Fact Sheet: Bioprocess Intelligent Optimization System (BIOS)

Modified Ludzack-Ettinger (MLE) Activated Sludge Process BIOS Implementation

The BIOS is an integrated hardware and software solution that enables real-time monitoring and dynamic control of Biological Nutrient Removal (BNR) processes, such as the MLE process.

The BIOS process control algorithms optimize operation of the BNR process, making adjustments to account for the variable influent loading and biological activity in the bioreactor.

The BIOS consists of a controller and nutrient analyzers. The BIOS controller calculates optimal Dissolved Oxygen (DO) and Internal Recycle Flow (IRQ) set-points based upon real-time measurements from the nutrient analyzers, and transmits the set-points to the plant SCADA system for use in plant control.

Features and Benefits

Features

- Calculates optimal DO and IRQ set-points
- Feed-forward, real time control
- Monitors real time influent and operating data
- Works with existing plant infrastructure
- Real time process simulation using the Activated Sludge Model
- Communicates with plant SCADA system
- Allows remote monitoring and control
- Easy to install and operate
- Touch screen user-interface
- Self-calibrating

Benefits

- Reduces blower energy by up to 25% and total plant energy by up to 15%
- Provides an environment for optimal biological performance
- Optimizes nitrogen removal in the MLE process
- Stabilizes the process
- Manages plant start-up, maintenance, and recovery conditions
- Maximizes oxygen transfer efficiency
- Quick return on investment

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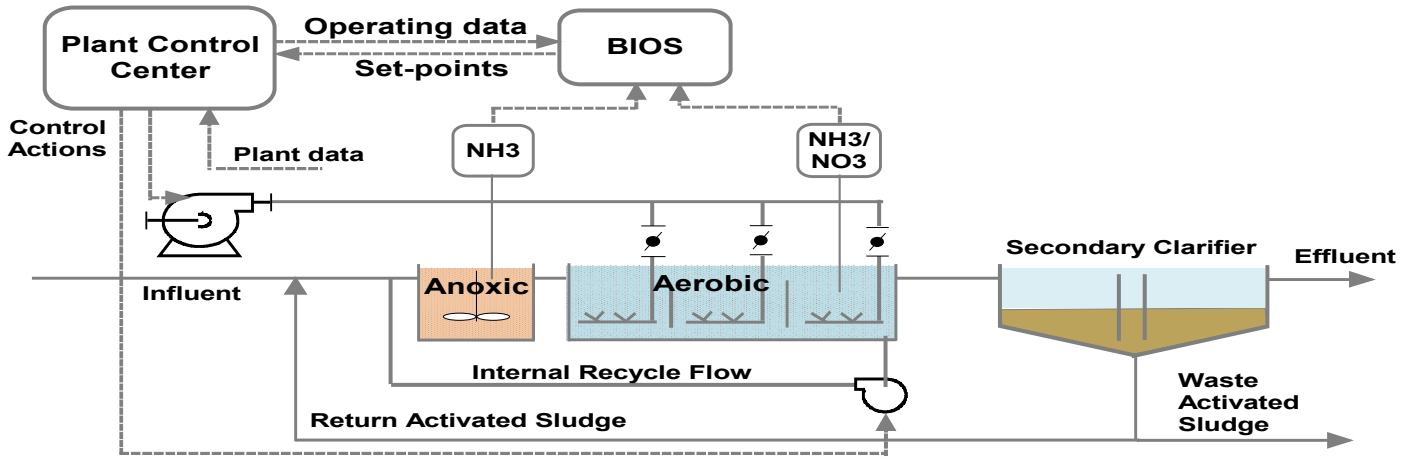
Modified Ludzack-Ettinger (MLE) Process Description



The Modified Ludzack-Ettinger (MLE) process has been developed for the combination removal of BOD, ammonia, and nitrate/nitrite. The process employs a combination of an anoxic and aerobic zone. Nitrification (ammonia removal) occurs in the aerobic zone. The mixed liquor, high in nitrate from nitrification, is recycled to the anoxic zone (by the internal recycle) for denitrification. Typical IRQ rates range from 200 – 400% of the process influent flow rate. The MLE process can achieve a 6 to 8 mg/l Total Nitrogen discharge, depending upon the wastewater influent characteristics.

BIOS Control Theory

DO Control Theory

The BIOS DO Set-Point Controller calculates the optimal DO set-point(s) to treat the BOD and ammonia loading. Optimizing the DO set-point(s) decreases the aeration requirements and increases the oxygen transfer efficiency, ultimately resulting in energy savings.

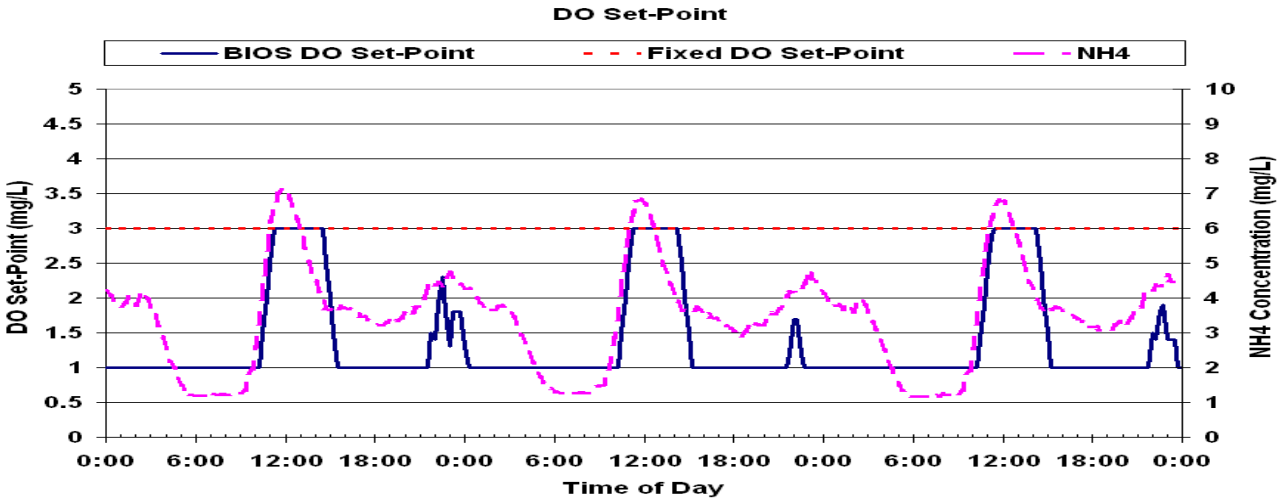
An ammonia analyzer located in the last anoxic zone provides the control system with the ammonia concentration entering the aerobic zones. Utilizing the measured ammonia concentration along with other measured parameters such as flow rates, DO, and MLSS, the BIOS DO Set-Point Controller conducts biological and hydraulic simulations to predict how the DO concentration will effect the final effluent quality. The optimum DO set-point(s) is the minimum DO concentration required to meet the effluent quality goals. An effluent ammonia analyzer is used to confirm the simulation results and automatically adjust model parameters if necessary.

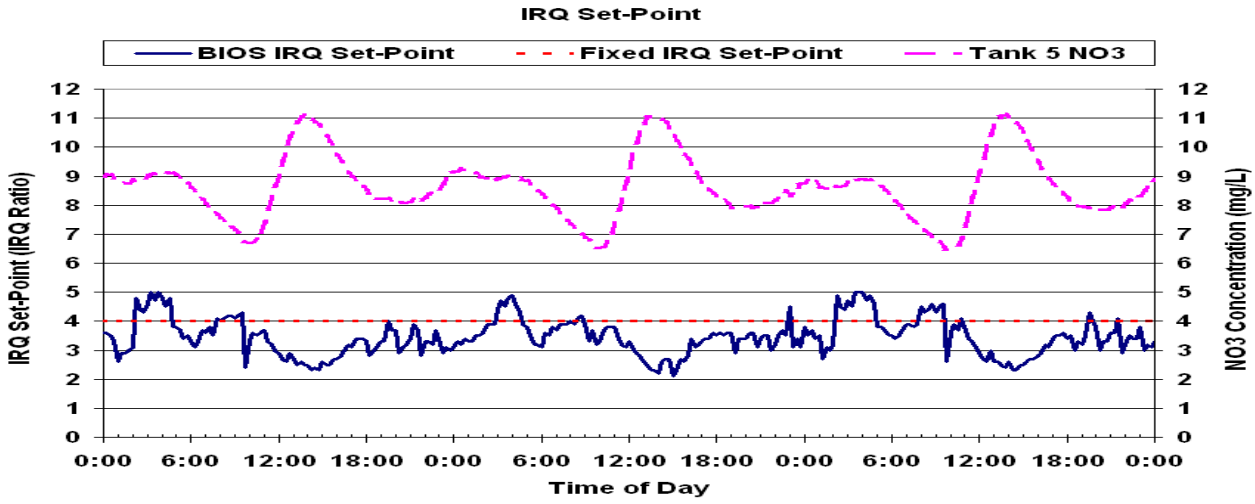
IRQ Control Theory

The BIOS IRQ Set-Point Controller calculates the IRQ set-point required to maximize denitrification performance. Optimizing the IRQ set-point results in several benefits including: minimizing effluent total nitrogen, maximizing oxygen credits generated in the anoxic zone(s) to reduce aeration requirements, and minimizing IRQ pumping energy.

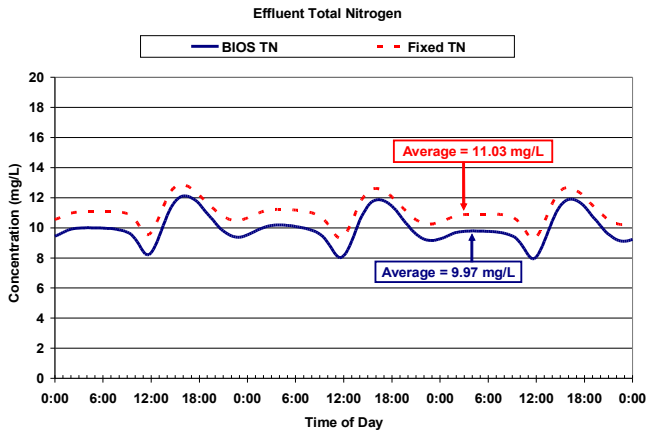
A nitrate analyzer located by the IRQ pump inlet provides the control system with the nitrate concentration in the IR stream. The controller conducts iterated biological and hydraulic simulations that predict the effluent ammonia and nitrate concentrations under different IRQ rates. The optimum IRQ set-point is the value that results in the lowest effluent ammonia and nitrate concentration.

BIOS Versus Fixed Set-Points

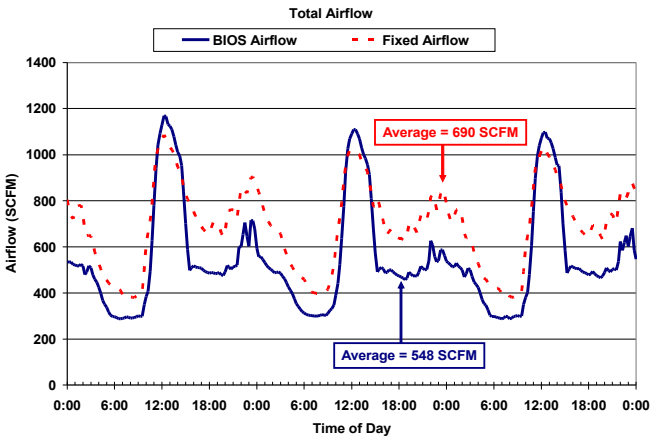




BIOS Results



9.6% TN Reduction with BIOS



20% Airflow Reduction with BIOS

BIOS Specifications

Control Panel	
Calculation Frequency	15 Minutes
Programmable Logic Controller (PLC)	CompactLogix L35E or Equal
Industrial Computer	PanelView 1000 (Allen Bradley) or Equal
Dimensions (HxWxD)	33 x 24 x 11 inches
Weight	115 lbs.
Enclosure Ratings	NEMA 4X, IP 66
Temperature Rating	-21° to 131°F (-30° to 55°C)
AC Power Supply	115 VAC 60 Hz
Average Current Consumption	5A
Maximum Current Consumption	8A
User Interface	Analog resistive touch screen
Protocol	EtherNet/IP messages encapsulated within standard TCP/UDP/IP protocol, or MODBUS TCP/IP
Common Application Layer	ControlNet and DeviceNet
Cable	Category 5 twisted pair cable
Speed	Half/Full Duplex 10 Mbit or 100 Mbit operation

Nutrient Analyzer	
Measurement Parameters	Ammonia and Nitrate
Measurement Type	Ion-Selective, In-situ
Measurement Range	0.1 – 99.9 ppm
Resolution	0.1 ppm
Reproducibility	Within 5%
Calibration Method	Automatic
Calibration Frequency	Variable (operator settable)
Accuracy	+/- 5 % of measurement or +/- 0.5 ppm (whichever is larger)
Temperature Rating (Controller system)	-21° to 140° F (-30° to 60°C)
Sample Temperature	34° to 122^{O} F (1° to 50°C)
AC Power Supply	115 VAC 60 Hz
Average Current Consumption	1A
Maximum Current Consumption	5A
Internal Data Storage	150,000 time-stamped measurements
Output Signals	4-20 mA, MODBUS, RS-485, RS-232, RS-422
Relays / Alarms	(4) relays as follows: High and Low levels detected for Ammonium and Nitrate Concentration. (1) alarm condition for Low Calibration Solution / Reagent Warning and for Empty Calibration Solution / Reagent – Automatic analyzer shutdown.
Display Screen	Daylight readable QVGA LCD

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