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Treatment of Crude Oil Contaminated Water Using Metal Oxide Nanocomposites

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The contamination of rivers and oceans with crude oil pollutants and their waste poses a serious threat to human health and various animal species. With the continued expansion of global industrial activities, the demand for crude oil has increased significantly, leading to its widespread consumption. The presence of numerous offshore and onshore oil fields, along with the extensive transportation of crude oil and its derivatives, increases the likelihood of oil spills or seepages through groundwater, especially those located close to water sources. The effects of these major oil spills are not limited to the depletion of valuable energy resources but also cause severe environmental degradation in the aquatic environment, disrupting ecosystems and raising widespread concerns. In addition to these large-scale incidents, smaller oil spills occur frequently on land, in marine environments, and across inland freshwater systems. This study sought to determine the optimal laboratory conditions for the treatment of real petroleum wastewater in water resources utilizing photocatalysts for the degradation of petroleum-derived contaminants.

An experimental strategy was developed to synthesize a oxide photocatalyst composite using a combination of precipitation/Co- precipitation and sol-gel methods.

The resulting catalysts were subjected to a series of characterization techniques to evaluate their structural, morphological, and surface properties. The degradation efficiency , chemical oxygen demand (COD) , total organic carbon (TOC) and Gas chromatography-mass spectrometry (GC-MS) analysis of oil refinery wastewater (DOR) were systematically analyzed and validated following treatment. The highest treatment efficiency was achieved through the nanophotocatalytic composite process.

The photocatalytic degradation efficiency of crude oil effluent was strongly impacted by catalyst type, UV irradiation, sunlight exposure, and crude oil concentrations . The TiO_2-based composite catalyst improved degrading performance by effective charge separation and increased production of reactive oxygen species. UV radiation has higher photocatalytic activity than sunlight due to its greater excitation capacity for electron-hole pair production. The adjusted circumstances resulted in a high removal efficiency, showing that the proposed photocatalyst is suitable for treating crude oil pollutants .

Keywords: Photocatalysis , Nanocomposite , Crude oil pollutants , water resources , magnetic nanoparticles

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