Cold Weather Bioaugmentation Product Case Study

ENVIRONMENTAL BUSINESS SPECIALISTS, LLC

Introduction

Environmental Business Specialists, LLC (EBS) was looking to expand its bioaugmentation product line by adding a product targeted to work in cold temperatures. EBS tested a new bioaugmentation product, CryoStart™ containing strains of cold weather tolerant bacteria against BioStar™, a traditional bioaugmentation product using continuous flow bench-scale bioreactors simulating a paper mill aerated stabilization basin. Bioreactors were placed in a water bath chilled to 10.5°C for the duration of the study. Paper mill influent was fed to both bioreactors, while one was bioaugmented daily with the CryoStart, and the other was bioaugmented with BioStar.

Executive Summary

- Two aerated lagoon bioreactors were run at 10.5°C to simulate winter conditions for a wastewater treatment plant. One bioreactor received the BioStar product while the other received CyroStart (containing the cold weather tolerant strains of bacteria).

- The bioreactor that was bioaugmented with CryoStart was able to degrade more biological oxygen demand (BOD) than the BioStar when the paper mill influent was spiked with a glycerin-based BOD source. This indicates that CryoStart would better protect an aerated lagoon system if an increased loading event were to occur during cold temperatures.

- The CryoStart bioreactor total and volatile suspended solids (TSS/VSS) were noticeably higher than the BioStar bioreactor TSS/VSS concentrations. Increased biological activity of the CryoStart product is likely what allowed for more BOD degradation to occur in its bioreactor.

- Proactive bioaugmentation of an aerated lagoon system with CryoStart could help reduce BOD breakthrough when there are rapid decreases in temperature, sustained cold temperatures, and increased loading events during cold temperatures.

Methods

Two continuous flow bench-scale bioreactors were operated at 10.5°C for just over 30 days. As a retention time of 5 days, this represents six hydraulic retention times of the reactors. Paper mill influent with supplemented nutrients was fed to both bioreactors. The only difference between the bioreactors was that one was supplemented with a CryoStart, and one was supplemented with BioStar.

Each bioreactor consisted of two aerated stages to simulate plug flow conditions of an aerated lagoon system. Effluent from the aerated stages was then settled at 4°C for 24 hours. Supernatant from the settled samples was tested for total and volatile suspended solids (TSS/VSS), chemical oxygen demand (COD), and biological oxygen demand (BOD).

The products used for bioaugmentation of the bioreactors are bacillus-based and are sold as a dry product. Before bioaugmenting the bioreactors, the dry product was grown in water for 18-24 hours. The purpose of growing the bacteria up before dosing was so that the lag time of the spores regenerating and entering the log growth phase would occur before addition to the bioreactors. Both bioreactors were dosed with a target dose of 5.0x105 CFU/mL of product.

The two bioreactors were fed from a communal influent supply. Paper mill influent was collected weekly, and therefore influent was consistent for a week at a time. Initially, only supplemental nutrients were added to the influent to ensure that the bacteria had the resources they needed to create new cells. However, both bioreactors were able to completely degrade the soluble BOD present in the paper mill influent in the retention time of the reactors. In order to determine which bioaugmentation product had a higher BOD removal efficiency, the paper mill influent was spiked with a glycerin-based supplemental BOD product to a COD of 3000 mg/L. Supplemental nutrients were kept at a BOD:N:P ratio of 100:2.5:0.5.

Results and Discussion

Figure 1 contains reactors effluent soluble BOD results from the study. Effluent BOD was stable and consistently low for the first few weeks of the study when influent BOD ranged from 270 mg/L to 450 mg/L. Once the glycerin product was added to the influent and the influent BOD increased to approximately 1500 mg/L, effluent BOD in both reactors began to increase. However, the effluent BOD of the reactor receiving the CryoStart leveled off and decreased faster than the effluent BOD of the reactor receiving the BioStar product. Both products were able to acclimate to the increased BOD loading and reach similar treatment efficiencies, but the reactor receiving the BioStar product had a greater BOD breakthrough in the meantime. The influent BOD concentrations increased to 2000 mg/L and then 2400 mg/L in the subsequent batches. The reactor receiving the BioStar product again allowed more BOD breakthrough while the reactor receiving the CryoStart product had more consistent and lower effluent BOD concentrations.

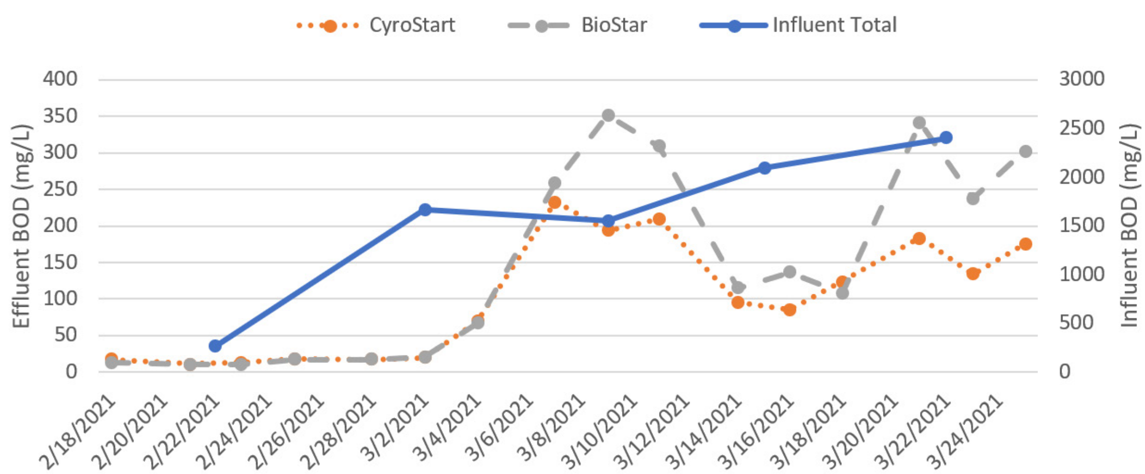

Figure 1 — Influent total and effluent soluble BOD concentrations

Figure 2 shows the VSS of the second stage of each reactor over the same time period. Both reactors started with and maintained almost identical VSS concentrations at the beginning of the study. Once the influent BOD was increased, the VSS in both reactors started to increase. The VSS in the reactor receiving the CryoStart continued to increase over the course of the study, while the VSS of the reactor receiving the BioStar leveled off. The increased biological activity in the CryoStart reactor is likely why more BOD degradation occurred. The cold weather tolerant bacteria were likely better able to reproduce at cold temperatures than the bacteria in the traditional bioaugmentation product.

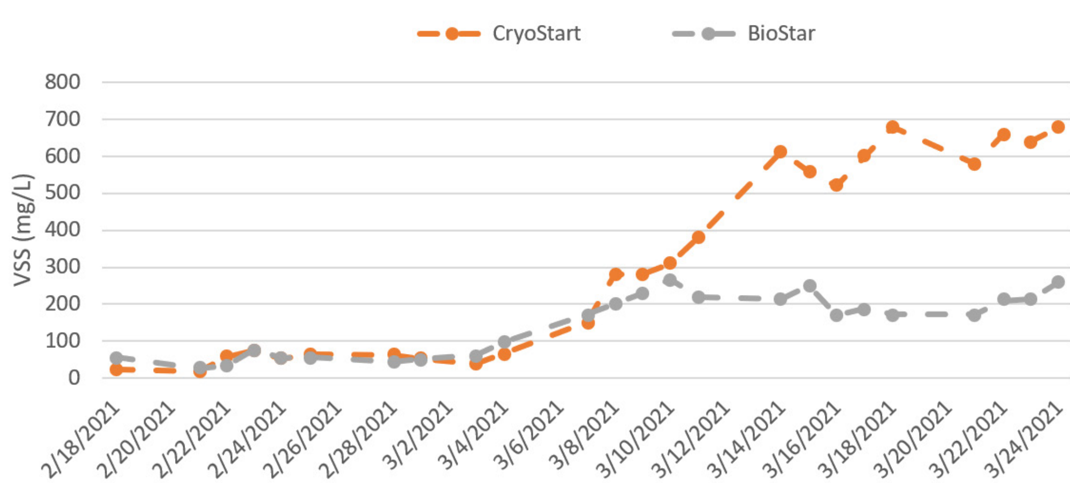

Figure 2 — Effluent VSS concentration

Conclusion

Two aerated lagoon-style bioreactors were operated at a cold temperature, 10.5°C, to simulate winter conditions in a wastewater treatment plant. The reactors were operated the exact same way; only one received a BioStar product, and the other received CryoStart, a new bioaugmentation product containing a cold weather tolerant strain of bacteria. Paper mill wastewater treatment plant influent with a BOD concentration of 270 mg/L to 450 mg/L was used as the influent to the reactors. Initially, both reactors were able to degrade almost all soluble BOD in the influent, and there was little difference between the reactors. However, differences between the reactors began to appear once the influent was spiked with a glycerin-based BOD source to a COD concentration of 3000 mg/L.

Effluent soluble BOD and reactor VSS concentrations increased equally in both reactors at first. Effluent soluble BOD leveled off and decreased in the reactor that was dosed with CryoStart while the BOD of the reactor dosed with BioStar continued to increase. After about a week, the reactor effluent BODs were again at a similar level. When the influent BOD was increased even more, the effluent BOD of the reactor receiving the BioStar product spiked again while there was only a modest increase in BOD from the CryoStart reactor. The VSS in the reactor dosed with the CyroStart increased to approximately three times that of the BioStar reactor, indicating increased biologic activity from the CryoStart cold bug containing strain.

Based on the results of this study, EBS recommends using the CryoStart bioaugmentation product in aerated lagoon systems when the ambient weather decreases during the fall and winter seasons. The addition of the cold bug strains will likely reduce swings in effluent BOD when the temperature in the basins decreases and will reduce the time required for treatment if BOD loading increases in a system during cold temperatures.