

Optimizing Chemical Dosing Reduces Chemical Use while Meeting Effluent TP Limits

Results from Black River Falls, Wisconsin, USA

Chemical, biological treatment, or a combination of both, is the common method for removing phosphorus in a wastewater treatment plant (WWTP). When using chemical treatment, metal salts are added which react with soluble reactive phosphate (i.e., Orthophosphate) to form solid precipitates that are removed by physical processes such as clarification and filtration. The required chemical dosing rate depends on factors such as the targeted effluent phosphorous concentration, the influent phosphorus load and the amount of phosphorus that is being removed biologically.

The city of Black River Falls in Wisconsin used chemical treatment with ferric chloride (FeCl_3) to achieve their effluent total phosphorus (TP) permit of 1.0 mg/l. Historically, the chemical dosing rate was manually adjusted on a daily basis based on the measured effluent TP concentration. Besides the required manual labor, this method did not account for changes in influent loading, biological update or change in dosing requirement during weekends and holidays.

The plant was upgraded with an OSCAR process performance optimizer control system with phosphorus controller, which uses continuous measurement of orthophosphate using a YSI IQ SensorNet P700 analyzer to automatically adjust the chemical dosing rate to maintain a desired effluent TP concentration without overdosing.



TEST PLANT: Black River Falls, Wisconsin
DESIGN FLOW: 0.86 MGD
TEST DATES: Feb 2014 - Jan 2016

PROCESS CONTROL SYSTEM

Before Upgrade	Manual control of FeCl_3 dosing rate based on the daily effluent TP concentration.
After Upgrade	OSCAR system with phosphorus controller, automatically adjusting FeCl_3 dosing rate based on the real time measured effluent orthophosphate concentration.



YSI IQSN P700 Ortho-phosphate analyzer

Plant data

The phosphorus removal at Black River Falls WWTP was monitored with weekly measured influent TP concentration and effluent TP concentrations measured five days per week using laboratory wet-chemistry analysis. The chemical dosing rate was logged daily. Baseline data was gathered for one year prior to updating the plant. After upgrading with the OSCAR system, the phosphorus removal and chemical consumption was measured for an additional year.

Phosphorus control system

Using the OSCAR system with phosphorus controller, the chemical dosing rate was continuously adjusted based on the real-time effluent orthophosphate concentration. The target effluent TP concentration was set to 1.0 mg/l.

Results

When the plant was upgraded to automatically adjust chemical dosing using a phosphorus analyzer, FeCl_3 dosing rate decreased over 45% despite the influent TP load increasing by 20% during the first year of operation. The plant dosed an average of 22.9 gallons FeCl_3 /day before the control system and analyzer installation. Additionally, this plant dosed an average of 11.5 gallons/day caustic to recover pH. After the upgrade, chemical consumption was reduced to an average of 12.5 gallons/day FeCl_3 while still meeting the effluent phosphorus permit of 1 mg/l of TP. In addition, the optimized dosing eliminated the need to add caustic. The reduction in ferric and caustic dosing resulted in a payback period for installing the analyzer and control system of less than 20 months.

Conclusions

This study showed that the use of an online orthophosphate analyzer combined with automated controls can reduce chemical consumption and costs while maintaining effluent quality. In addition, upgrading with automatic control provides greater visibility of the process and improved operational stability. The reduced cost of chemical at Black River Falls WWTP gave a payback for the investment of less than 20 months.

FeCl₃ and caustic uses and costs

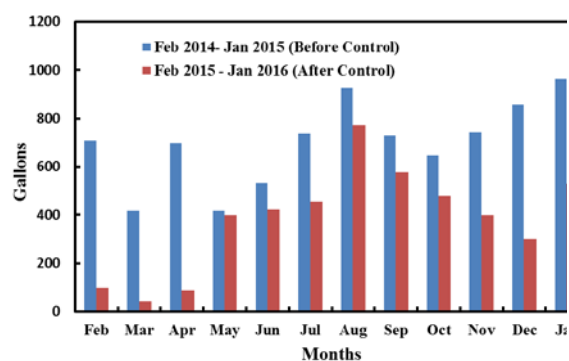
Before upgrade	
FeCl ₃ used	22.9 gal/day
Caustic used	11.45 gal/day
Annual costs	\$ 49,858
After upgrade	
Feb 2015-Jan 2016 FeCl ₃ used	12.5 gal/day
Feb 2015-Jan 2016 caustic used	0.0 gal/day
Annual costs	\$ 15,193

(Based on FeCl_3 : \$3.33/gal; Caustic: \$5.27/gal)

Average effluent TP concentration

Before analyzer installation	0.50 mg/l
After analyzer installation	0.68 mg/l

Total FeCl₃ used per month before and after upgrade



'We realized significant FeCl₃ and caustic cost savings during the first 12 months of the orthophosphate analyzer and controls installation. We also completely eliminated caustic usages due to controlled FeCl₃ dosing. Currently, chemical dosing rate is controlled 24/7 based on the real-time effluent orthophosphate data and we do not need to worry about chemical feed pump operation.'

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