Making Good Bacteria Even Better: Bioaugmentation in Pulp and Paper Wastewater Treatment

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As the world's need for clean, sustainable water sources continues to increase, so does the need for industrial operations to reduce freshwater intake and to efficiently treat wastewater before it is released back into the environment. Pulp and paper manufacturers, as participants in a particularly water-intensive industry, have a special responsibility to control and optimize water use throughout production, from pulp formation, to bleaching and washing, to steam drying. Efficiently producing pollutant-free effluent remains one of the industry's highest priorities.

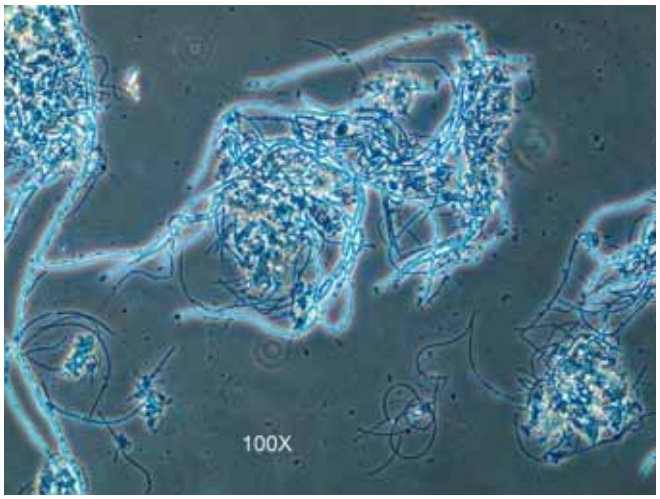
Pulp and paper mills rely on clarification as a primary wastewater treatment to remove total suspended solids (TSS) and other particulate matter, followed by biological treatment as a secondary stage (activated sludge process) to remove organic matter. The activated sludge process uses microorganisms to degrade organic contaminants, which produces a higher-quality effluent. Unfortunately, maintaining a stable biomass is not always easy. A number of factors, including process and temperature fluctuations, can inhibit the activity of microbiological populations and lead to compliance or other operational issues.

A BOOST TO THE BIOMASS

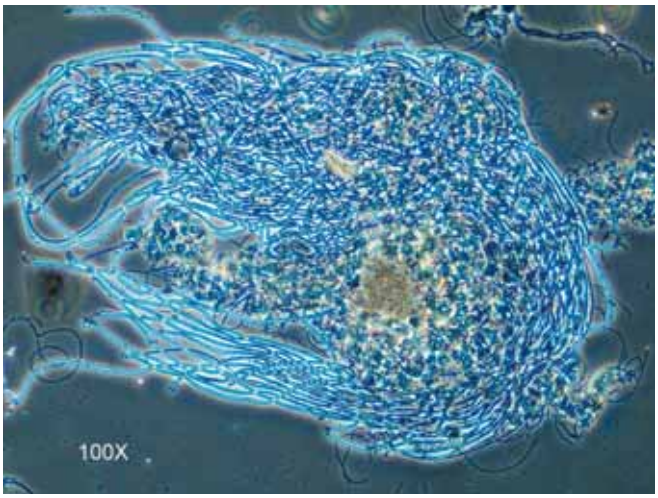
Many pulp and paper mills are improving their wastewater treatment by incorporating bioaugmentation alongside their chemical treatment solutions. Bioaugmentation involves adding specialized bacteria, enzyme products, or other active biologics to a treatment system. Bioaugmentation is part of a multi-faceted solution toolkit that enables wastewater treatment partners to ensure an effective program to meet their compliance requirements. It's especially well-suited for upset recovery or for systems experiencing biological stress.

Treatment upsets at pulp and paper mills are typically caused by inhibition or toxicity of process chemicals, temperature stress and seasonality, shock loadings, power outages, or equipment failures. This could cause shifts in discharge process water quality, leading to ongoing compliance issues when plants exceed or approach permit limits; and can also cause odor complaints. Other signs of a system upset include:

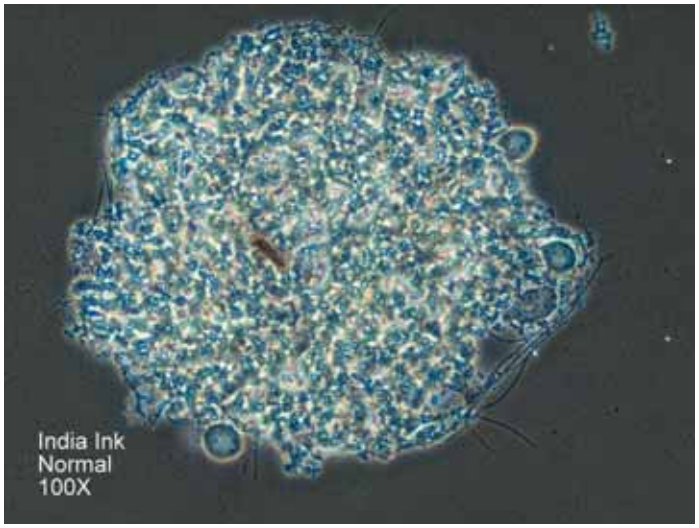
- Floating solids/bulking
- Excessive foaming
- Chemical oxygen demand (COD), total organic carbon (TOC), biochemical oxygen demand (BOD), and ammonia breakthrough
- High effluent turbidity
- Lack of protozoa diversity and activity
- High effluent TSS



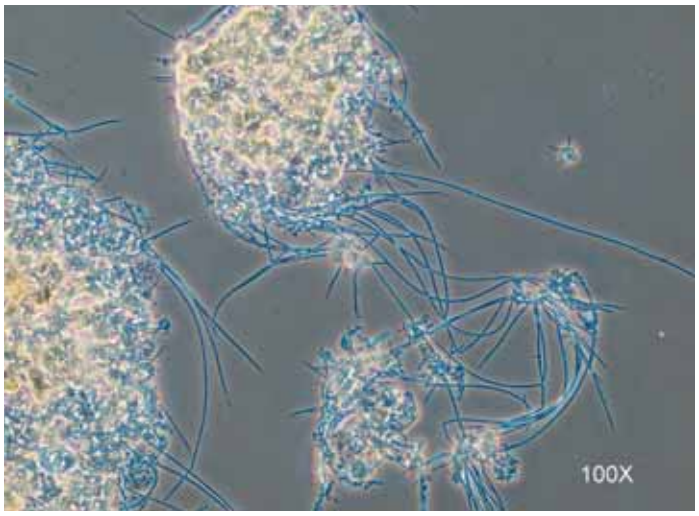
Before bioaugmentation treatment: floc inhibition due to filamentous bacterial impact on floc – 100x.



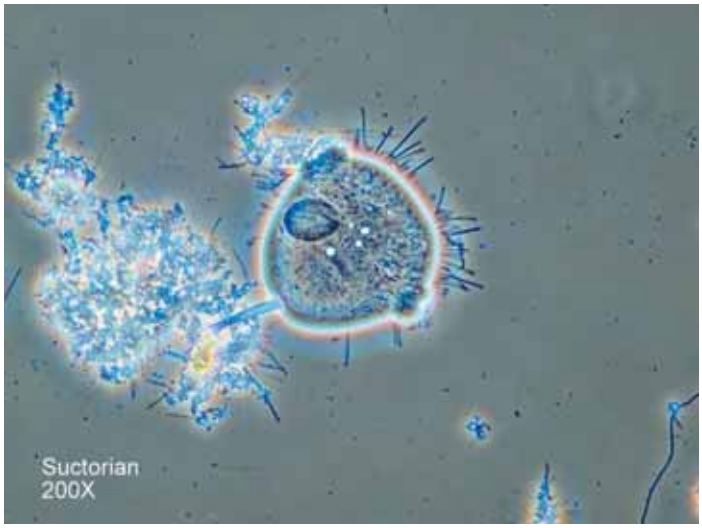
Before bioaugmentation treatment: floc and excessive filamentous bacteria – 100x.



Post-treatment, 3 months: india ink – improved floc formation (normal and firm floc) and reduced total filmentous abundance – 100x.



Post-treatment, 3 months: floc generation and bulk water clarity – 100x.



Post-treatment, 3 months: increased floc formation and protozoa activity - suctorian (a type of complex, single-cell protozoan that obtains food through specialized tentacles) – 200x.

- Poor secondary clarifier settling performance
- Highly variable (low and high) respiration rates

Inoculating a treatment system with strains of microorganisms to deal with these issues is known as reactive bioaugmentation. Pulp and paper mills that have recently brought a system upset under control using operations alone can still benefit from proactive bioaugmentation—minimizing future poor performance by using bioaugmentation to establish broader bacteria strains that can handle wider contaminate and environmental profiles.

In either reactive or proactive scenarios, the organisms introduced during bioaugmentation produce multiple types of enzymes, such as protease, amylase, esterase, xylanase, urease, cellulase, and lipase. When applied to an existing biomass, these enzymes optimize the BOD removal—associated with cellulose, starch, and various hydrocarbons and lignin—and improve effluent TOC, COD, and TSS. Bioaugmentation can also reduce sludge volumes, in turn reducing sludge handling and disposal costs.

COLLABORATION IS CRITICAL

Not all bioaugmentation solutions are the same. Different providers offer blends of microbes with very different attributes. A variety of bacterial strains have been created to treat a broad range of organic waste, such as proteins, various carbohydrates, hydrocarbons, and surfactants. Administered in either dry or liquid product blends, the ideal strains are introduced to the system in specific dosing rates for either performance recovery or enhancement.

Before pulp and paper plants adopt a bioaugmentation solution, they should consult with their chemical or wastewater treatment partners. Often, an audit of a mill's treatment system can help identify challenges and opportunities. This will involve collecting current and past treatment performance and operational data, exploring problems to be solved, and confirming treatment goals.

Once this discovery is completed, the mill/provider team can design a fully customized wastewater treatment program leveraging bioaugmentation that can realize all of the benefits of the technology: improved wastewater reliability and compliance, as well as reduced TOC, COD, BOD, TSS, and effluent surcharge costs.

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