Undoing Upsets

Use of biostimulants & buffers for upset recovery at paper mill wastewater system

By Shawn Whitmer

Industrial pulp and paper wastewater is considered one of the more challenging waters to treat biologically. The most commonly adopted pulp and paper mill biological treatment methods are activated sludge process, aerated and anaerobic lagoons and digesters, and their modifications. Biological/biochemical processes depend on microbial activity to effectively remediate wastewater.

Wastewater treatment systems often are influenced or impacted by increased hydraulic and/or chemical oxygen demand (COD) loading as mills add new chemicals or otherwise modify mill operations. These events oftentimes inhibit the wastewater microbial activity, causing "upsets" and, potentially, discharge-limit violations. However, providing the necessary biostimulants and buffers to the microbial system—as described in this case study—can significantly improve system-upset recovery time and overall operational stability.

Technology Selection

Two specific Probiotic Solutions liquid bioremediation products were used to address process upsets at a paper mill in China. The products involved were Bio Energizer (BE)—a scientific formulation of organic acids, buffers, natural biological stimulants, micronutrients and energy systems—and Micatrol (MT), a specialized product that uses organic acid as a substrate to buffer wastewater microbial life. Both BE and MT are complexed with the proprietary Micro Carbon Technology (MCT), a process that converts a soft, humic material into extremely small oxygen-rich carbon molecules. The MCT process results in a carbon source that is an ultra-efficient carrier—due to the micro-carbon molecule's low molecular weight, greater specific surface area and higher cation exchange capacity—to deliver readily bioavailable nutrients to microorganisms.

In this trial, BE and MT were applied to the biological treatment system of a large-scale paper mill to manage the hydraulic loading from new upstream processes that led to a system upset.

The capacity of the biological treatment system was 30,000 cu meters per day. BE and MT were added into the return-activated sludge of the wastewater treatment system at a dosage of 1 ppm for a duration of 30 days via a chemical dosing pump.

The system consists of a primary sedimentation tank and aeration basins, followed by secondary clarification. Samples were collected at the outlets of the primary sedimentation tank and the secondary clarifier. The sampling parameters and standard methods used are described in Table 1.

Removal of COD

The duration of BE and MT application was 30 days. These results were compared with 30 days of pre-application and 29 days of post-application. Results for the 89 days are summarized in Figure 1.

Figure 1 shows that the effluent COD of the primary sedimentation tank fluctuates dramatically due to changing loading from new upstream processes. The average COD during the 89 days was 950 mg/L, with the highest value being 1,575 mg/L.

Figure 1 and Table 2 show that before BT and MT were applied, the system's treatment performance was poor. The average COD removal rate prior to dosing was only 58.1% and the average

Table 1. Sample Parameters & Standard Methodology

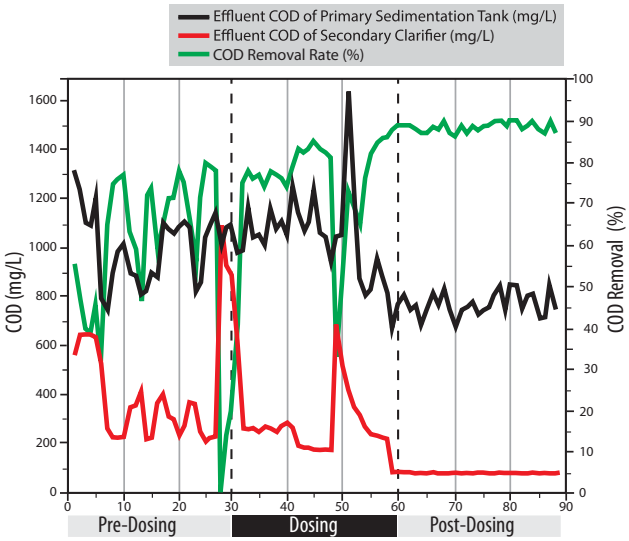
Parameters	Standards
COD	Potassium Dichromate
MLSS	Dry Weight
DO	Dissolved-Oxygen Meter
Settling	SV_{30}
NH_3-N	Spectrophotometry
TP	Spectrophotometry
Microbial Morphology	Microscopic Analysis

Table 2. System COD Concentration Before, During & After Dosing

System Location	Pre-Dosing 30 Days	Dosing 30 Days	Post-Dosing 29 Days
Average effluent COD of primary sedimentation tank (mg/L)	1,014.7	1,045.1	780.5
Average effluent COD of secondary clarifier (mg/L)	425.2	253.8	83.5
Average COD removal rate (%)	58.1	75.7	89.3

effluent COD of the secondary clarifier was 425.2 mg/L, which exceeded the 100 mg/L discharge standard. When BE and MT were used, the treatment improved, the average effluent COD of the secondary clarifier was reduced to 253.8 mg/L, and the average COD removal rate increased to 75.7%—an improvement of 17.6 percentage points. After dosing, the average effluent COD of the secondary clarifier was reduced to 83.5 mg/L (an 89.3% removal rate) with minimal fluctuation, indicating that the system had recovered and met discharge requirements.

Figure 1. Effluent COD Concentration



During the dosing period, the system received a high load of COD—1,575 mg/L (Figure 1). At that time, the activated sludge turned black, mixed-liquor suspended solids (MLSS) and dissolved oxygen (DO) decreased, and settled volume at 30 minutes (SV_{30}) was up to 95%. Spontaneous recovery time for this system typically ranges from seven to nine days. But after just five days of dosing, the color of activated sludge turned back to a normal yellow (Figure 2), DO recovered to more than 2.0 mg/L, and SV_{30} decreased to less than 80%.

Figure 2. Activated Sludge Wastewater, Before & After Dosing High-COD Load

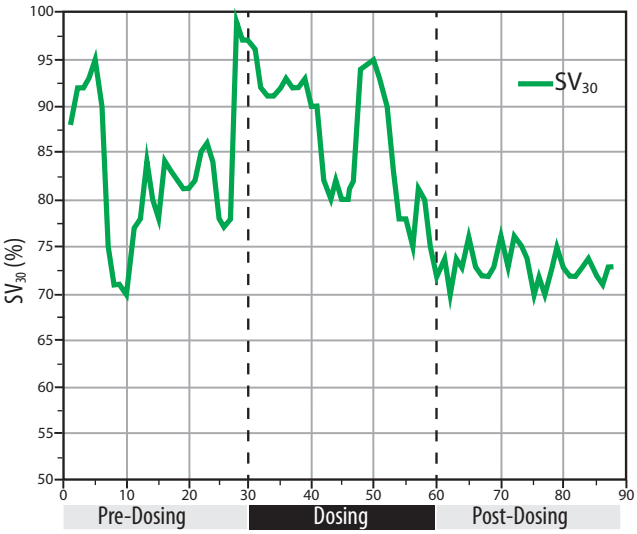
Comparisons

During the use of BE and MT, MLSS tended to be more stable and higher than the average of the previous 30 days, indicating a healthier biomass. It is noted that during this period, MLSS sharply decreased once owing to a one-day high-COD-loading event. BE and MT enhanced the activity and growth rate of the biomass when the system was impacted.

The activated sludge treatment system process can be susceptible to sludge bulking caused by filamentous microorganisms, which leads to poor settling. SV_{30} is a standard method of analyzing sludge settleability: the lower the SV_{30} percentage, the better the settleability.

When wastewater system operations are unstable or impacted, SV_{30} fluctuates. Previously, this system operated unstably and SV_{30} could be as high as 99%—concurrent with sludge bulking. Figure 3 shows that the SV_{30} of the activated sludge system prior to dosing was very high. During the dosing period, SV_{30} decreased gradually, and at the end of application, the SV_{30} stabilized at under 75%.

Figure 3. Settling Analysis Using SV_{30}



Microbial Review

The microscopy results before dosing showed that the zoogloea was loose, with smaller pin floc, a large amount of filamentous bacteria and very few flagellate-protozoans in the aeration basin. This indicates that excessive loading was occurring and new bacteria could not grow or be supplied in time. After one week of dosing with BE and MT, very small quantities of *Vorticellidae* (*Vorticella*-stalked ciliates, various species) were found in the system, indicating that the system was beginning to recover. One month post application, floc formation improved, with larger quantities of *Vorticellidae* along with smaller quantities of rotifers and various other types of protozoans and metazoans. This is an indication that the system had totally recovered, leading to improved treatment efficiency and operational stability.

Providing necessary biostimulants and buffers to the microbial system can significantly improve system upset recoverability and overall operational stability. The combined dosing program of BE and MT can significantly improve systems' ability to recover after an upset condition, such as when systems experience instantaneous high COD or hydraulic loading, or experience high-toxicity events. The microbiology recovers quicker than is typical—leading to improved COD removal and settling, which improves water clarity and quality. Dosing BE and MT can improve, buffer, diversify and strengthen the microbiology in the system—allowing the biochemical system to accommodate the events and maintain treatment efficiency. **iWWD**

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