Enhanced Removal of Industrial Water Pollutants Using a Pyrolytic Carbon Fibre–Graphene Oxide–Iron Tri-Composite Adsorbent

Chandrani Pramanik
Amartya Bhattacharyya, Trilochan Bagarti, Manjula Gupta, Navin Kumar
Graphene, New Materials Business, Tata Steel Limited, Jamshedpur, India
Chandrani.pramanik@tatasteel.com

Abstract

Industrial wastewater contains hazardous pollutants such as dyes, heavy metals, and cyanides, contributing significantly to global water contamination and associated health risks. Conventional activated charcoal, though widely used, has limited adsorption capacity and poor reusability. In this study, a high-efficiency tri-composite adsorbent was developed using pyrolytic carbon fibre (PCF) integrated with graphene oxide and iron particles. The resulting PCF–GO–Fe composite demonstrates markedly superior pollutant removal across diverse contaminants. Plant dye effluents from a Steel Plant are removed nine times more effectively than with activated charcoal, while methylene blue removal improves fourfold. For inorganic toxins, cyanide and chromium removal efficiencies increase by fourfold and 1.4-fold, respectively, and arsenic removal is enhanced by an exceptional thirty-eight times. Reusability tests show sustained performance across three treatment cycles. Overall, the composite offers a powerful and sustainable alternative to activated charcoal for advanced industrial wastewater purification.

References

[1] Faiza Asghar, Bushra Shakoor, Saira Fatima, Shamsa Munir, Humaira Razzaq, Shazia Naheed and Ian S. Butlerd, RSC Adv., 12 (2022), 11750 *Fabrication and prospective applications of graphene oxide-modified nanocomposites for wastewater remediation*

[2] Yichang Huang, Jingpeng Zhang, Hanwen Li, Jiye Fan, Yuanhao Wang, *International Journal of Low-Carbon Technologies*, 20 (2025), 2117 *Application of graphene oxide-assisted membranes and its applications in water treatment and purification: a mini review*

[3] A Process For Preparation of A Pyrolytic Carbonized Fibre and Applications Thereof (2025), India Patent application No. 202431006320

Figures

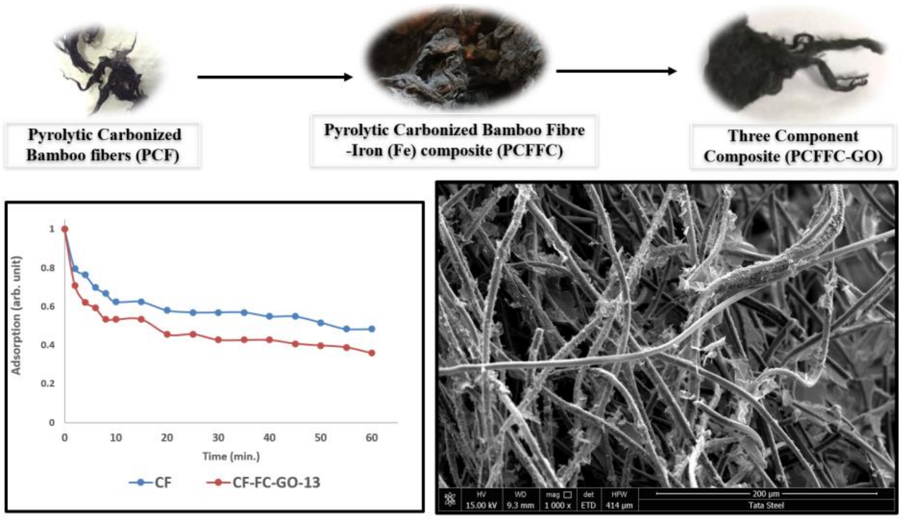

Figure 1: Comparison of adsorption of methylene blue dye by tri-components composite of, PCF composite comprising GO-Iron-CF (CF-FC-GO) with respect to carbon fibre (CF) and SEM image of CF-FC-GO.