EXPLORING AND OPTIMIZING REMOVAL CHARACTERISTICS OF HEAVY METAL IONS FROM WASTEWATER STREAM BY EMPLOYING ELECTROCOAGULATION AND NANOFILTRATION PROCESSES.

By

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Problem Statement

- Industries are one of the major users of water and optimal water use is critical for sustainable water management.
- Wastewater generated in metal processing and other metal smelting industries poses a severe pollution problem.
- Low pH and high concentrations of various heavy metals make these effluents a major concern because of possible hazardous effects on the surroundings.
- Conventional chemical treatment processes have limitation of maintenance, cost and chemical sludge generation
- Microbes in biological treatment systems are negatively affected by high metal concentration.

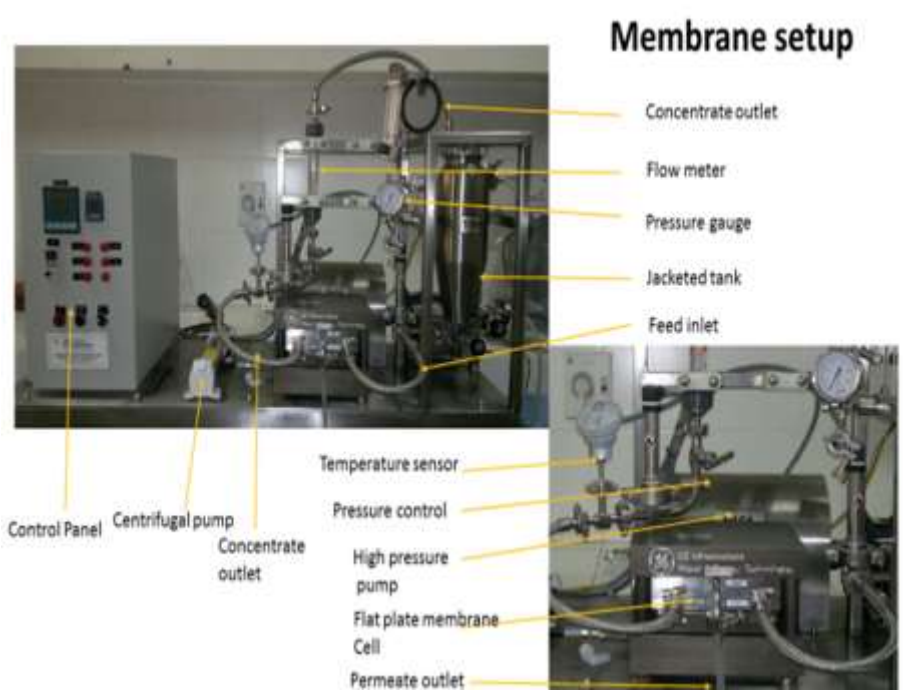
Research Objective

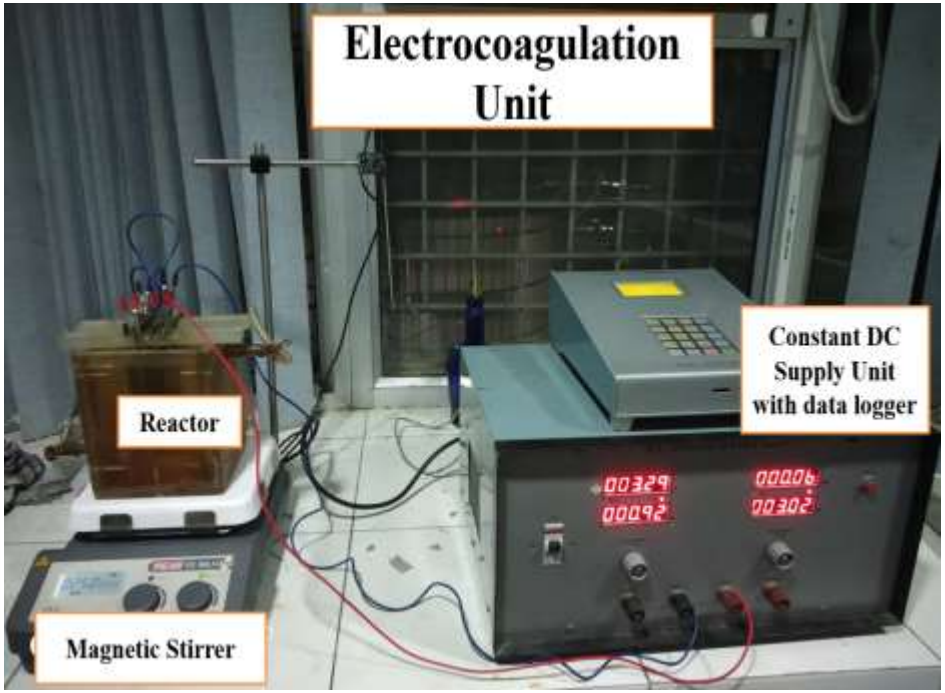
Explore effective removal of metals from a multi-metal mixed solution through nanofiltration and electrocoagulation processes

Materials & Methods

Multi-metal solution: Metal solution was prepared by dissolving appropriate mass of each metal in high purity Milli-Q water (18.2 MΩ cm).

Experimental Setup: Membrane and EC unit setup shown below.





Materials & Methods… contd.

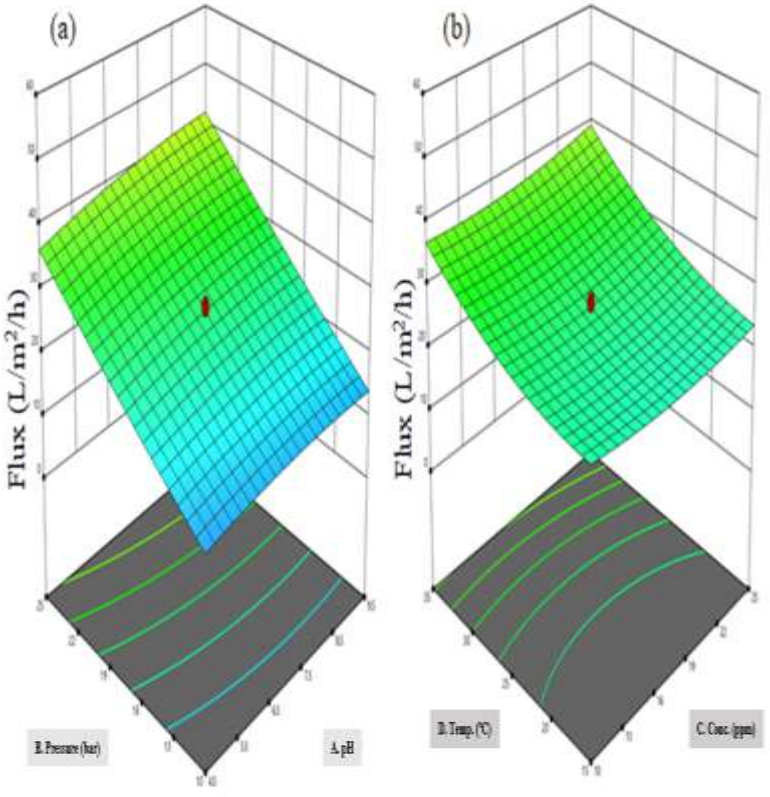
Factor and range for RSM based design for NF and EC experiments

Table below shows the details

Code	**Factors**	**Coded level of N.F.**				
		-α	**-1**	**0**	**+1**	**+ α**
X_1	pH	2.0	4.5	7.0	9.5	12.0
X_2	Pressure (bar)	2.5	10	17.5	25	32.5
X_3	Concentration (ppm)	2.5	10	17.5	25	32.5
X_4	Temperature (ºC)	5	15	25	35	45
Code	**Factors**	**Coded level of E.C.**				
		-α	**-1**	**0**	**+1**	**+ α**
X_1	pH	3.0	4.5	6.0	7.5	9.0
X_2	Time (min)	20	40	60	80	100
X_3	Concentration(ppm)	2.5	10	17.5	25	32.5
X_4	Current (Å)	0.5	1.0	1.5	2.0	2.5

Results & Discussion

NF Membrane: Experimental Observations



RSM plot for permeate flux (a) Effect of pressure and pH and (b) Effect of temperature and concentration.

Permeate Flux Behaviour of NF

- The observations show an upsurge in the permeate flux simultaneously with the increase in transmembrane pressure.
- The experiments demonstrated a linear increase in the slope of flux with the rise in temperature Check if you want to say this only.
- Concentration and pH of the solution not significantly affects the flux of membrane.

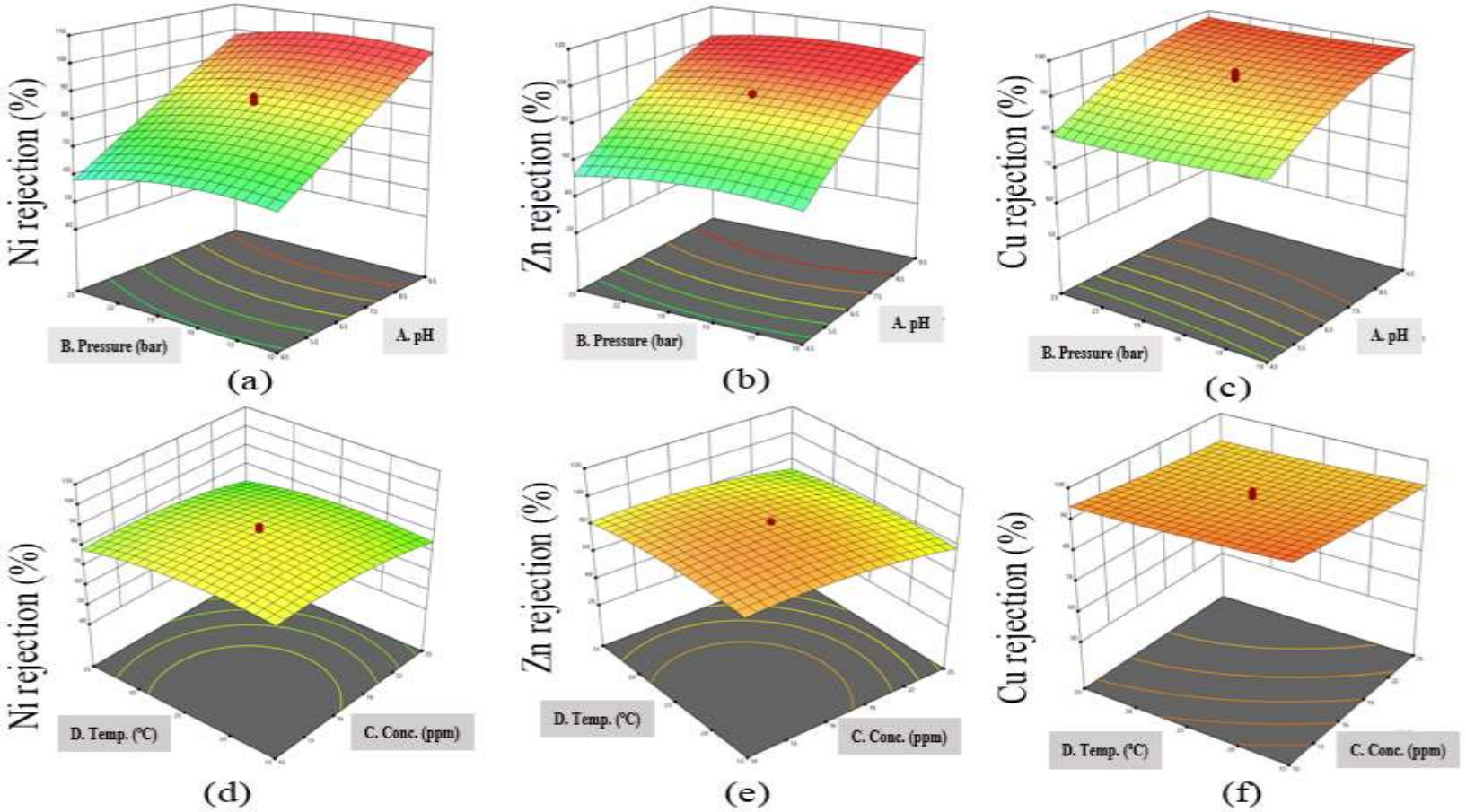
Rejection of Metals Ions by NF

- The solution pH served as an essential factor, which influences the membrane charge and, therefore, the rejection properties of the membrane.

- The rejection of Cu, Ni, and Zn ions increased with the increase in the solution pH. The feeding solution pH determined the ion charge in the solution and surface charge density of the membranes.

- Rejection of metals ions decreased when the concentration of feed solution increased, a common phenomenon for NF membranes.

Rejection by NF… contd.



RSM plots showing pH and pressure effects on metal ion rejection % efficiency

(a) Ni ions, (b) Zn ions and (c) Cu ions and effect of temperature and concentration on metal ions rejection % efficiency (d) Zn ions, (e) Ni ions and (f) Cu ions

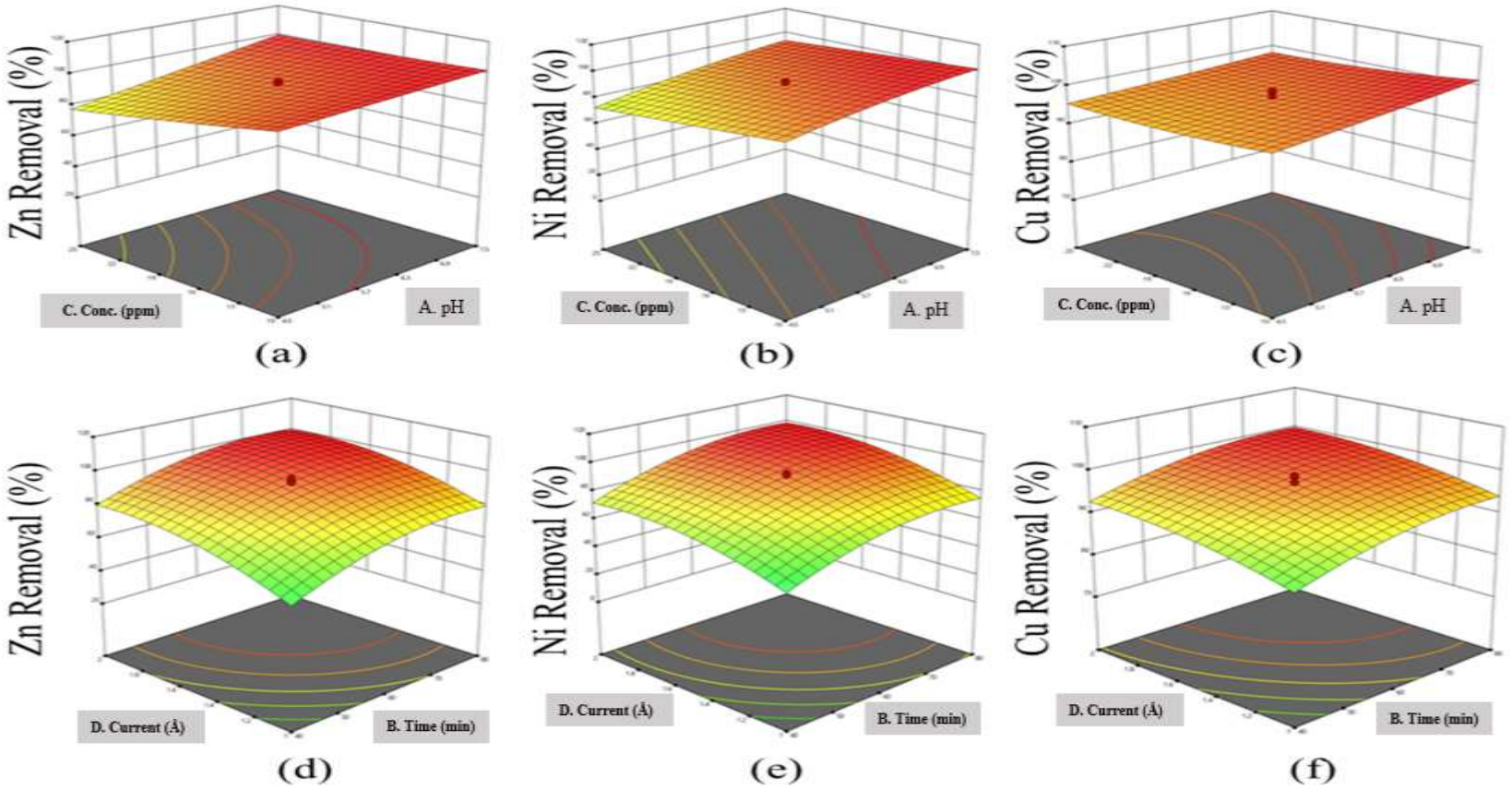
EC: Experimental Observations

- Initial pH in the EC process is an essential operating parameter that is strongly affecting the EC process performance. Lower efficiency was obtained at a lower pH value.

- Increasing the constant current led to a substantial reduction of metals ions. The constant current was a crucial parameter in improving metals ion removal.

- Electrolysis time period played a vital role in metal ions removal alongwith the constant current, pH and concentration.

EC…. Contd.



RSM graphs: effects of concentration and pH on removal % efficiency of metal ions (a) Zn ions, (b) Ni ions and (c) Cu ions. Effect of current and reaction time on removal % efficiency of metal ions (a) Zn ions, (b) Ni ions and (c) Cu ions.

Key Findings

- The highest permeate flux of 59.34 L/m^2 h was observed at the operating condition of pH 9.5, pressure 25 bar, concentration 25 ppm and temperature 35 °C in NF membrane. The removal rate was 95.32% for Zn, 94.98% for Ni and 96.93% for Cu, respectively.

- EC system showed maximum removal of 99.46% for Zn, 98.14% for Ni, and 99.87% for Cu respectively at operating condition pH 6, time 60 min, concentration 2.5 ppm and current 1.5 Å.

- Overall both NF membrane and EC systems showed excellent rejection for a mixed solution of Zn, Ni and Cu. Both NF membrane and EC systems appear to be promising solutions for the removal of heavy metals from the wastewater stream.

THANKS