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MOTORIZED STUDY OF ACID ORANGE 5 ON BALSAMODENDRON CAUDATUM LUMBER WASTE ACTIVATED NANO POROUS CARBON SUBSTANCE AND CONNECTING IN AVF TECHNOLOGY

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ABSTRACT

Balsamodendron caudatum-activated nanoporous carbon substances (BCNCS), derived from wood waste, can adsorb dye from aqueous solutions. The improper disposal of dye into waste water poses risks to ecosystems. and leads to environmental issues. This study focuses on using BCNCS waste as an adsorbent to remove Acid Orange 5. The dye material adsorption kinetics were examined using Pseudo-First-order and Pseudo-Second-order, prototypes and AVF is an advanced wastewater treatment system. In this procedure, the filter media migrate downward, purifying the treated water as it flows upward. Since the filtered liquid cleans the filter during the treatment process, no special filter media cleaning or fresh water is required. A two-stage series arrangement is used to produce exceptionally high-quality filtrate. For reusing secondary wastewater, this approach is ideal. AVF Technology was analyzed.

Keywords: BCNCS, Sorption, Acid Orange 5, Low-Cost Adsorbents, Pseudo-First-Order, Pseudo-Secod-Order AVF.

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INTRODUCTION

Water adulteration from human activities has become a major environmental concern with numerous contributing influences. So we have to reduce the pollution. Water always contains a wide array of inorganic and organic substances, most of which are a result of complex interactions between water, soil, geological processes, and biological or microbiological activities in both soil and water. Commonly found contaminants include plant debris, suspended and colloidal minerals, and protozoa. Activated carbon, microporous structure and favorable chemical properties, is an effective adsorbent for removing color from industrial wastewater. It is estimated that approximately 800,000 tons of dye are produced annually. consequently, water may be regarded as a crucial component of the ecosystem.[1]

However, the alternative, very low-cost sorbents due to the great price and associated issues of rejuvenation. Red mud4, hydrochar and ZnO[2], Arundodonax seeds[3], red mud[4], TiO2 nanocomposite[5], oryza sativa husk[6], green adsorbent[7], Hildegardia barter activated carbon, and TiO2 nanocomposite[8], adsorbent resin made from e-waste[9] multiwalled carbon nanotubes[10], nano-adsorbents[11], ZnO, MgO, and FeO[12], bibliometric evaluation of nanoadsorbents[13], and nanomaterials as adsorbents[14], carbon-activated nanomaterial[15], carbon-activated nanomaterial[16], nanomaterials as adsorbents[17], metal oxides, carbon-based nanomaterials, cellulose-based nanomaterials.[18]

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EXPERIMENTAL

Adsorbent

Wood waste from *Balsamodendron caudatum* was gathered from different areas in Mettupalayam. The *Balsamodendron caudatum* material was utilized as an adsorbent, recognized for being cost-effective, eco-friendly, and economically viable. The wood was initially cleaned with deionized water. To improve its adsorption capacity. To remove the attached conventional components, the dried material was treated using H_2O_2 (50 wt / vol) for approximately 24 hours at normal room temperature. Later, it was thoroughly rinsed with double-distilled water and heated at 125°C to eliminate any remaining moisture. A portion of the material was then turned into carbon at 130–140°C in a muffle chamber after being soaked in water and orthophosphoric acid for a whole day. After that, the material was heated to 600°C for 60 minutes in a muffle furnace to activate and flatten it. To get rid of any remaining acid, the carbon that was produced after activation was thoroughly cleaned with lots of water. After drying, the material was ground into the appropriate particle size. BCNCS was the designation given to the finished carbon product.

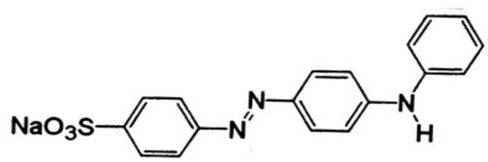

Fig.-1: Structure of Acid Orange 5

Table-1: Individuality of the Dye

Collection	Typical	Communal Name	CI No.	Mwt
Acid	OA5	Acid Orange 5	13080	375.38

Pseudo 1St Order Speed Equation

It is generally frayed as:

$$dq_t / dt = k_1(q_e - q_t) \tag{1}$$

Pseudo 2ndorder equation

Pseudo 2nd-order equation is expressed such as:[19]

$$dq_t / dt = k_1(q_e - q_t)^2 \tag{2}$$

Elovich Model Equation

It is normally stated as:[2]

$$q_t = 1/\beta \ln(\alpha\beta) + 1/\beta \ \ln t \tag{3}$$

RESULTS AND DISCUSSION

Categorizations of Sorbent

Categorizations of the sorbents were accessible in Table-2. N2 adsorption at 77K was used to measure the BCNCS's surface area using a Nova1000 Quanta Chrome Corporation. Hence, pHpzc of the BCNCS under investigation in this test was discovered to be 4.7 based on the findings of the "pH drift" experiment.

Table-2: Features of BCNCS

Parameter	BCNCS
P^H	6.7
External surface area (m^2/g)	458
P^H zpc	4.7

Consequences of pH

The set of tests designed to determine how pH affects the adsorption phenomenon revealed that pH has an impact on the dye in water, as well as the BCNCS surface dye, necessary sites. The amount of dye adsorbed at the initial pH value using an acid-activated absorbent is depicted in Fig.-1. The starting dye concentration in this experiment was set at 20 milligrams/ liter, 40 milligrams/ liter, and 60 milligrams/ liter. Colour elimination of the dye, Acid orange 5, noted at 6.7 pH in the shake flask studies. With an extreme dye acceptance of 98.5mg/g, pH 6.7 was shown to be the ideal level for Acid Orange 5 uptake. A tendency of declining qe values was noted in the pH range of 5.5 to 8.0. The qe values were discovered to be identical to the reduction in the pH alkaline range of 7.0–10.1. Reported outcomes are comparable.

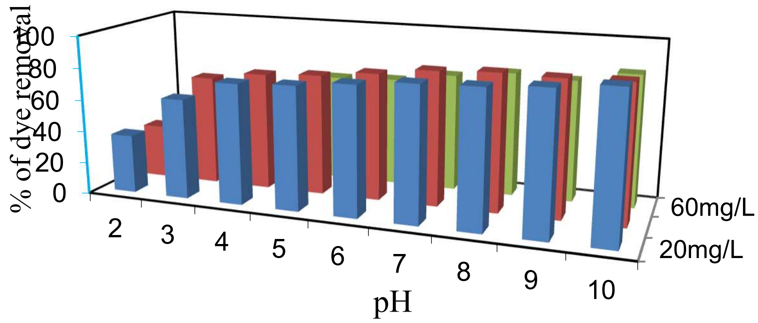

Fig.-2: Consequence of P ^{H} on Stability Acceptance of Acid Orange 5 Sorption Over BCNCS. 100 mg, V, =100 ml, C $_{0}$ 20 Milligram/ Liter, 40 Milligram/ Liter, and 60 Milligram/ Liter. and 30° C.

Consequence of Sorbent Dose

These investigations were all carried out at room temperature and 250 rpm continual speediness. An increase in the dosage of adsorbent was found to result in a higher percentage of color removal.

Consequence of Original Dye Deliberation

Dye stayed stirred in equal intervals in order to conduct the kinetic tests. Contact time studies were performed by agitating 100 ml of Acid Orange 5 solutions. The excitement speediness was kept constant at 300 rpm. By applying the absorb BANCS dimensions, the color reduction profiles were produced.

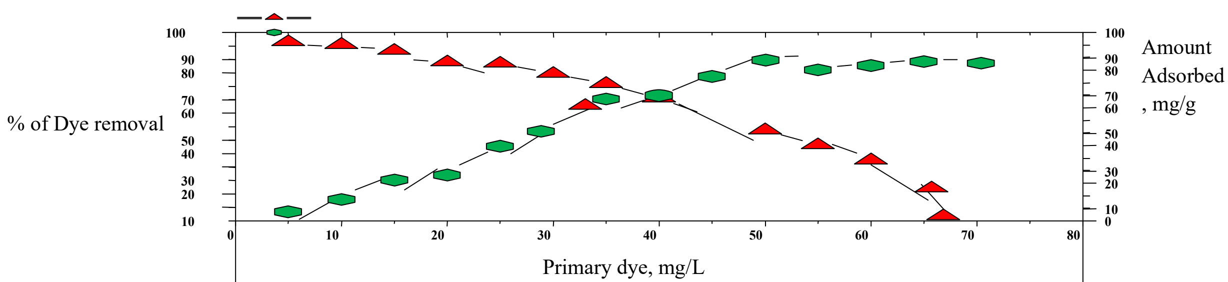

Fig.-3: Influence of Preliminary Deliberation of Acid Orange 5

SEM Analysis

The adsorbent shown in Fig.-3's SEM reveals that the elements are most penetrable to the surrounding air. It was first discovered that the model's front elevation contained unidentifiable holes and grotto group openings that would have a surface area that was significantly larger than before.[21]

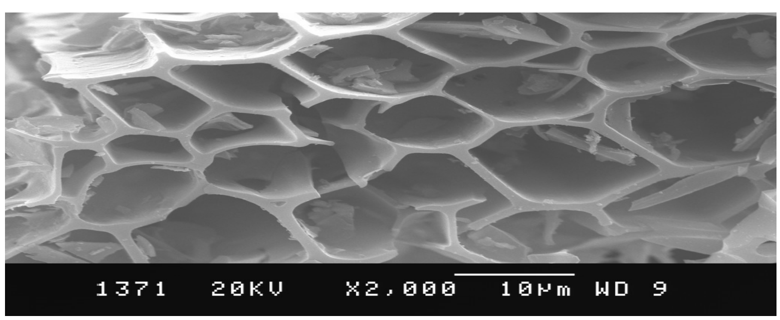

Fig.-4: SEM Examination for BCNC

Consequences of Hotness Over Dynamic Speed Constant and Speed Limits

Adsorption of acid orange 5 on BANCS stimulated nano carbon is finest defined by the 1st -order speed calculation, as evidenced by a recession coefficient rate exceeding 0.99.

The AVF process is equipped with sensors, actuated valves, and programmable logic controllers that automatically switch from serial to parallel mode[22] when wet weather or other predetermined operating circumstances.

Table-3: Sorption Kinetic Speed Coefficients used for BCNCS on Different Hotness

Sorbent	Initial Temperature	1^{st} Order		2^{nd} Order			Elovich Typical model		
		Rate constant 1 [k1] min^{-1}	r^2	Rate constant 2 [k2] g mg^{-1}	h mg g^{-1} min^{-1}	r^2	β g min^{-1}	α mg g^{--1} min^{-1}	r^2
BCNCS	30^0C	0.0145	0.9365	0.0015	0.4799	0.1973	0.1346	0.7585	0.9511
	45^0C	0.0086	0.8876	0.0400	5.3134	0.3265	0.1654	0.4375	0.9277
	60^0C	0.0345	0.6236	0.0045	0.1668	0.6546	0.2348	0.5476	0.9907

Morden Methodology for Removal of Acid Orange 5

Opening Feed and Overview to the AVF System

After being pumped into the AVF units, the Acid Orange 5 feed enters the system by flowing downhill. o To ensure a uniform distribution of flow, influence is supplied at the top of the system and progressively moves downward into the media bed via a network of feed radials.

Mounting Flow through Downward-Moving Media Bed

Flowing upward via a media bed that moves downward, Effective contact between the Acid Orange 5 and the media is made possible by the influent flowing upward via the media bed that moves downward. The media bed's nano-porous carbon (BANCS) efficiently absorbs pollutants by adsorbing both organic and inorganic contaminants, such as Acid Orange.

Waste Collection and Clean Filtrate Exit

The clean, polished waste moves upward and exits at the top of the AVF filter via an effluent pipe.
The upward flow of filtrate ensures minimal turbulence, allowing scums to remain in the media bed.

Clean Filtrate Exit and Effluent Collection

The polished, clean effluent travels upward and leaves through an effluent pipe at the top of the AVF filter.
The filtrate's upward flow guarantees little turbulence, keeping contaminants in the media bed.

The Mechanism of the Scouring and Airlift Pipe

As the media moves downward through concentric stages of the washer, it encounters a small flow of polished filtrate moving upward, further removing residual impurities.
This cleaning process ensures the media is thoroughly scoured and ready for reuse in the filtration process.

Recycling of Cleaned Media

The media is drawn into the airlift by introducing a tiny quantity of compressed air at the bottom of the airlift pipe.
The media are subjected to intense scrutiny during the airlift. Compared to traditional sand filtration backwash, this scouring is more successful in removing any impurities and associated solid particles from the medium grains.

Role of BANCS as an Adsorbent

BANCS's large surface area and porous structure enable it to efficiently adsorb Acid Orange 5 and other contaminants from the wastewater, making it a sustainable, cost-effective solution for dye removal.

Advantages of the Methodology

Efficient Cleaning Mechanism

The scouring and recycling of media reduce the need for frequent replacement, lowering maintenance costs and increasing system efficiency.

Effective Dye Removal
BANCS's adsorptive capabilities allow it to capture even trace levels of dyes and heavy metals, ensuring high-quality treated water.
Environmental Sustainability
The use of AVF reduces water and energy consumption, while BANCS offers a renewable alternative to more costly adsorbents.

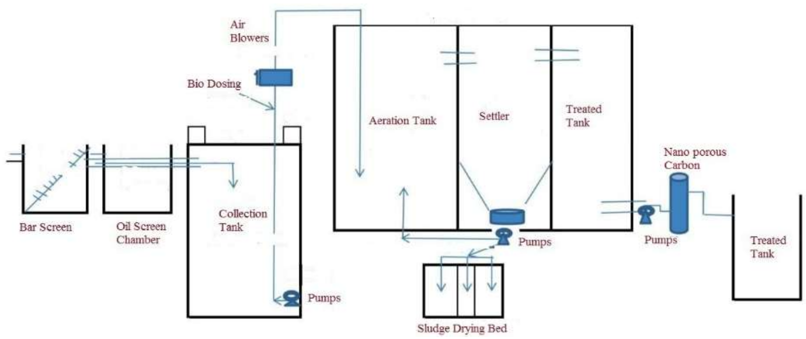

Fig.-5: This Methodology Provides an Efficient, Cost-Effective Approach to Handling Textile Dye Effluents, Helping Industries Comply with Environmental Standards and Contributing to Water Conservation Efforts

CONCLUSION

The sorption of the dye onto BANCS was originally expected to be affected by factors such as temperature, adsorbent concentration, and pH, with pH 6.7 being optimal for Acid Orange 5. The thermodynamic properties of the adsorbent were used to evaluate the feasibility of the process at different concentrations. Adsorption equilibrium for the dye was achieved after 102 minutes of contact time. In the AVF system, BANCS (nano-porous activated carbon derived from Balsamodendron caudatum wood waste) demonstrated excellent efficiency as a sorbent and reduced pollution. The adsorption kinetics of Acid Orange 5 were best described by a pseudo-first-order speed equation.

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CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS

The present work is related to *SDG-6: Clean Water and Sanitation*. All the authors contributed significantly to this manuscript, participated in reviewing/editing and approved the final draft for publication. The research profile of the authors can be verified from their ORCID ids, given below:

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REFERENCES

1. M. Khaled, M. Alaqad Asma Elsharif, M. Mahmoud Abdelnaby, Abdulkadir Tanimu, Ismail Abdulazeez, *Environmental Pollution and Management*, **2**, 1(2025), https://doi.org/10.1016/j.epm.2024.12.003

2. Van hung Hoang , Thi minh Phuong Nguyen , Thi dong Nguyen ,Thi hong Vien Nguyen , Thi hong Huyen Chu , Le Phuong Hoang , Phan Quang Thang , Lan Huong Nguyen ,Trung Kien Hoang and Huu-tap Van, *Royal Society of Chemistry,* **15,** 6634(2025), https://doi.org/10.1039/d5ra00493d
3. Arwa abdelhay, Abeer al bsoul, Amani al-othman,Nada mal-ananzeh,Inshadjum'hahmed and Aal-taani, *Adsorption Science and Technology,***36**, 46(2018), https://doi.org/10.1177/0263617416684347
4. Zhong-pan hu, Ze-min gao, Xinying liu and Zhong-yong yuan, *Adsorption Science and Technology,* **27**, 62(2017), https://doi: org/10.1177/0263617416684348
5. Dayeon choi, Soohoham and Du jeonjang , *Journal Environmental Chemical Engineering*, **6**, 1(2018), https://doi.org/10.1016/j.jece.2017.11.065
6. Mandeep Kaur, Santosh Kumari and Praveen Sharma, *Biotechnology Reports*, **25**, e00410(2020), https://doi.org/10.1016/j.btre.2019.e00410
7. S. Asma, S. Al-wasidi, ibtisam i, Alzahrani, H. Thawibaraka , M. A. Naglah , Mohamed G. el-desouky and Mohamed A. el-bindary, *Journal of Molecular Structure,* **1250**, 131736(2022), https://doi.org/10.1016/j.molstruc.2021.131736
8. Lkehindesholaobayomi, Sieyon lau, Divineakubuo-casmir, Muibatdiekolayahy, ManaseAuta, A. S. M. Fazle Bari, Ayomide Elizabeth Oluwadiya, Oluwatobi Victoria Obayom and Mohammadmahmudur Rahman, *Journal of Molecular Liquid,* **352**, 118735(2022), https://doi.org/10.1016/j.molliq.2022.118735
9. Kayode Adesina Adegokea , Solomon Olanrewaju Giwa , Oyeladun Rhoda Adegokec , Nobanathi and Wendy Maxakatoa, **21**, e0175(2023), https://doi.org/10.1016/j.sciaf.2023.e01753
10. K. M. Abualnaja , A. E. Alprol, M. A. Abu-saied, Mohamed Ashour and Abdallahtagelde in Mansour, *Sustainability,***13**,7077(2021), https://doi.org/ 10.3390/su13137077
11. M. Manyangadzea, N.H.M. Chikuruwob, T.B. Narsaiahc, C.S. Chakrad, M. Radhakumarie, *South African Journal of Chemical Engineering* **32**, 3125(2020), https://doi.org/10.1016/j.sajce.2019.11.003
12. Saima Noreena, Ushna Khalida Sobhy, M. Ibrahimb, Tariq Javedd, Ambreen Ghani , Saima Nazf and Munawar Iqbal, *Journal of Materials Research and Technology,* **9(3)**, 5881(2000), https://doi.org/10.1016/j.jmrt.2020.03.115
13. Kayode Adesina Adegokea, Solomon Olanrewaju Giwa , Oyeladun Rhoda Adegokec and Nobanathi Wendy Maxakatoa, *Scientific African,* **21**, e01753(2023), https://doi.org/10.1016/j.sciaf.2023.e01753
14. Dimitrios Kalderis, Georgios Stavroulakis, Toshiki Tsubota, and Selda Dogan, Calhan, *Chemistry for the Environment,* **5**,100057(2024), https://doi.org/10.1016/j.scenv.2023.100057
15. Valentina Segneria, Antonio Trincaa, Nelson libardib, Leonardo Colellia Mattia Micciancioa and Giorgio Vilardia, *Chemical Engineering Transactions,* **101**, 133(2023), https://doi.org/10.3303/CET23101023
16. V. Kalapala Prasad, R. Ravi Kumar, A. Suresh Kumar, S. Rajesh Anjani Kumar Rai, Essam, A. Al-Ammar, Saikh Mohammad Wabaidur, Amjad Iqbal, and Dawit Kefyalew, *Adsorption Science & Technology*, **2023**, Article ID 4048676 (2023), https://doi.org/10.1155/2023/4048676
17. Aleesha Jamshed , Asif Iqbal , Sohail Ali , Salman Ali , and Mamoon , *Ecology & Environmental Sciences,***8(3)** , 86(2023), https://doi.org/10.15406/mojes.2023.08.00278
18. Heilyn Péreza , Omar Jasiel Quintero Garcíaa , Myriam adela amezcua-allierib and Refugio rodríguez vazqueza , *Water Science & Technology* , **87** , 2971(2023), https://doi.org/10.2166/wst.2023.179
19. S. Chien and W. R. Clayton, *Soil Science. Society of America Journal,* **44**, 265(1980), http://dx.doi.org/10.2136/sssaj1980.03615995004400020013x
20. Y. S. Ho , G. Mckay, D. A. J. Wase and C.F. Foster, *Adsorption Science & Technogyl,***18**, 639(2000), https://doi:10.1260/0263617001493693
21. D. Khattri and M.K. Singh, *Water, Air and Soil Pollution,* **120**, 283(2000), https://doi.org/10.1023/A:1005207803041
22. V. Gaonkar Gopalkrishna and P. S. Pavan, *Journal of Emerging Technologies and Innovative Research,* **6** 102(2019)

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