Treatment of Naphthalene-Based Contaminated Seepage in a Rainwater Reservoir Using Coagulant-Charcoal Hybrid Approach in a Chemical Manufacturing Facility

Prathamesh Ankush More,[1] and Rajkumar Lakhotia [2], Shivani Krantikumar Wadke[3]
[1,2] M. Tech Environmental Engineering Dr. Babasaheb Ambedkar Technological University, Lonere
[3] M.Sc. Organic Chemistry D.G. Tatkare Mahavidyalaya, Mangaon, Raigad

***Abstract*—This study addresses naphthalene-based seepage contamination in a rainwater reservoir at a Chemical manufacturing facility in Mahad MIDC, Maharashtra. A hybrid treatment using poly aluminum chloride (PAC) with cationic polyelectrolytes, followed by activated charcoal filtration, effectively reduces turbidity and chemical oxygen demand. Optimized trials ensured the treated water met environmental norms for gardening use, offering a replicable solution for industrial water reuse.**

Index Terms - **Activated Charcoal Filtration, Coagulant-Charcoal Hybrid Treatment, Naphthalene Contamination, Rainwater Reuse, Water Quality Remediation**.

I. INTRODUCTION

Industrial expansion in chemical clusters, such as Mahad MIDC in Raigad district, Maharashtra, often presents significant environmental challenges, especially concerning water quality. This study focuses on a Chemical manufacturing industry where a rainwater reservoir located at the southeast corner of the site experienced unexpected seepage of black contaminated water during its construction phase. The seepage was traced to surrounding soils likely impacted by naphthalene-based dye intermediates, common in specialty chemicals and adhesive industries nearby. This contamination posed a serious obstacle in utilizing rainwater for non-potable applications, particularly for gardening. This paper presents a systematic investigation and treatment protocol that successfully addressed this issue, ensuring environmental compliance and reuse of the reservoir water.

II. LITERATURE REVIEW

The occurrence of dark-colored contaminated groundwater or seepage is common in areas surrounded by dye intermediates and aromatic hydrocarbon producers. Naphthalene-based compounds are known for their stability and resistance to conventional treatment processes due to their high chemical oxygen demand (COD) and intense coloration [Singh et al., 2018]. Traditional coagulants like alum and ferric chloride often fall short in treating such effluents, necessitating a hybrid approach involving advanced coagulants and adsorbents. Poly aluminum chloride (PAC) in combination with cationic polyelectrolytes has shown promise for primary treatment in reducing suspended solids and partial decolorization [Kumar & Bansal, 2020]. Further treatment using activated charcoal filtration has been effective for polishing and final color removal, especially when dealing with recalcitrant aromatic contaminants [Zhang et al., 2017]

III. EXPERIMENTAL PART

3.1 Primary Treatment via Jar Testing: - Multiple coagulant formulations were evaluated for their performance in clarity improvement and sludge minimization. Combinations of PAC and various cationic polyelectrolytes were prepared and tested using standard jar test procedures.

3.2 Secondary Polishing Treatment: - The primary treated water, though clear in appearance, retained a slight black tint. This was addressed using a gravity-fed activated charcoal bed setup to adsorb residual colorants and reduce turbidity and COD.

3.3 Sampling and Characterization: Contaminated water samples from the reservoir were collected and subjected to fingerprint analysis in-house and by a third-party laboratory. Key parameters such as COD, pH, TDS, color, and turbidity were recorded. Initial COD was 800 mg/L, pH was neutral (6.8-7.2), TDS was 350 mg/L, color was distinct black hue, Turbidity was 420 NTU.

3.4 Jar Test Optimization: Ten distinct coagulant formulations were trialed. Each trial involved varying the PAC and polyelectrolyte dose, maintaining consistent mixing and settling conditions. Trial No. 6 (PAC: 80 mg/L + Cationic Polymer: 5 mg/L) resulted in optimal clarity and minimal sludge production.

3.5 Activated Charcoal Filtration: Primary treated effluent passed through a bed of activated charcoal (mesh size: 4–8 mm; bed depth: 30 cm). The effluent was allowed to pass at a constant rate ensuring maximum contact time.

IV. RESULT AND DISCUSSION

4.1 Jar Testing**:** Trial No. 6 demonstrated the best performance with over 90% turbidity reduction and significantly reduced sludge volume compared to other combinations.

4.2Polishing Treatment: Activated charcoal filtration brought turbidity down to 4 NTU. COD was reduced to <50 mg/L, TDS was reduced to <100 Color was changed from distinct black to colorless and pH was neutral (6.8–7.2).

4.3 Final Water Quality: The treated water parameters fell within permissible limits for use in gardening and landscaping purposes as per local environmental guidelines.

Table 1 :- Treatment Chemical addition and Analysis

Sample No	Cationic Polymer 0.2% (ml)	PAC 10% (ml)	pH	COD (mg/L)	TDS (mg/L)	Turbidity (NTU)
1	8	90	6.89	56	69	51
2	14	29	6.95	72	78	42
3	10	60	6.62	88	65	64
4	3	120	6.23	104	63	38
5	11.5	19	7.03	64	83	10
6	5	80	7.15	40	58	2

Graph 1:- Consumption of Polyelectrolyte and polyaluminium chloride against each trial

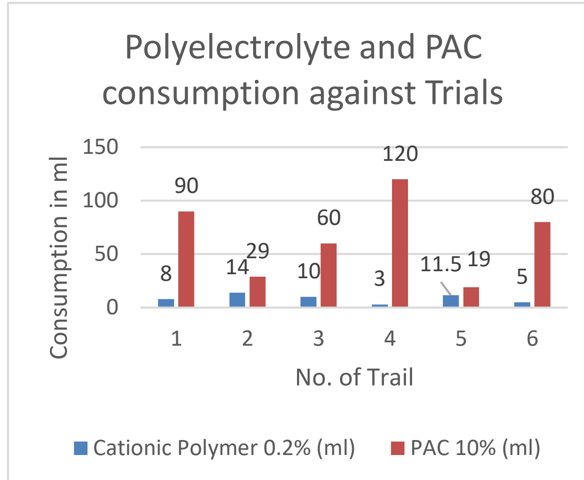

Fig.1: - Initial Sample Fig.2: --After Treatment

Fig.3 Charcoal Bed Fig.4 Treated Effluent

V. CONCLUSION

The unexpected infiltration of black naphthalene-based effluent into the rainwater reservoir posed a serious challenge to water reuse efforts at the Chemical manufacturing site. Through systematic evaluation and optimization, a hybrid treatment strategy involving PAC + cationic polyelectrolyte (Trial 6) followed by activated charcoal polishing proved effective. The treated water was within permissible garden water quality norms and can now be safely used for non-potable purposes. This approach not only salvaged the utility of the reservoir but also presents a replicable model for other industrial setups facing similar contamination challenges.

REFERENCE

[1] Singh, M., Yadav, R., & Sharma, R. (2018). Treatment of dye intermediates using advanced coagulation methods. Journal of Environmental Chemical Engineering, 6(3), 2891-2898.
[2] Kumar, A., & Bansal, P. (2020). Use of polyaluminium chloride and polyelectrolytes for dye wastewater treatment: A comparative study. International Journal of Environmental Science and Technology, 17(1051–1060).
[3] Zhang, L., Chen, Y., & Wang, T. (2017). Activated carbon for water treatment: Principles and practices. *Water Research*, 123, 277-290.
[4] CPCB Guidelines (2021). Water quality criteria for reuse in gardening and landscaping. Central Pollution Control Board, India.