iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 Issue: VI Month of publication: June 2025

DOI: https://doi.org/10.22214/ijraset.2025.72875

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue VI June 2025- Available at www.ijraset.com

The Application of Activated Carbon Impregnated Hydrogels for Water Purification

Ms. Sudhanya KS[1], Fahiz CK[2], Mohammed Shahir KK[3], Shinos KV[4], Fawaz CP[5]
[1, 2, 3, 4, 5]*Department of Civil Engineering, MEA Engineering College*

Abstract: This study investigates the potential of utilizing activated carbon impregnated hydrogel(ACIH) as an innovative solution for water purification. The researchevaluates the adsorption capacity, filtration efficiency, and reusability of ACIH, with a focus on contaminants such as turbidity,BOD, and COD in kitchen drainage water. Synthesized using chitosan and activated carbon from tamarind shells, ACIH demonstrated significant improvements in water quality parameters. Findings suggest that ACIH offers a cost-effective, sustainable, and highly efficient alternative for decentralized water treatment
Keywords: Hydrogel, Activated Carbon, Water Purification, Adsorption, Sustainability.

I. INTRODUCTION

Water pollution is a critical challenge worldwide. Existing purification technologies often fail to address a wide spectrum of contaminants effectively. This study introduces activated carbon impregnated hydrogel, a material that leverages the adsorption capacity of activated carbon and the structural properties of hydrogels, to address this gap.

II. SPECIFIC OBJECTIVES

1) To design and synthesize a novel ACIH material for water treatment..
2) To evaluate the adsorption capacity for various pollutants.
3) To analyze the efficiency of ACIH in improving water quality parameters
4) To compare the performance of footwear waste-modified bitumen with conventional bitumen mixes.
5) To improve the feasibility of the material

III. MATERIALS AND METHODS

A. *Materials*

Chitosan-based hydrogel was synthesized with activated carbon derived from tamarind shells, using crosslinking agents to ensure structural integrity. Kitchen drainage water was treated with the hydrogel in a filtration setup, testing various thicknesses and carbon dosages. Water quality improvements, including turbidity, BOD, and COD reductions, were analyzed, and reusability tests evaluated performance over multiple cycles..

VOLUME

Thickness (cm)	Volume of Hydrogel (cm^3)	Volume of water (ml)
3	2.85	64.62
6	5.7	64.62
9	8.55	64.62

B. *Experimental Procedure*

1) Hydrogel Preparation: Dissolve chitosan in acetic acid, mix with activated carbon, add a crosslinking agent, and polymerize. Cure and wash the hydrogel.
2) Sample Collection: Gather kitchen drainage water and conduct initial quality tests (turbidity, BOD, COD, etc.).
3) Filtration: Pass water through hydrogel layers of varying thickness in a filtration setup at a controlled flow rate.
4) Analysis: Test treated water for improvements in key parameters and record results.

IV. RESULTS AND DISCUSSION

The activated carbon impregnated hydrogel (ACIH) demonstrated significant improvements in water quality. Turbidity decreased from 61 NTU to 8 NTU, and BOD reduced from 33 mg/L to 15 mg/L, showcasing its high adsorption capacity. The optimal hydrogel thickness of 6 cm and 1.5 g of activated carbon yielded the best performance. Reusability tests confirmed the material's durability, with consistent results across multiple cycles. These findings highlight the hydrogel's potential for effective and sustainable water purification, though scalability and field applications require further study.

TABLE IVII
PRE-TREATMENT RESULTS

CHARACTERSTICS	UNITS	SAMPLE 1	SAMPLE2	SAMPLE 3	LIMIT
HARDNESS	Mg/l	47.5	49	46	0-60/61-120/121-180
PH		9.75	10	11	<7 – acidic >7 basic
CONDUCTIVITY	µS/cm	1211	1544	1269	0-800 µS/cm
TURBIDITY	NTU	61	55	41	5-10 NTU
CHLORIDE	Mg/l	1646	1245	893	250 mg/l
DO	Mg/l	19	15	17	6.5-8 mg/l
COD	Mg/l	688	646	588	Upto 250 mg/l
BOD	Mg/l	33	25	28	Upto 20 mg/l
FLUORIDE	M	2	2.5	2	0.6-1.2 M

Fig. 1 represents the variation of biological oxygen demand on variation of activated carbon

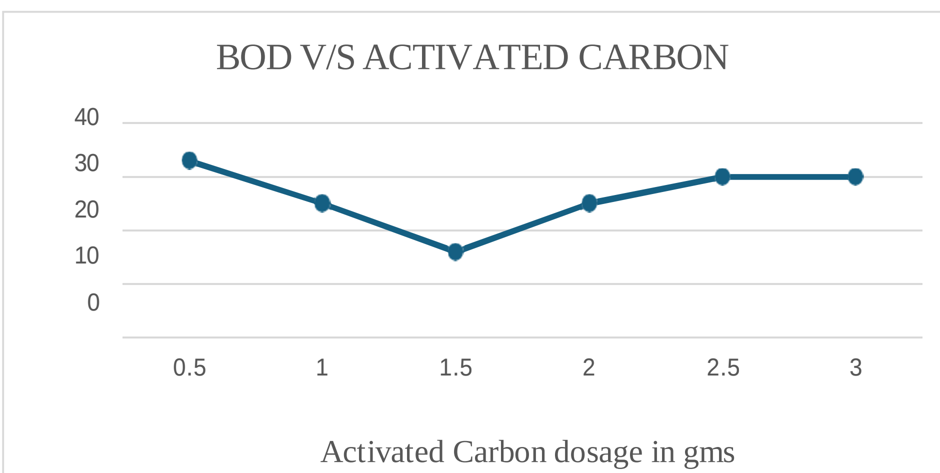
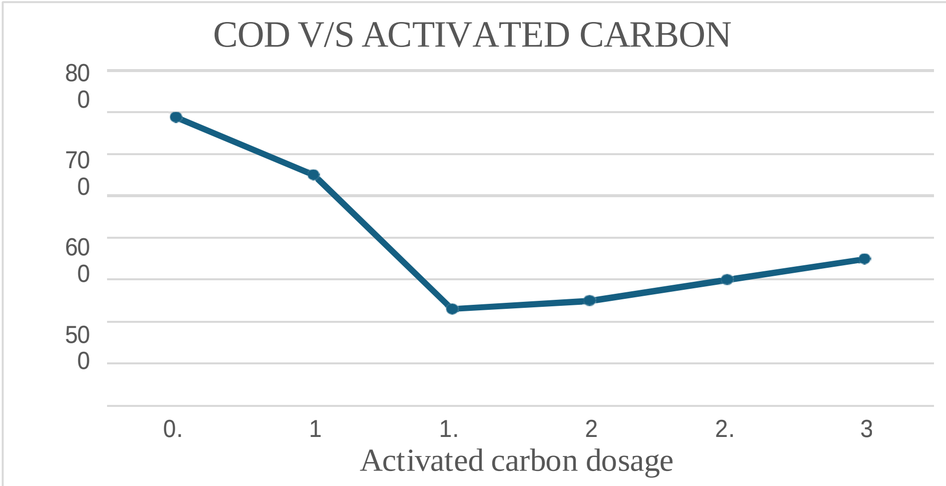


Fig. 2 represents the graphical analysis of cod v/s activated carbon



The analysis of results provides a detailed evaluation of the activated carbon impregnated hydrogel (ACIH) effectively improved water quality, reducing turbidity from 61 NTU to 8 NTU and BOD from 33 mg/L to 15 mg/L, indicating efficient pollutant removal. Optimal performance was achieved with a 6 cm hydrogel thickness and 1.5 g of activated carbon. Reusability tests showed consistent efficiency over multiple cycles, demonstrating economic and environmental sustainability. Additionally, fluoride levels and pH were brought within permissible limits, confirming ACIH as a promising solution for water purification with potential for broader applications

V. CONCLUSIONS

The present study aimed at the development, application, and performance evaluation of activated carbon impregnated hydrogel (ACIH) for water purification, particularly focusing on its capability to treat kitchen drainage water. Through extensive experimentation and testing, the results have clearly demonstrated the efficacy of this composite material in removing a wide range of contaminants, including physical impurities, chemical toxins, and microbial elements. By leveraging the superior adsorption properties of activated carbon and the water-retentive, porous structure of hydrogel, the material showcased its potential as a highly effective, reusable, and sustainable option for modern water purification needs.

From a methodological standpoint, the process included sample collection from kitchen drainage, hydrogel preparation, activated carbon impregnation, and performance testing through both batch and filtration modes.

The hydrogel was tested under different conditions, including variations in thickness and activated carbon dosage, to identify the optimal configuration. A 6 cm thickness was found ideal, balancing flow rate and adsorption efficiency. Dosage experiments revealed 1.5 g of activated carbon as the optimum amount for maximal BOD and COD reduction without compromising flow. The material also allowed for easy regeneration, enabling reusability over multiple cycles, further strengthening its sustainability credentials.

REFERENCES

[1] Gokhale, D., Hamelberg, A., Doyle, P. (2024). “Multifunctional zwitterionic hydrogels for the rapid elimination of organic and inorganic micropollutants from water.” *Nature Water*, 2(2731-6084), 62–71.

[2] Mariana, M., Khalil, A., Mistar, E., Yahya, E., Alfatah, T., Danish, M., Amayreh, M. (2021). “Recent advances in activated carbon modification techniques for enhanced heavy metal absorption.” *Journal of Water Process Engineering*, 43(2214-7144).

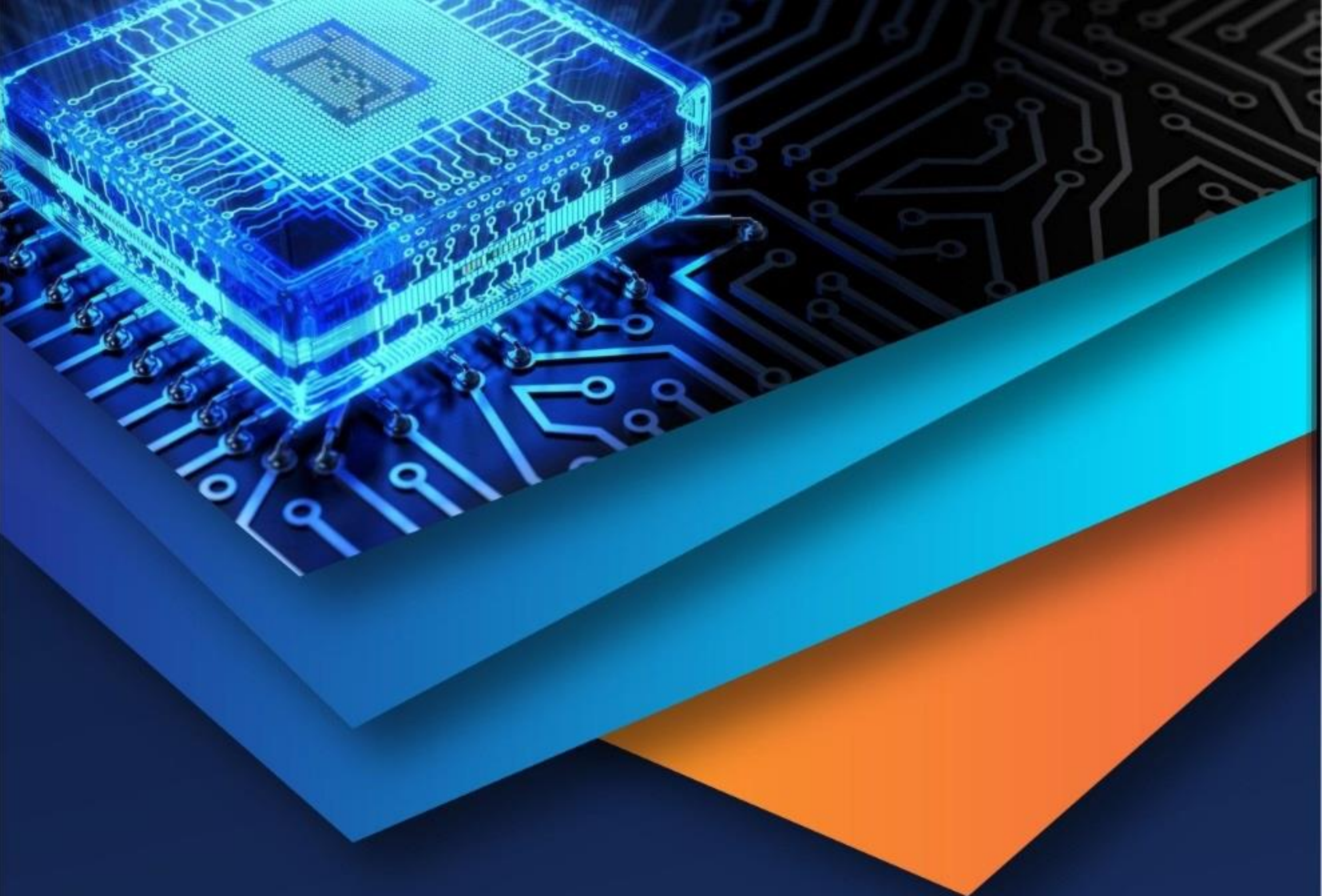
[3] An, N., Jiang, Y., Wang, Z., Sun, Q., Guo, B., Gao, B., Zhou, W., Li, Q. (2022). “Efficient water purification and desalination using hydrogel and aerogel solar evaporators based on different carbon materials.” *Separation and Purification Technology*, 301(1383-5866).

[4] Jiang, C., Cui, S., Han, Q., Li, P. (2019). “Study on Application of Activated Carbon in Water Treatment.” *International Journal of Scientific & Engineering Research*, 10(2), 237–242.

[5] Ahmad, R., Mirza, A., Yousaf, A., Jahan, Z. (2021). “Chitosan-based hydrogels: Preparation and applications in water purification.” *Journal of Applied Polymer Science*, 138(18), 50477.

[6] Sadeghi, M., Ghasemi, N., Soleimani, H. (2018). “Preparation of superabsorbent hydrogel from sodium alginate for removal of heavy metals from aqueous solution.” *Desalination and Water Treatment*, 103(1), 331–338.

[7] Gupta, V.K., Nayak, A., Agarwal, S. (2017). “Hydrogel composites for water treatment: Current trends and future outlook.” *Critical Reviews in Environmental Science and Technology*, 47(3), 208–257.



doi crossref
10.22214/IJRASET

INDEX COPERNICUS
45.98

ISRA JIF
IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL
IMPACT FACTOR:
7.429

ISI

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY