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PHOTOCATALYTIC DEGRADATION OF PHARMACEUTICAL COMPOUND IN AQUEOUS SOLUTION BY NICKEL BEAD CATALYST

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ABSTRACT

Batch tests were carried out to determine the photocatalytic degradation performance of these hybrid nickel bead catalysts under various circumstances. Preliminary studies demonstrate that hybrid nickel bead catalysts have significant photocatalytic activity, indicating its potential for successfully decomposing aspirin compounds in aqueous solutions. This discovery makes a substantial contribution to the development of effective photocatalytic systems for the breakdown of pharmaceutical chemicals in water. By addressing environmental concerns about pharmaceutical presence in aquatic ecosystems, photocatalytic degradation holds significant potential as a sustainable solution for aspirin compound removal, contributing to the preservation of environmental quality and human health.

KEYWORD

Ni-bead catalysts, photocatalytic reaction, aspirin, visible light irradiation, wastewater treatment

INTRODUCTION

Pharmaceuticals are designed to heal a variety of dangerous diseases, extend life spans, and improve life quality. The success of the pharmaceutical sector may result in environmental contaminants (Patel et al., 2019). One of the pharmacological chemicals investigated in this study is aspirin. Aspirin, commonly known as acetylsalicylic acid (ASA), is a medicine used to treat fever, relieve pain, and inflammation. Aspirin belongs to a family of medications known as nonsteroidal anti-inflammatory drugs. Aspirin may pollute water through a variety of pathways, including incorrect disposal, medical waste, agricultural runoff, and the sewage system. The presence of aspirin in water bodies can have negative impacts on aquatic ecosystems, pH adjustment, bioaccumulation, and may pose concerns to human health if the waters are utilized for drinking and irrigation (Ebele et al., 2017).

The photocatalytic technique is one of the most advanced methods for removing aspirin. Photocatalytic degradation is a process in which catalysts are utilized as photocatalysts to degrade organic contaminants into smaller, less hazardous molecules under light exposure. Photocatalytic degradation is regarded as a potential approach for wastewater treatment and environmental remediation because it offers several advantages, including high efficiency, cost-effectiveness, and environmental friendliness (Mishra & Sundaram, 2023). However, the effectiveness of the process is determined by a number of parameters, including the photocatalyst's characteristics, the intensity of the wavelength of light, and the concentration of aspirin.

MATERIAL AND METHODOLOGY

The photodegradation activity of the pharmaceutical component was quantified using a batch photoreactor system with a photocatalyst of nickel beads. A basic batch photoreactor system includes a light, a simple reactor with ventilation, a heating plate, and a magnetic stirrer (Figure 1). The light source is situated on top of the reactor, 15 cm above the sample solution. Within the reactor is a beaker containing the sample solution and photocatalyst for evaluation. A simple batch photoreactor is used to enhance the photon of light, which is necessary for the breakdown of aspirin compounds in aqueous solutions. During the irradiation procedure, aluminium foil is wrapped around the interior of the constructed box (photoreactor) to maximize the sample solution's exposure intensity under high reflectivity conditions. The function of thermometer is to maintain a specified temperature range. The synthetic aspirin solution was exposed to visible light to assess the activity of the nickel bead catalyst. The bead detergent mixing solution and aspirin solution are subjected to radiation at room temperature for two hours while in contact with fluorescent light. The distance between the light source and the reaction vessel is approximately 15 cm, allowing for reliable measurement of another sample. At a predetermined contact time, 1.5 mL of each sample is collected and analyzed using a UV-Vis spectrophotometer (Shimadzu UV-2600i) at a particular wavelength.

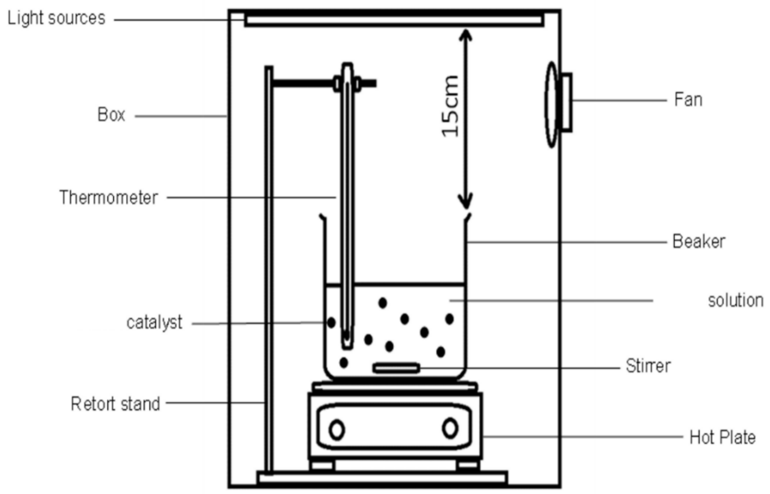

Figure 1: Photodegradation Reactor System

RESULT AND DISCUSSION

Mechanism of photocatalytic degradation aspirin begins with adsorption. Light activates the process, the photocatalyst absorbs photons from light, which results in the formation of electron-hole pairs inside its structure. Next, aspirin molecules are then adsorbed onto the photocatalyst surface during the adsorption stage. The photocatalyst surface generates excited electrons (e-) and positively charged (h^+) that participate in redox reactions with the adsorbed aspirin molecules (Koe et al, 2020). Electrons may transfer from the photocatalyst to aspirin, resulting in the production of radical species or intermediate products. During the redox reaction, reactive oxygen species (ROS) such as hydroxyl radicals (•OH) may be formed (Koe et al, 2020).

These extremely reactive species can further oxidize aspirin molecules, resulting in smaller fragments. The semiconductor material's photocatalytic activity facilitates the decomposition of aspirin molecules into simpler and less toxic chemicals like carbon dioxide, water, and other innocuous inorganic compounds. After the degradation reactions, the photocatalyst can be returned to its original state and employed for additional cycles of aspirin degradation with prolonged light exposure. A summary of the photocatalytic degradation mechanism, as shown in Figure 2. In this study, photocatalytic reactions perform better in the breakdown of aspirin compounds, with Ni-beads catalyst achieving a maximum degradation rate of 98.55% after 2 hours of irradiation.

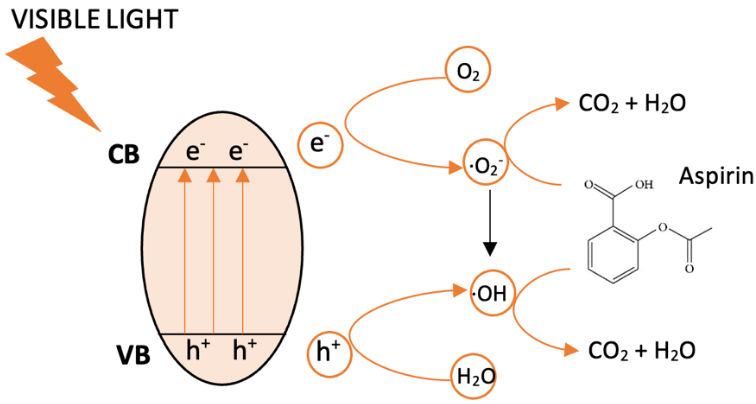

Figure 2 Mechanisms of Photocatalytic degradation of Aspirin.

CONCLUSION

As conclusion, photocatalytic degradation appears to be a potential approach for removing aspirin compounds from various environmental matrices. Aspirin molecules were efficiently converted into harmless byproducts using photocatalysts and a light source. However, more research is needed to enhance photocatalytic conditions for complete removal and to investigate the potential long-term environmental impacts. Nonetheless, photocatalytic degradation has tremendous potential as a long-term solution for removing aspirin compounds, helping to preserve environmental quality and human health.

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