Appendix G

Aero-Mod
Treatment Process
Support Documentation

G-8: Process Field Evaluation

AeroMod SEQUOX BNR Process: Field Evaluation and Process Modeling

Background and Objectives

The SEQUOX ™ process, developed by AeroMod, Inc., has been implemented in over 250 wastewater treatment plants across the United States and around the world. Originally developed as a low-cost, operator-friendly solution for wastewater treatment, it has increasingly found application for nutrient removal where effluent limits are stringent and operators are "on a steep learning curve."

Periodic surveys of plant performance have shown that the SEQUOX process achieves very low concentrations of total inorganic nitrogen (TIN) and, more recently with additional process enhancements, total phosphorus. The objectives of this study were to (a) assess SEQUOX biological nutrient removal (BNR) performance and (b) relate observed performance to widely accepted biokinetics (using BioWin as the modeling tool) as a basis for further process enhancements.

Process Summary

SEQUOX is generally implemented as extended aeration activated sludge in a two-stage aeration basin design. It uses post-denitrification for nitrogen removal as well as an initial anoxic selector (or anaerobic fermentor and selector for biological phosphorus removal). Earlier applications involved continuous aeration of the first-stage aeration basin and intermittent aeration of the second stage. More recently, enhancements have included intermittent aeration of the first stage aeration basin and dissolved oxygen control, both to reduce power consumption and to improve nutrient removal.

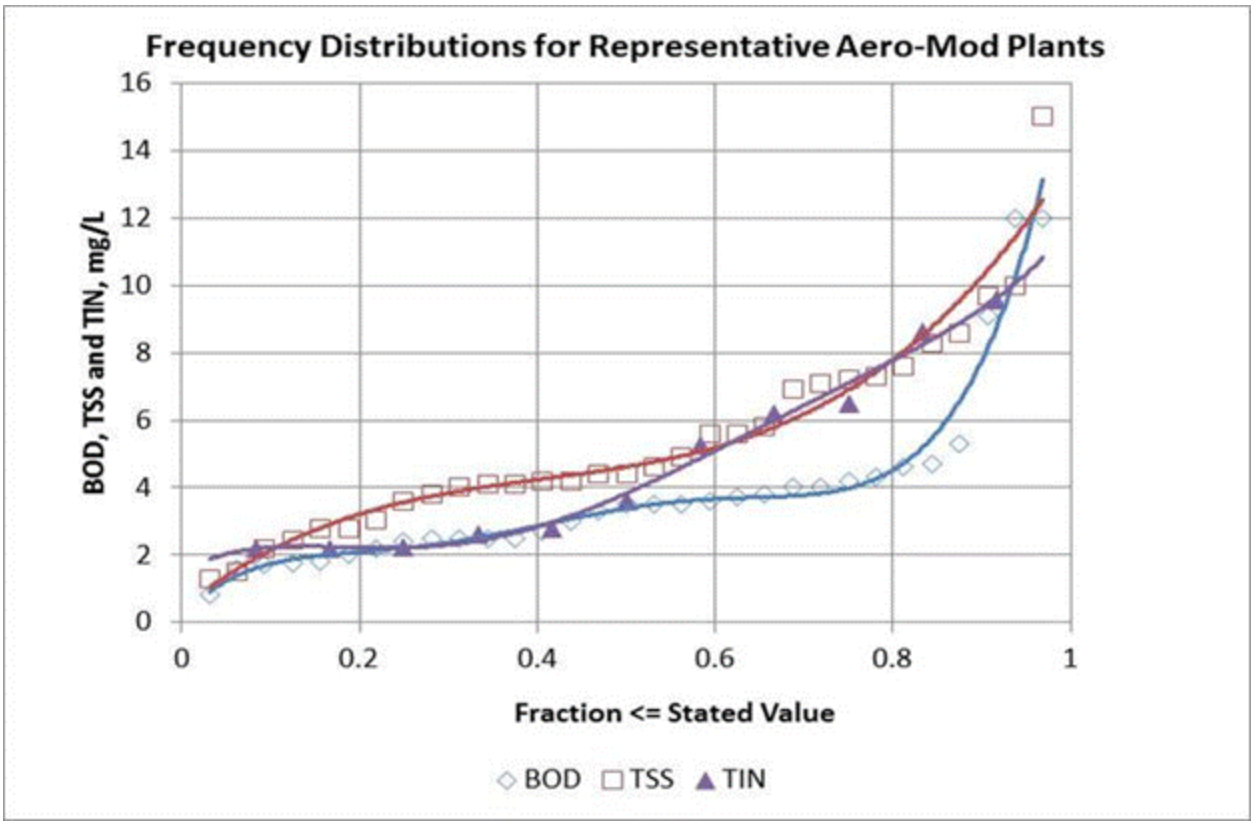
DATABASE SUMMARY

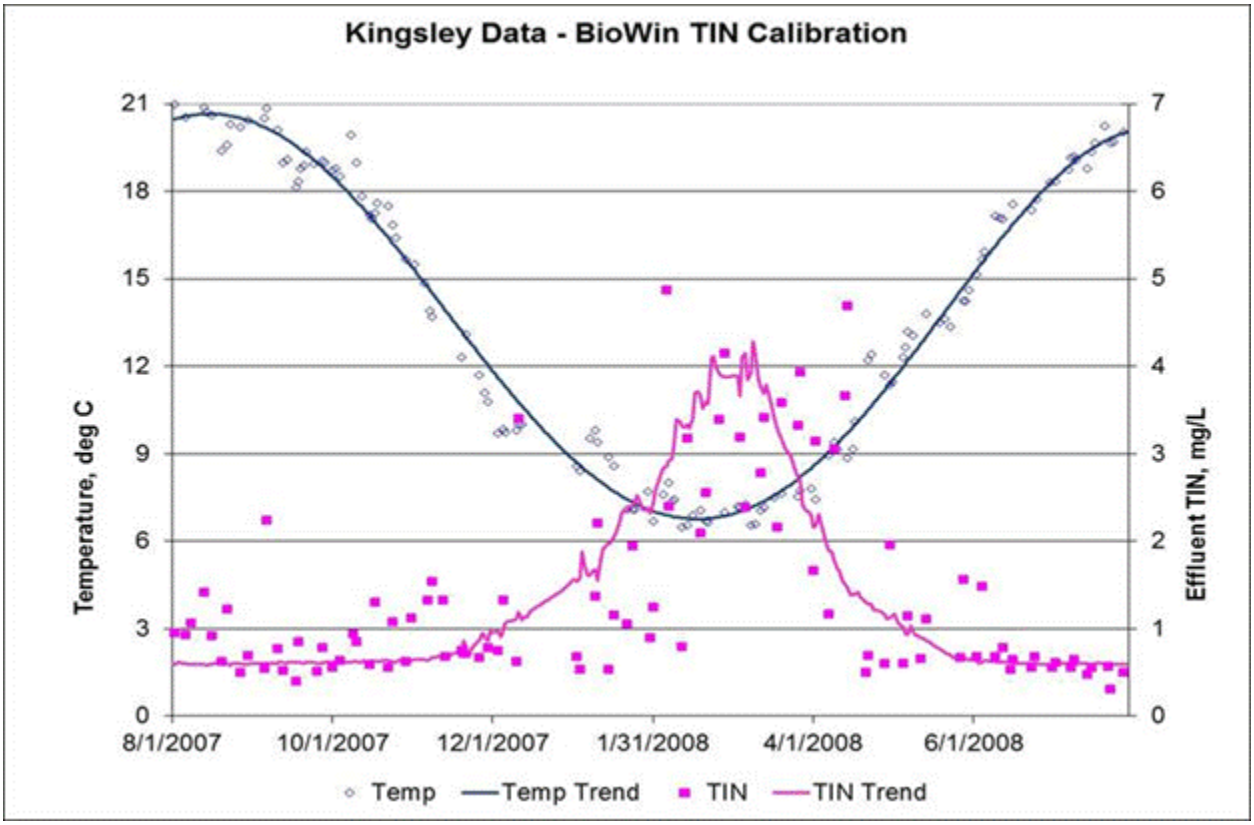
Performance data for the initial assessment were collected from thirty-two facilities. The period of record was a minimum of twelve months in all but eight cases. The plant flows ranged from 0.02 to 2.4 mgd and represent plants in twelve states, from northern climates (such as Michigan and Indiana) to southern climates (such as Texas and Florida).

Some of the initial data set for the study is presented in the figure below (averages of monthly data) as frequency distributions. TIN is of particular significance. These plants have achieved effluent TIN concentrations less than 9 mg/L ninety percent of the time and less than 4 mg/L fifty percent of the time – remarkable performance compared with other process options and considering the level of operator sophistication at many of these facilities. It is even more remarkable considering that few of these plants have effluent nitrogen limits.

REPRESENTATIVE CASE STUDY AND PROCESS MODEL DEVELOPMENT

To further examine process performance characteristics and to develop a basis for process modeling, specific facilities were examined in more detail. One representative twelve-month data set is presented in the figure below, which shows measured and predicted TIN concentrations for a plant in Michigan. The solid lines represent simulated temperatures and predicted TIN values, respectively, while and the data points represent results of discrete samples. As indicated, the plant consistently produced effluent TIN concentrations less than 5 mg/L, even in the coldest months (the high values during January through March are the result of decreased nitrification). The predicted values in this figure were developed using BioWin.


Frequency Distributions for Representative Aero-Mod Plants
BOD, TSS and TIN, mg/L
16
14
12
10
8
6
4
2
0
0
0.2
0.4
0.6
0.8
1
Fraction <= Stated Value
BOD
TSS
TIN


Kingsley Data - BioWin TIN Calibration
Temperature, deg C
21
18
15
12
9
6
3
0
Effluent TIN, mg/L
7
6
5
4
3
2
1
0
8/1/2007
10/1/2007
12/1/2007
1/31/2008
4/1/2008
6/1/2008
Temp
Temp Trend
TIN
TIN Trend

APPLICATION OF RESULTS

Performance data from full-scale plants have demonstrated the capabilities of this innovative process. As effluent nutrient limits continue to trend lower, approaching the lower bound on what can be achieved biologically (and in some cases even dropping below that lower bound), having cost-effective biological treatment systems that can meet these limits becomes increasingly important. This performance assessment, aided by process modeling, has demonstrated that the SEQUOX process is one such cost-effective system.