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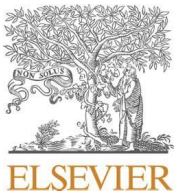

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Treatment of waste using waste-derived materials and free energy: A practical concept of circular-economy

Aditi Bhole [a], Gopal C. Koladia [a], Shubham P. Koladia [b], Nisha V. Bora [c], Leena V. Bora [a,*]

[a] Department of Chemical Engineering, Institute of Technology, Nirma University, Sarkhej-Gandhinagar Highway, Ahmedabad, Gujarat, 382481, India
[b] School of Applied Sciences, L. J. University, Sarkhej-Sanand Circle, Ahmedabad, Gujarat, 382210, India
[c] Department of Mechanical Engineering, L.D. College of Engineering, Navrangpura, Ahmedabad, Gujarat, 380015, India

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ABSTRACT

Controlling industrial effluent and treating it with improvised technologies continues to be a dominant research topic in the scientific community. In this study, the concepts of circular-economy and control-of-waste-by-waste were applied to the synthesis of a photocatalyst composite composed entirely of waste resources, namely waste rust (Fe_2O_3) and seashells (CaO). The ratio of these two waste materials was optimized to yield a composition 10% Fe_2O_3/90% CaO (10-FC) that was effective in decolorizing 85% of methylene blue in 60 min, with a formal quantum efficiency of 0.27% in direct sunlight. The heterogeneous photocatalyst was characterized by UV–Vis/NIR, SEM and XRD and is proposed to follow Langmuir-Hinshelwood kinetics and Z-scheme mechanism of charge transfer. Here, waste products were integrated and utilized to create a resource that is recommended for the treatment of dye effluent using a renewable energy source. This research aims to identify elements present in waste dumps and create a valuable resource from them to promote sustainable practices.

1. Introduction

The ubiquitous presence of organic dyes in industrial effluent contributes significantly to environmental contamination. Textile dyes, a significant source of global water pollution, are toxic, carcinogenic, and mutagenic. Conventional treatment methods, such as flocculation, precipitation, ion-exchange, etc., have their limitations, such as hazardous waste generation, membrane contamination, additional pollutant production, etc. (Gou et al., 2022; Saravanan et al., 2021). Numerous researchers today emphasize on developing effluent remediation techniques that are not only effective, but also economically viable and time-efficient (Hasija et al., 2021; Nguyen et al., 2020). Photocatalysis is a simple, non-polluting process that requires no additional chemicals and makes use of a clean, renewable energy source (Ali et al., 2023; Wang et al., 2023). Conventional photocatalysts, including TiO_2, ZnO, etc., require UV stimulation, which is restricted to approximately 4% of the total solar spectrum. Utilization of noble metals or other efficient photocatalysts, such as Ag, g-C_3N_4, graphene oxide, etc. (Abdulnabi et al., 2023; Li et al., 2023; Sansom et al., 2021; Zhang et al., 2022) have excellent efficiency but are limited by their scarcity, high-cost and probable detrition to practical applications (Haslinda Shariffuddin et al., 2018). As a consequence, continual efforts are underway to introduce new materials with superior performance in the

* Corresponding author.
E-mail address: leena.bora@nirmauni.ac.in (L.V. Bora).

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