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Batch mode adsorption of a Cationic Dye on a Biomass Waste: Modeling and optimization of operating conditions using experimental design

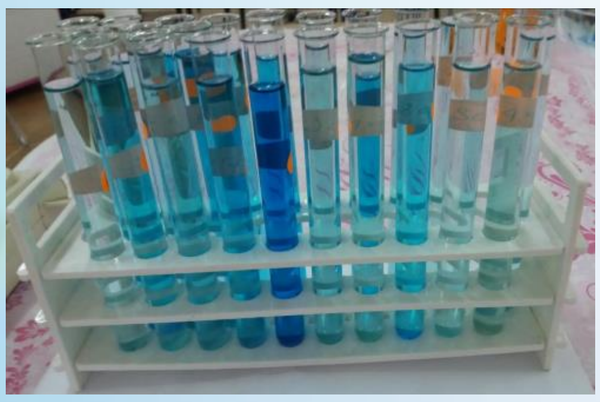
BENSEDJAD Assia, OUAZANI Fouzia, BENOUIS Khedidja, BOUANANI Meriem

Laboratory of Process Engineering, Materials and Environment, Faculty of Technology, University of Djillali Liabes, PO Box 89, Sidi Bel Abbes 22000 Algeria

INTRODUCTION & AIM

Industrial wastewater, laden with hazardous pollutants like carcinogenic dyes, poses a significant environmental challenge. Conventional treatment methods are often costly, necessitating sustainable and economical alternatives.

This study explores the use of grape pomace, an agricultural waste byproduct, as a low-cost biosorbent for removing Methylene Blue (MB) dye from wastewater.



METHODS

Biosorbent Used:

- Grape Pomace (GP), washed, dried then ground to a powder.

Adsorption Parameters Studied:

- Methylene blue concentration: 30,40,50 mg/L
- Biosorbent mass: 50,75,100 mg
- Adsorption time: 10,30,50 min
- pH of the MB solution: 2,5,8

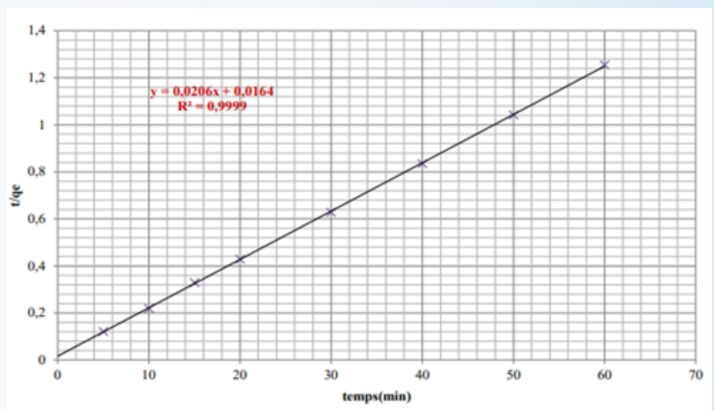
Experimental Setup:

- Batch mode adsorption
- Optimization Model: Box-Behnken design

RESULTS & DISCUSSION

Kinetic Analysis:

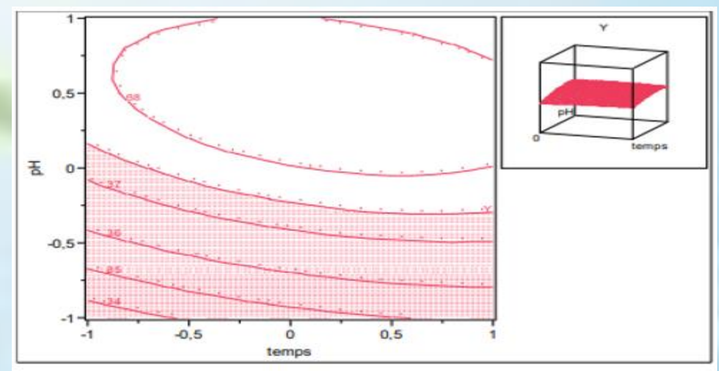
- Pseudo-second-order model: Best fit with $R^2 = 0.9999$



Pseudo second order kinetic model

Optimization via Box-Behnken Design:

- Optimal conditions: pH = 5,
- Biosorbent mass = 75 mg,
- Dye concentration = 40 mg/L
- Adsorption capacity: 37.38 mg/g



Identification of the working area for maximum adsorption capacity

Discussion

- Effectiveness: Grape Pomace effectively removes Methylene Blue from wastewater.
- Sustainability: Utilizing agricultural waste for pollutant removal supports sustainable development.
- Economic Viability: Low-cost alternative to conventional methods.

CONCLUSION

These findings highlight the potential of utilizing agricultural waste for environmental remediation, providing a cost-effective and eco-friendly alternative to conventional wastewater treatment methods. Implementing such sustainable practices can significantly contribute to reducing environmental pollution and promoting sustainable development.