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METHOD OF PARTIAL SUMS FOR ENHANCED BIOCHEMICAL OXYGEN DEMAND KINETIC PARAMETER ESTIMATION

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Abstract

Biochemical Oxygen Demand (BOD) underpins wastewater assessment and design, yet estimating the ultimate BOD (L_0) and the deoxygenation constant (k) often relies on iterative fitting or graphical methods. This study introduces and validates the Method of Partial Sums (MPS), a simple algebraic approach that derives closed-form estimates of L_0 and k from BOD exertion measured at uniform intervals under first-stage carbonaceous biochemical oxygen demand (CBOD) kinetics. We evaluate MPS against five established approaches—**Least squares**, **Thomas**, **Fujimoto**, **Daily Difference**, and **Nonlinear Regression (NLR)** — using two contrasting historical datasets from **1961 (Willamette River)** and **1927 (Ohio River)**. Accuracy and parsimony were assessed via Nash–Sutcliffe efficiency (NSE), root mean square error (RMSE), and Akaike information criterion (AIC), with additional correlation checks against NLR. Across both rivers, MPS achieved NSE > 0.99, produced the lowest RMSE, and yielded AIC values comparable to or lower than NLR, indicating high predictive accuracy with minimal complexity; correlations with NLR-based metrics were approximately 0.99–1.00. Because MPS leverages relations across multiple time points, it is relatively insensitive to single-point noise. We recommend MPS for rapid, routine estimation of BOD kinetic parameters in monitoring and design, with allylthiourea (ATU) used to isolate CBOD in high-nitrogen matrices and triplicate replication under standard quality assurance/quality control (QA/QC); future work should extend MPS to multi-stage kinetics and non-uniform sampling.

Key words: biochemical oxygen demand, method of partial sums, nash-sutcliffe efficiency, reaction rate constant, wastewater treatment

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