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Use of Biostimulants and Buffers for Upset Recovery in Paper Mill Wastewater Systems

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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.[1] Biological/biochemical processes depend on microbial activity to effectively remediate wastewater.[2,3]

Wastewater treatment systems are often influenced/impacted by increased hydraulic and/or COD (chemical oxygen demand) 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 we describe in this case study—can significantly improve system-upset recovery time and overall operational stability.

Introduction

Two specific Probiotic Solutions® liquid bioremediation products were used to address process upsets at a paper mill in China. The products involved are 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 our 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.

Method

The capacity of the biological treatment system was 30,000 m^3/d. BE and MT were added into the return activated sludge (RAS) 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.

Table 1. Sample Parameters and Standard Methodology

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

Results and Discussion

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 Fig. 1.

From Fig. 1, we know that the effluent COD of the primary sedimentation tank fluctuates dramatically due to changing loading from new upstream pro-

cesses. The average COD during the 89 days was 950 mg/L, with the highest value being 1,575 mg/L.

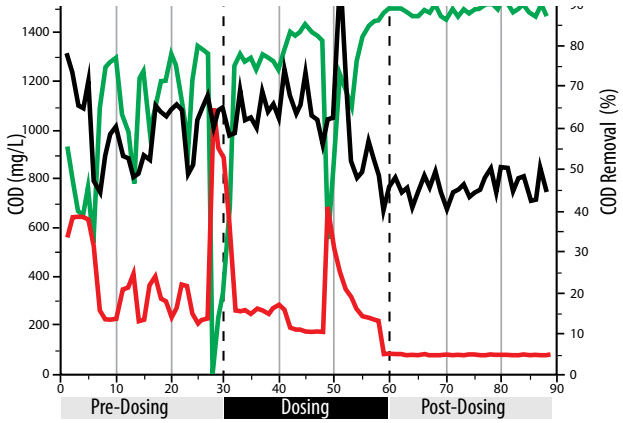

Figure 1. Effluent COD Concentration

Fig. 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 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.

Table 2. System COD Concentration Before, During, and 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

During the dosing period, the system received a high load of COD, 1,575 mg/L (Fig. 1). At that time, the activated sludge turned black, MLSS and DO decreased, and SV30 was up to 95%. Spontaneous recovery time for this system typically ranges from 7 to 9 days. But after just 5 days of dosing, the color of activated sludge turned back to a normal yellow (Fig. 2), DO recovered to more than 2.0 mg/L, and SV30 decreased to under 80%.

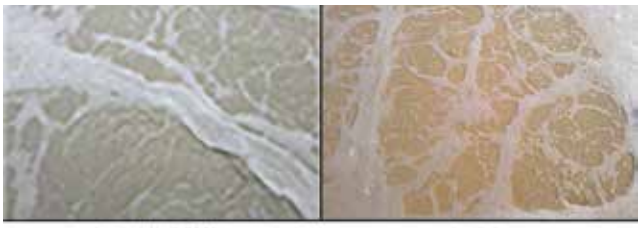

Figure 2. Activated Sludge Wastewater, Before and After Dosing High-COD Load

MLSS Comparison

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.

SV_{30} Comparison

The activated-sludge treatment system process can be susceptible to sludge bulking caused by filamentous microorganisms that 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. Fig. 3 shows that the SV_{30} of the activated sludge system prior to dosing was very high. During the dosing period SV_{30} decreased gradu-

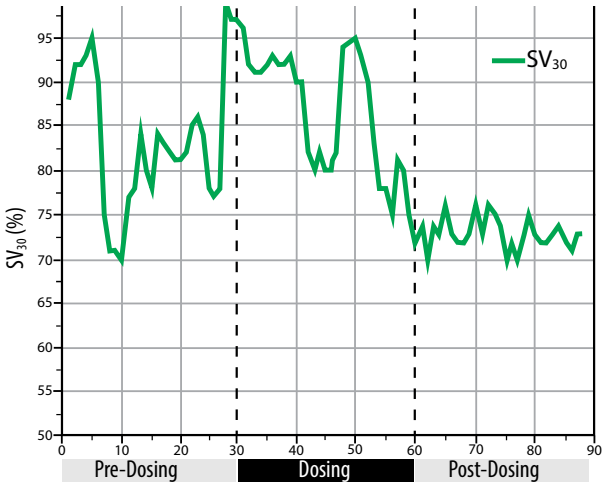

Figure 3. Settling Analysis Using SV30

ally, and at the end of application the SV_{30} stabilized at under 75%.

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 little flagellate-protozoans in the aeration basin. This indicates that excessive loading was occurring and new bacteria couldn't 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.

Conclusion

Providing necessary biostimulants and buffers to the microbial system can significantly improve system upset recovery ability and overall operational stability. The combined dosing program of Bio Energizer® and Micatrol® significantly improves 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 Bio Energizer® and Micatrol® improves, buffers, diversifies, and strengthens the microbiology in the system—allowing the biochemical system to accommodate the "events" and maintain treatment efficiency

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