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Adsorption of Nickel(II) from aqueous solution using recyclable three-dimensional cellulose nanocrystals using central composite design

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INTRODUCTION & AIM

Wastewater contamination by Nickel (II) is a complex issue that threatens environmental integrity and human health. Industrial operations, the production and disposal of goods containing nickel, and agricultural runoff from fertilisers and herbicides are ways that Nickel (II) enters wastewater. Nickel (II) can remain in treated effluents because conventional wastewater treatment techniques frequently fail to remove it completely. Additionally, by releasing this hazardous metal into wastewater systems, corrosion of nickel-II-containing drainage systems and fixtures can make the problem worse. Through direct discharge and landfill leachate, mining and smelting operations also contribute to the contamination of waterways, especially rivers.

This study uses cellulose nanocrystal hydrogel adsorption techniques mixed with a central composite design. Previous studies have investigated a variety of approaches for heavy metal remediation. This novel strategy seeks to support sustainable wastewater management techniques in addition to reducing the negative impacts of Nickel (II) on ecosystems and public health

Aim: To remove Nickel (II) from aqueous solution through adsorption using cellulose nanocrystals hydrogel.

METHOD

Materials
Nickel sulphate hexahydrate(98%), Sodium Hydroxide (98%), Hydrochloric acid (32%), Ethylenediaminetetraacetic acid (EDTA)(0.99), A pH meter, Cellulose nanocrystals and starch.

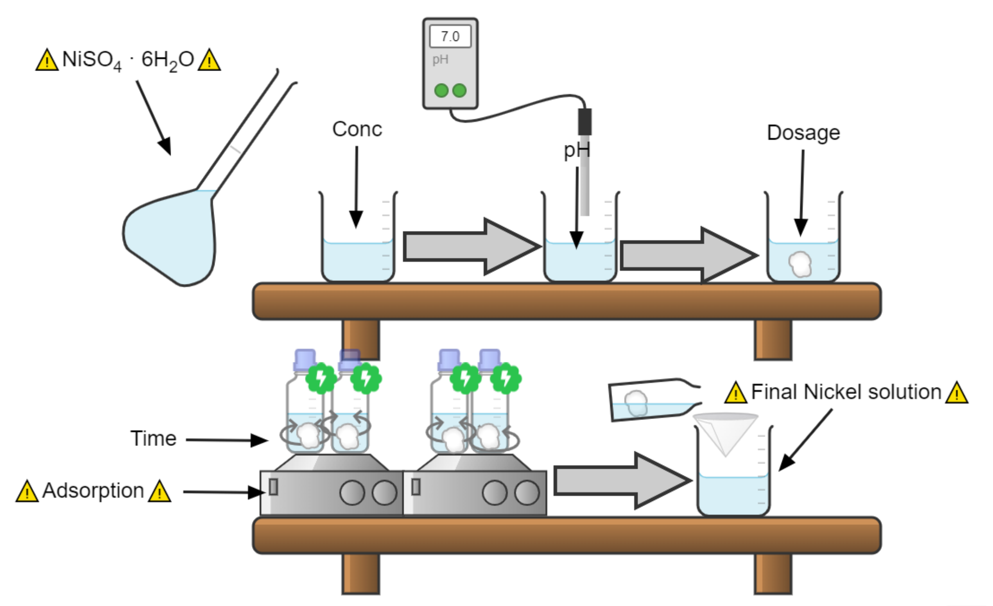

Figure 1: Experimental procedure

Characterization techniques: Fourier Transform Infrared Spectroscopy (FTIR)

RESULTS & DISCUSSION

FTIR analysis

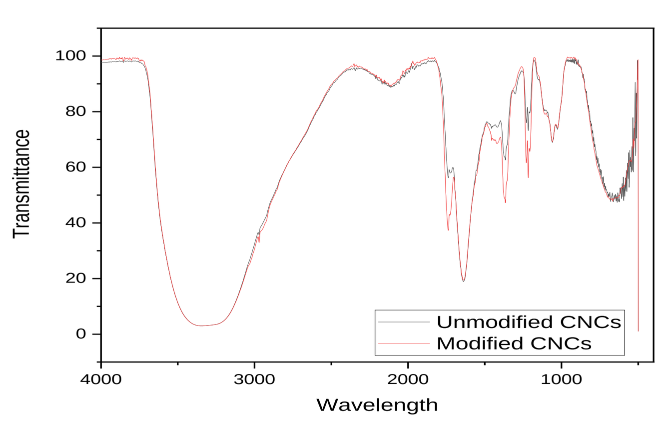

Figure 2: FTIR of unmodified CNC and modified CNCsH

Effect of parameters

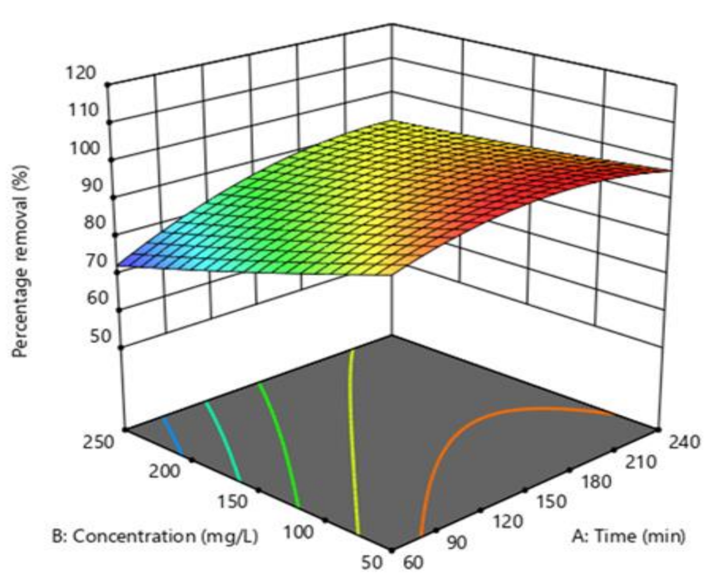

Figure 3: The effect of time vs Concentration

RESULTS & DISCUSSION

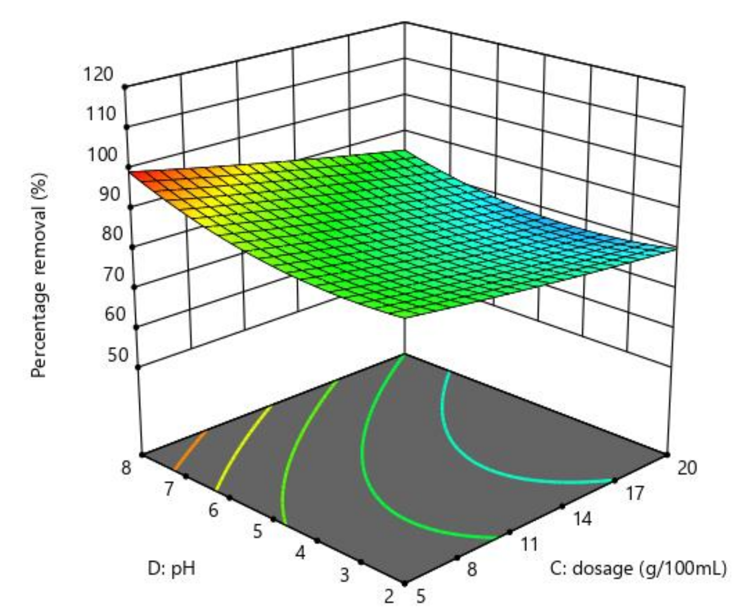

Figure 4 : The effect of pH and Dosage on adsorption efficiency

Optimal points for the most effective Nickel (II) removal

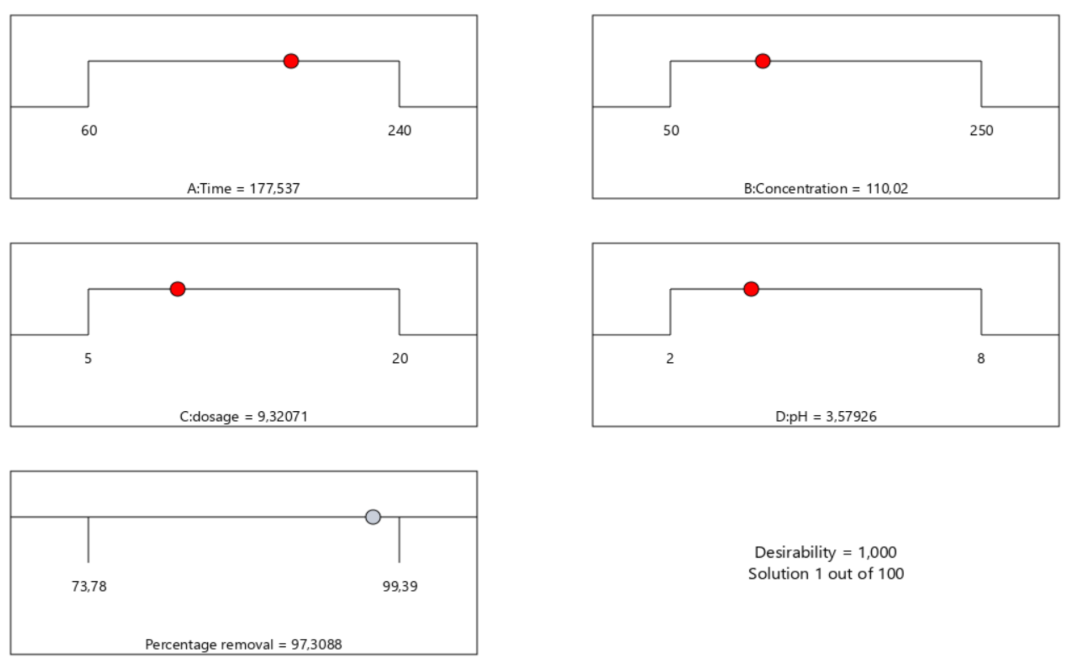

Figure 5: Shows the optimal points for the optimal adsorption of Nickel (II) using the CCD in RSM model.

CONCLUSION

- Cellulose nano crystals hydrogel were developed. FTIR Identified hydroxyl(3000-3600 cm^{-1}) and carboxyl (1650-1800 cm^{-1})
- As time increases, the rate of adsorption increases, while a decrease in concentration leads to a higher removal efficiency.
- Dosage stabilizes adsorption efficiency. An increase in pH levels lads to a higher removal efficiency.
- Time at 177.537 minutes, Concentration at 110.02 ppm, Dosage at 9.321 g/100ml and pH at 3.58 are the most optimal points. Which will produce an efficiency removal of 97.31%.

FUTURE WORK / REFERENCES

- Further studies be conducted and investigating the effect of temperature on the removal of Nickel (II) from aqueous solution.
- Further investigations be done on the stirring speed and have determine whether it is significant to the removal of Nickel (II).

- Banza, M., & Seodigeng, T. (2023). Modelling and Optimisation of Zinc (II) Removal from Synthetic Acid Mine Drainage via Three-Dimensional Adsorbent Using a Machine Learning Approach. *Engineering Proceedings*, *37*(1), 52. https://doi.org/10.3390/ECP2023-14711
- Banza, M., & Seodigeng, T. (2023). Enhanced Removal of Cr (VI) from Wastewater with Green and Low-Cost Nanomaterials Using a Fuzzy Inference System (FIS) and an Artificial Neural Network (ANN). *Engineering Proceedings*, *37*(1), 112. https://doi.org/10.3390/ECP2023-14677