolytes with or without additives, and also from a Watts-type electrolyte containing nickel sulfate, nickel chloride and boric acid.
- Decorative coatings are obtained by electroplating from special Ni-Watts solutions containing organic addition agents. The coatings are protective, mirror-bright, and smooth.

Treatment of electroplating effluent

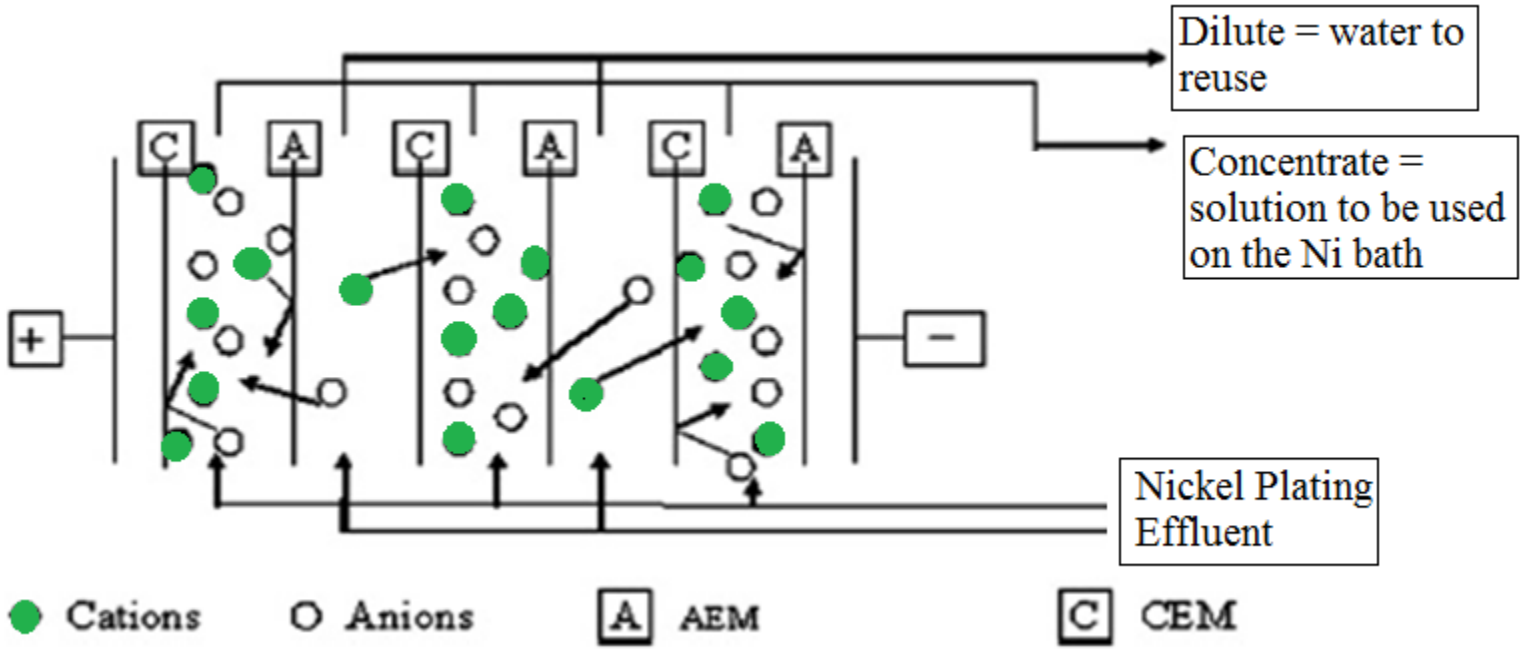
- Electroplating wastewaters need to be treated before discharge in the environment or to permit water reuse and chemicals recovery.

- Coagulation/precipitation is the most applied among the traditional treatment methods.
- This process generates galvanic sludge that is considered a hazardous waste.

- Ion exchange resins, electrolysis, adsorption and membrane filtration process are cleaner technologies that have been studied and applied.

- Among the electrochemical treatments, the electrodialysis process allows the recovery and reuse of water and chemicals in the electroplating process.

Electrodialysis and Nickel plating process



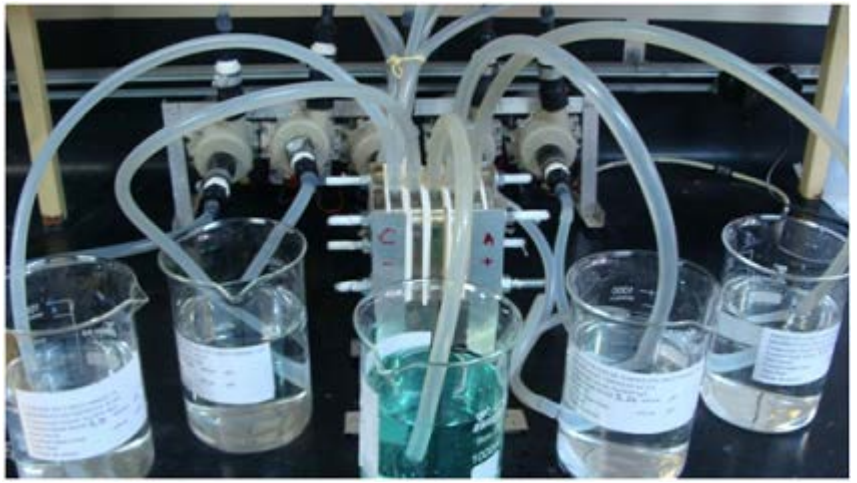
Purpose

This work addresses the electrodialysis treatment of a bright nickel electroplating effluent to concentrate and extract nickel and its salts.

It was evaluated the pH and conductivity for all compartments and the percentual extraction of nickel. After ED, the treated effluent was evaluated by chemical analysis for verify its quality for reuse.

Materials and Methods

- Synthetic solution simulating the rinsewater of bright nickel electroplating and corresponding to 1% of bright nickel bath in distilled water: 1,3mg.L^{-1} Ni, 3mS.cm^{-1} and pH4.4
- Electrolytic solution: Na_2SO_4 4g.L^{-1} (5.5 mS.cm^{-1} and pH 5).
- Current Density: 1.8 mA.cm^{-2}
- Electrodes: 16cm^2 Ti plate coated with $Ti_{0.7}/Ru_{0.3}O_2$
- Membranes: Cationic (C) Ionac MC-3470 and anionic (A) Ionac MA-3475
- Recirculation: 80L.h^{-1}
- Stack configuration (Cat-)A-C-A-A(-An).



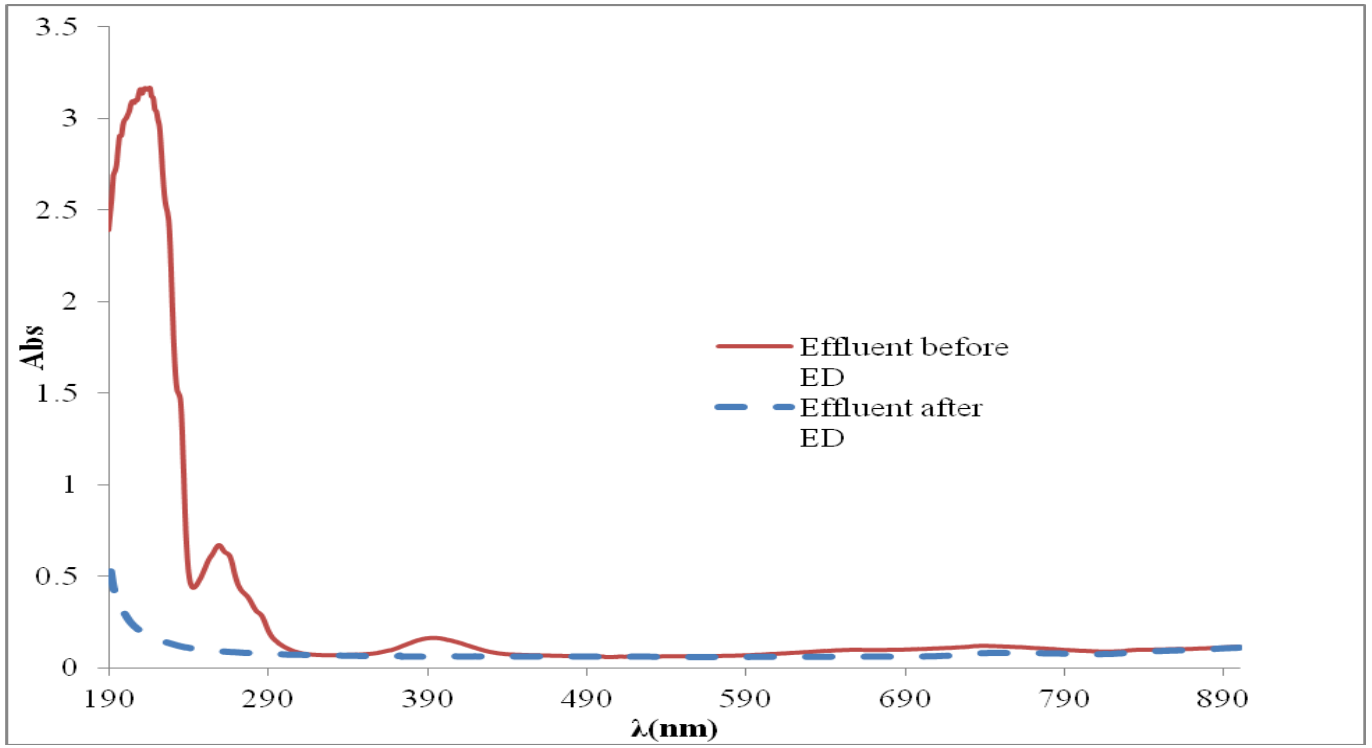
Evaluating ED efficiency

- **Demineralization Rate: $DR\% = [1-(EC^t/EC^0)].100$**
- **Percentual extraction: $PE\% = [(1-(M_i^t/M_i^0)].100$**

Electrodialysis treatment of nickel electroplating effluent: concentration, percentual removal and demineralization rate.

Treatment/Parameter	ED 1	ED2	ED3	Mean	
Treatment Time (h)	44.55	37.60	37.55	39.9	4.03
Final Conductivity ($mS.cm^{-1}$)	0.10	0.23	0.18	0.17	0.06
DR%	96.75	92.77	94.33	94.61	2.01
PE% [Ni^{2+}]	99.93	96.46	95.90	97.43	2.18
PE% [Ni^{2+}].h^{-1}	2.24	2.57	2.55	2.44	0.18
PE% [Cl^-]	96.61	95.04	99.81	97.16	2.43
PE% [SO_4^{2-}]	99.10	97.77	99.27	98.71	0.82
PE% [Na^+]	92.59	96.95	99.14	96.23	3.34
PE% [K^+]	89.41	97.89	96.98	94.76	4.66

Treated solution for reuse



UV-Vis spectra for synthetic Ni plating effluent before and after the ED treatment applying 1.8mA.cm^{-2} for 39.9h indicated the reduction in organic compounds absorbance after ED treatment.

Conclusions

- Electrodialysis is a clean technique able to produce dilute and concentrated solutions from a contaminated started solution.

- The treated effluent had sufficient quality for reuse as rinsewater in galvanic process. All ions detected presented adequate concentrations for reuse. Even the organic compounds from the additives could be removed by ED.

Conclusions

- Optimizing parameters for ED process has been studied for obtain a higher removal for Ni, and the energy consumption will be evaluated for an ED treatment effective and at the lowest possible cost, producing quality water for reuse in various industrial processes.

- This process has already been applied for treat electroplating effluents around the world. This work only reinforces the opportunity to reduce costs and consumption of chemicals and natural resources provided by the application of technology to ED

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