

Investigation of Photocatalytic Pathways of Common Siloxanes in Water

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Abstract

Regulatory constraints on cyclic volatile methyl siloxanes (cVMS), particularly octamethylcyclotetrasiloxane (D4) and decamethylcyclopentasiloxane (D5), are driving a shift toward alternative compounds such as hexamethylcyclotrisiloxane (D3) and linear siloxanes. This transition is expected to increase their occurrence in wastewater streams used for biogas production. As a result, the combustion of siloxane-containing biogas leads to silica deposition, contributing to increased engine failure rates.

This study investigates differences in the behavior of selected siloxanes and their mixtures during photocatalytic processes in an aqueous environment, as an exploratory research for potential removal method of siloxanes from wastewater. While individual compounds exhibited limited hydrolysis, multicomponent systems significantly altered transformation pathways. The photocatalytic degradation of a representative mixture (D3–D5 and L3–L5) was examined in the aqueous phase using TiO₂ under UV irradiation, resulting in complete conversion of all siloxanes within 48 hours.

Due to its atypical behavior observed in preliminary analyses, the photocatalytic degradation of D3 was also studied individually to better understand its reactivity and transformation mechanisms.

Keywords

Siloxanes, Photocatalysis, Titanium dioxide, Biogas, Wastewater treatment.