Accurate On-Line DO and TSS Monitoring Helps Optimize Petrochem Effluent Treatment

Introduction

Biological treatment of complex petrochemical wastewater requires optimum on-line instrumentation to help maintain optimum bioreactor and filter performance. Accurate on-line dissolved oxygen and total suspended solids (TSS) measurements are essential to effluent treatment plants. One Hach customer utilizes on-line DO and solids probes provide operators with critical, real-time information to help them make informed treatment process decisions.

An Expanding Pertrochem Complex

A Hach customer added significant production expansions and upgrades since its initial VCM/PVC units went online over 30 years ago. The site consists of 15 production units and a variety of support facilities. Besides VCM/PVC, production now also includes olefins, LLDPE, HDPE, polypropylene, chlor-alkali, ethylene dichloride, plus a new circulating fluidized bed (CFB) energy unit that provides highly energy-efficient steam and electricity to the site.

Environmental protection is an important factor in process design at this petrochemical complex, and the site operates an extensive water-reuse program. Its effluent treatment plant, typically treats more than three million gallons per day (mgd).

Treatment System Overview

Production effluent entering the treatment plant is made up of numerous streams with high variability of hydraulic and organic loadings. Pretreatment is essential for removal of heavy metals (primarily zinc and copper) and other compounds which may be toxic to or inhibit the treatment plant's biological processes.

The treatment plant includes three parallel biological treatment trains (A,B,C) to treat selected streams and to minimize any downtime resulting from potential bacterial inactivation caused by shock loads of specific components in a stream. Loadings are understandably high and effective effluent treatment requires making deep reductions in biochemical oxygen demand (BOD). The three bioreactors provide an activated sludge process served by aeration prior to clarification. Pretreated effluent enters at the head of each bioreactor and flows through its three aeration chambers in plug flow fashion.

DO Readings Critical

Dissolved oxygen (DO) is the critical measurement for process control in the bioreactors. Sufficient oxygen must be maintained at all times to ensure complete waste stabilization. Insufficient oxygen will slow down or kill off the very aerobic organisms the chambers are designed to cultivate. If DO levels are too high, however, it can result in excessive power consumption as well as create conditions ripe for developing undesirable organisms.

The plant originally relied on fixed membrane-type probes to measure the DO of the streams entering and exiting the bioreactors. According to the utilities instrument maintenance supervisor, the membrane-type probes proved unreliable, and their maintenance demands were high:

“They had a tendency to foul out, and the membranes were delicate and would often tear during replacement. We also had to be very careful when cleaning them because if we accidentally scratched the membrane, it would have to be replaced,” he says. “They also didn’t seem to hold calibration very well.”

Selecting New DO Instrumentation

These issues led the treatment unit to find an alternative to the membrane-type DO probes. It was determined that not only must the new DO instrumentation provide accurate, repeatable measurement, it must also be easy to calibrate and be sufficiently durable to hold up to the high strength wastewater streams and intense agitation.

In order to achieve consistently tight DO monitoring in its aeration process, the plant replaced the membrane-type DO probes with a completely new type of probe—Hach LDO® Luminescent Technology. The new probes were installed soon after Hach LDO was first made commercially available in 2003.

Membrane-type DO probes rely on the consumption of oxygen at one electrode and the resulting current flowing through electrolyte to a second electrode. LDO probes, unlike galvanic and polarographic DO sensors, do not consume oxygen as part of the measurement process. Also there are no membranes or electrolyte solutions to replace. The measurement process is continuous and rapid. Also, it’s unaffected by the presence of wastewater chemicals or heavy metals—a key factor in the selection of LDO probes for plant’s effluent treatment operations.

Six on-line LDO probes provide operators with critical, real-time information that, combined with scheduled grab sample analysis, helps make informed blower adjustments to maintain optimum aeration inside the bioreactors. The three bioreactors are equipped with two LDO probes each–one at each inlet and one at each outlet. The probes are mounted on the ends of PVC stanchions affixed to the railings of the 30-feet-tall tanks and positioned approximately 30 inches below the water surface.

"The DO levels at each inlet to the biological treatment system are typically low: around 0.3 to 0.7 mg/l coming in, and around a 7.0 mg/l going out," says theinstrument technician for the complex's effluent treatment facility. "The DO level of our C train effluent is often slightly higher, around 9.0 mg/l." Following clarification, “C” train effluent goes to the site's demineralization unit for further processing before being reused as cooling water.

A Robust Online Instrument

The performance of the wastewater treatment unit probes has shown the LDO probe to be a robust instrument for long-term reliability and accuracy. "They hold up real well," the instrument technician says. "I've only had to replace two probes since they were installed." He says installing the two new probes was easy. "We already had 110 power there as well as 4-20mA connections that had been used for our previous two probes. It was just matter of connecting four wires and putting the probes on the end of the PVC pipe."

Besides long service life, no time-consuming calibrations are required and frequent cleanings are also not required for the LDO probes to produce accurate DO readings; the system will produce accurate DO readings even with organic build-up on the sensor.

Following biological treatment, the mixed liquor flows to clarifiers for separation of the biomass. A portion of the final effluent is discharged to the bay while the other portion (taken from the "C" treatment stream) is sent to the complex's demineralization unit for further processing for use as cooling water.

The instrument technician says he runs PMs on the LDO probes serving the three bioreactors every 90 days. "I clean them, check them, and make sure all the connectors look good. I also wipe off the cap," he says. "And sometimes I'll pull the cap off just to make sure there's no water in between the cap and the instrument."

Continuous DO Readings

The six on-line Hach LDO probes installed in the plant's three biological treatment trains (plus a seventh stationary LDO probe installed at the sump right before the final treated effluent is discharged into the bay) are continuously read by either sc100 or sc200 Hach Universal Controllers that communicate to the plant's Distributed Control System (DCS) for precise, real-time DO monitoring.

The sc100 and sc200 controllers linked to the LDO probes each have a built-in datalogger that collect measurements at user selectable intervals (one to 15 minutes), along with calibration and verification points, alarm history, and instrument setup changes for up to six months. Each controller is designed to receive data from up to two sensors simultaneously, providing flexibility by allowing for broader parameter measurements (LDO, conductivity, pH/ORP, or turbidity) if needed. The plant uses this function to operate two LDO probes per controller for monitoring the wastewater plant’s three bioreactors.

Operators at the facility manually regulate the amount of air going into the bioreactor chambers based on DO readings from the stationary LDO probes as well as from results of scheduled grab samples. Using the controllers' 4-20mA signal, an alert notifies operators if DO in the streams exiting the bioreactors falls below preset levels. At similar installations at other chemical processing plants, many use the Hach controllers and stationary LDO probes for automated aeration control.

On-line Solids Monitoring

When significant production expansions and upgrades were added at the facility in 2002, the site also initiated an extensive water-reuse program. During this time, the company installed a Hach SOLITAX® sc sensor for real-time monitoring of total suspended solids (TSS) levels of final effluent from the wastewater plant's C train, and prior to it entering the complex’s demineralization unit. This allows operators to see the real-time solids level on the DCS screen inside the control room, 24 hours a day. The SOLITAX sc analyzer's dual infrared light technique eliminates color interference, minimizes calibration, and improves accuracy. At industrial wastewater treatment plants the probe can measure turbidity up to 4000 NTU and suspended solids up to 150 g/L in plant influent, filtrate/centrate, mixed liquor, final effluent, and primary, digested, and thickened sludge.

SOLITAX sc sensors are serviceable so that their useful life, in many cases, is double that of conventional turbidity and suspended solids sensors, which are potted and discarded when they no longer function. After more than a dozen years of continuous operation, the stationary SOLITAX solids probe is performing as well as the day it was installed and has required very little maintenance. "The only thing I've had to do besides my PMs is change out the probe's wiper once," says the instrument technician.

At the plant, the SOLITAX probe continuously reads "C" train effluent solids levels after flows leaving the final clarifier and before entering a sand filtration unit at the complex's demineralization unit site. By monitoring real-time solids levels, operators can adjust polymer dosing to the clarifier to maximize run-time between sand filter backwash operations.

The instrument technician affirms the unit's easy one-point calibration of the SOLITAX unit and says that robustness of the sensor has been proven during its 12-plus year deployment. Real-time monitoring of solids in the "C" train effluent stream helped operators to optimize filter operations. Unlike conventional systems, SOLITAX sc sensors are immune to shifts in color caused by variations in through-flow volume, climatic fluctuations, or other unexpected events.

Conclusion

On-line water quality instrumentation at petrochemical effluent treatment plants is being used to provide operators with critical, real-time information to make informed process decisions to achieve improved effluent quality and optimize plant performance.

As on-line technologies and analytical systems have become more advanced, accurate and reliable, plant operators have become increasingly confident in their uses. Advanced on-line instrumentation and analytical systems help these facilities meet the essential demand for efficiently producing effluent that meets today's increasing requirements.

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