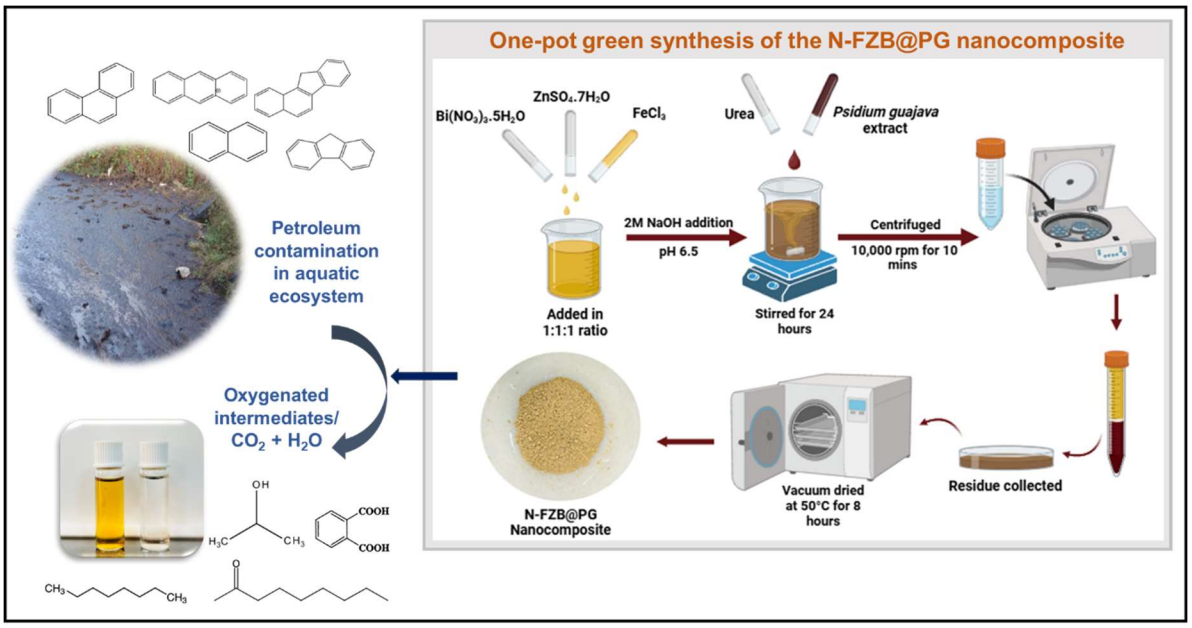
Enhanced Visible-Light-Driven Photodegradation of Total Petroleum Hydrocarbons Using Biogenic Trimetallic Nanocomposite

Brief description:

This invention aims at the synthesis of a biogenic trimetallic nanocomposite incorporating iron (Fe), zinc (Zn), and bismuth (Bi) using *Psidium guajava* leaf extract, aimed at the enhanced visible-light-driven photodegradation of total petroleum hydrocarbons (TPH) present in crude oil.

Details about the technology:

The present invention synthesizes a biogenic nitrogen-doped trimetallic nanocomposite comprising bismuth (Bi), iron (Fe), and zinc (Zn) oxides via a facile co-precipitation method using *Psidium guajava* (guava) leaf extract. The extract, rich in bioactive phytochemicals, served as a natural reducing, capping, and stabilizing agent during synthesis. This nanocomposite was specifically engineered for the visible-light-driven photocatalytic degradation of total petroleum hydrocarbons (TPH) present in crude oil. N-doping effectively narrowed the bandgap of the material, thereby enhancing visible-light absorption and significantly improving its photocatalytic performance, as evidenced by high degradation efficiency under simulated solar conditions.



Schematic representation of the process

The methodology of this process involves the following steps:

The present invention provides a process for synthesizing a biogenic nitrogen-doped trimetallic nanocomposite for petroleum hydrocarbon photodegradation, comprising the following steps:

1. Preparing *Psidium guajava* leaf extract by heating freshly chopped leaves in deionized water at 80 °C for 1 hour, followed by cooling and filtration.

2. Preparing 0.1 M aqueous solutions of bismuth nitrate pentahydrate, zinc sulphate heptahydrate, and ferric chloride, and mixing equal volumes under continuous stirring.
3. Adjusting the pH of the reaction mixture to 6.5-7.0 using 2 M NaOH solution.
4. Adding the prepared *Psidium guajava* leaf extract and 0.05 M urea solution to facilitate biogenic synthesis and nitrogen doping.
5. Stirring the reaction mixture at room temperature for 24 hours, followed by centrifugation to recover the precipitate.
6. Vacuum-drying the obtained solid at 50 °C for 12 hours to yield the final nitrogen-doped trimetallic nanocomposite.

What problem it solves/applicability of the technology:

The present invention discloses a green-synthesized nitrogen-doped trimetallic nanocomposite comprising Bi, Fe, and Zn oxides for efficient visible-light-driven degradation of total petroleum hydrocarbons in crude oil-contaminated water. *Psidium guajava* leaf extract was utilized as a natural reducing, capping, and stabilizing agent, eliminating the need for synthetic chemicals during synthesis. The developed photocatalyst achieved 86.37% TPH degradation at an initial concentration of 1000 mg/L within 240 minutes under visible light irradiation. The nanocomposite further exhibited excellent stability and reusability over multiple cycles, demonstrating its potential as a cost-effective, sustainable, and industrially applicable technology for petroleum hydrocarbon remediation.

Patent status:

Title of the Patent: Enhanced Visible-Light-Driven Photodegradation of Total Petroleum Hydrocarbons Using Biogenic Trimetallic Nanocomposite

Patent Assignee: IASST, Guwahati

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