

FRACTAL ANALYSIS OF ANAEROBIC DIGESTION DYNAMICS IN A TEQUILA VINASSE REACTOR

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Anaerobic digestion is widely used for waste treatment and renewable energy production, but its complex and nonlinear dynamics make real-time monitoring and control challenging. This study focuses on analyzing five key variables from time series data collected in a rising bed reactor treating tequila vinasse, an agricultural wastewater. Fractal analysis was applied by calculating the static Hurst exponent for each series, revealing that the anaerobic digestion process exhibits multifractal behavior with four distinct dynamic regimes across different time scales. To further explore the temporal dynamics, dynamic Hurst analysis was combined with Principal Component Analysis (PCA), allowing identification of key phenomena and interactions at multiple scales. Understanding these multiscale patterns is crucial for improving process stability and efficiency. These insights provide a valuable foundation for developing advanced monitoring tools and control strategies aimed at optimizing anaerobic digestion performance in industrial applications.

Keywords: Anaerobic Digestion, Fractal Analysis, Principal Component Analysis

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