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UNITING THE VIBRANT WORLD OF WATER

Industrial Wastewater Recycling and Reuse Methods

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UNITING THE VIBRANT WORLD OF WATER - TO PROVIDE A PROACTIVE PLATFORM FOR THE WATER INDUSTRY TO CONVERGE AND WORK TOGETHER IN ACHIEVING SOLUTIONS TO GLOBAL WATER PROBLEMS.

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FULLTIDE

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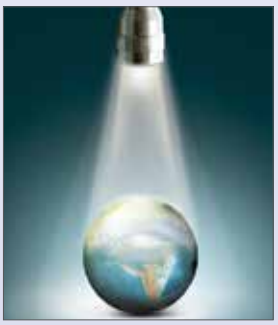
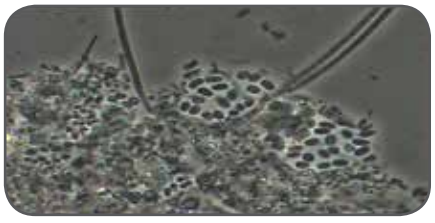
WATER WORKS

REGULARS



Microorganisms in Activated Sludge


The successful removal of wastes from the water depends on how efficiently the bacteria consume the organic material and on the ability of the bacteria to stick together, form floc and settle out of the bulk fluid. This article discusses the activated sludge process.

By Daniel L. Theobald

In the activated sludge process, microorganisms are mixed with wastewater. The microorganisms come in contact with the biodegradable materials in the wastewater and consume them as food. In addition, the bacteria develop a sticky layer of slime around the cell wall that enables them to clump together to form bio-solids or sludge that is then separated from the liquid phase. The successful removal of wastes from the water depends on how efficiently the bacteria consume the organic material and on the ability of the bacteria to stick together, form floc, and settle out of the bulk fluid. The flocculation (clumping) characteristics of the microorganisms inactivated sludge enable them to amass to form solid masses large enough to settle to the bottom of the settling basin. As the flocculation characteristics of the sludge improves, so is the improved settling and improved wastewater treatment.

After the aeration basin, the mixture of microorganisms and wastewater (mixed liquor) flows into a settling basin or clarifier where the sludge is allowed to settle. Some of the sludge volume is continuously recirculated from the clarifier, as Returned Activated Sludge (RAS), back to the aeration basin to ensure adequate amounts of microorganisms are maintained in the aeration tank. The microorganisms are again mixed with incoming wastewater where they are reactivated to consume organic nutrients. Then the process starts again.

The activated sludge process, under proper conditions, is very efficient. It removes 85-95% of the solids and reduces the biochemical oxygen demand (BOD) about the same amount. The efficiency of this system depends on many factors, including wastewater climate and characteristics. Toxic wastes that enter the treatment system can disrupt the biological activity. Wastes heavy in soaps or detergents can cause excessive frothing and thereby create aesthetic or nuisance problems. In areas where industrial and sanitary wastes are combined, industrial wastewater must often be pre-treated to remove the toxic chemical components before it is discharged into the activated sludge treatment process. Nevertheless, microbiological treatment of wastewater is by far the most natural and effective process for removing wastes from water.

There are five major groups of microorganisms generally found in the aeration basin of the activated sludge process:

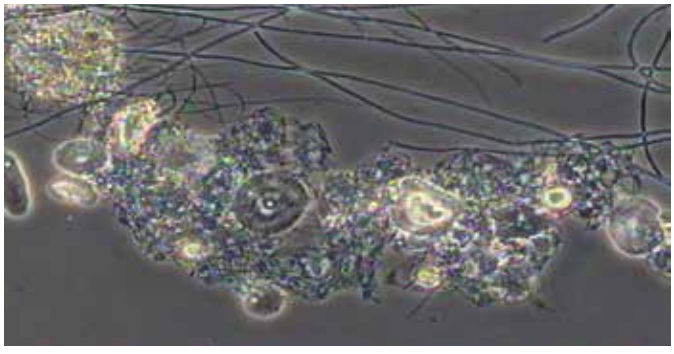
- **Bacteria:** Aerobic bacteria remove organic nutrients
- **Protozoa:** Remove and digests dispersed bacteria and suspended particles
- **Metazoa:** Dominate longer age systems including lagoons
- **Filamentous bacteria:** Bulking sludge (poor settling and turbid effluent)
- **Algae and fungi-Fungi:** is present with pH changes and older sludge

Bacteria are primarily responsible for removing organic nutrients from the wastewater.

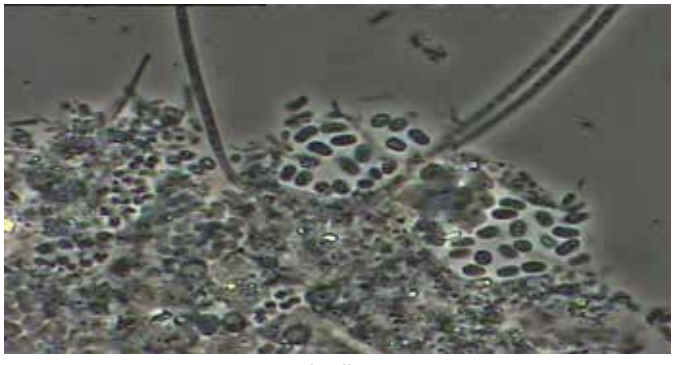
Protozoa play a critical role in the treatment process by removing and digesting free swimming dispersed bacteria and other suspended particles. This improves the clarity of the wastewater effluent. Like bacteria, some protozoa need oxygen, some require very little oxygen, and a few can survive without oxygen. The types of protozoa present give us some indication of treatment system performance which is classified as:

- **Amoebae**: Little effect on treatment & die off as amount of food decreases
- **Flagellates**: Feed primarily on soluble organic nutrients
- **Ciliates**: Clarify water by removing suspended bacteria
- **Ciliates:** Free-swimming-Removes free-dispersed bacteria
- **Ciliates:** Crawling (grazing)-Dominate activated sludge/ good treatment
- **Ciliates:** Stalked (sessile)-Dominates at process end

Protozoa images are below:

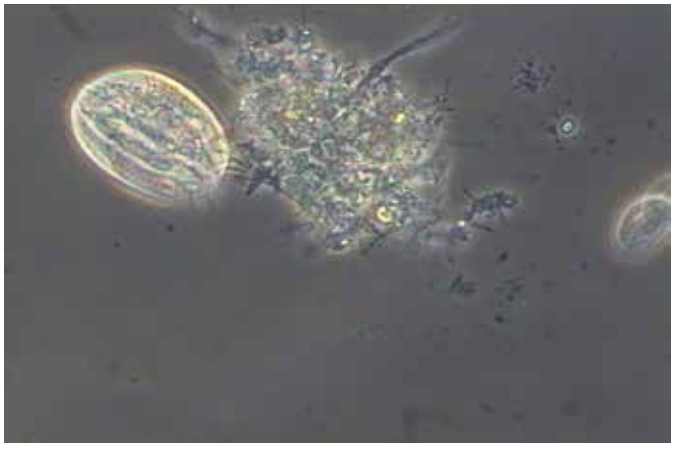


Amoeba



Flagellates

Ciliates: Free-swimming



Ciliates-Crawler

Ciliates-Stalked

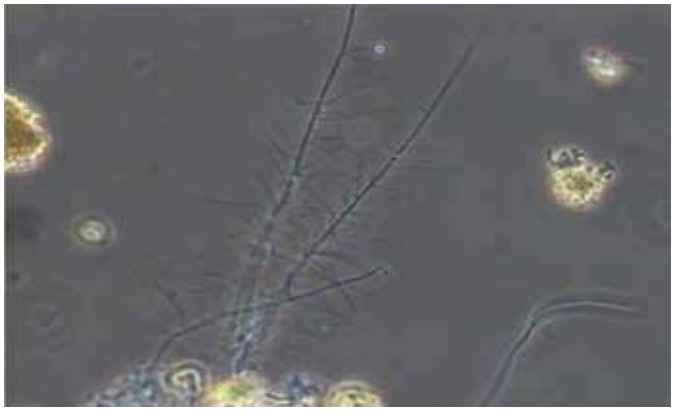
Metazoa are multi-cellular organisms which are larger than most protozoa and have very little to do with the removal of organic material from the wastewater. Although they do eat bacteria, they also feed on algae and protozoa.

A dominance of metazoa is usually found in longer age systems; namely, lagoon treatment systems. Although their contribution in the activated sludge treatment system is small, their presence does indicate treatment system conditions. Three most common metazoa found in the activated sludge treatment system.

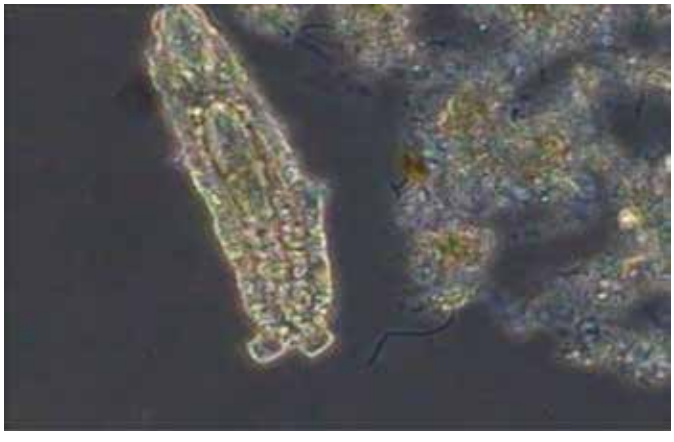
- **Rotifers**-Clarify and effluent are first affected by toxic loads
- **Nematodes**-Feed on bacteria, fungi, small protozoa and other nematodes
- **Tardigrades** (water bear)-Survive environmental extremes & toxic sensitivity

Metazoa images are below:

Rotifer



Nematodes

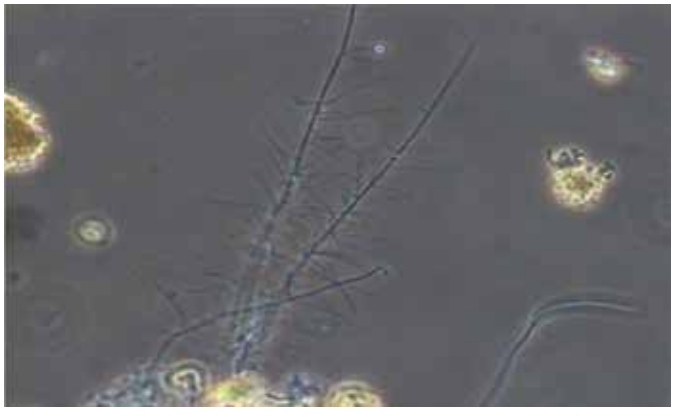


Tardigrades

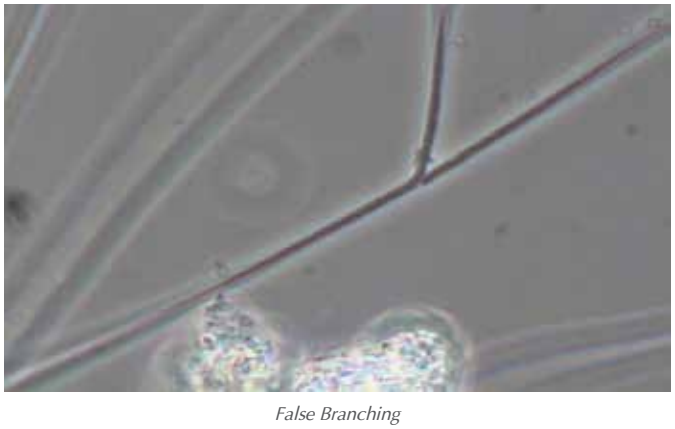
Filamentous bacteria are present when operational conditions drastically change. These bacteria grow in long filaments begin to gain an advantage. Changes in temperature, pH, DO, sludge age, or even the amounts of available nutrients such as nitrogen, phosphorus, oils & grease can affect these bacteria. The dominance of filamentous bacteria in the activated sludge treatment system can cause problems with sludge settling. At times excessive numbers of filamentous microorganisms interfere with floc settling and the sludge becomes bulky. This bulking sludge settles poorly and leaves behind a turbid effluent. Some filamentous microorganisms may cause foaming in the aeration basin and clarifiers.

Filamentous images are below:

Sheath



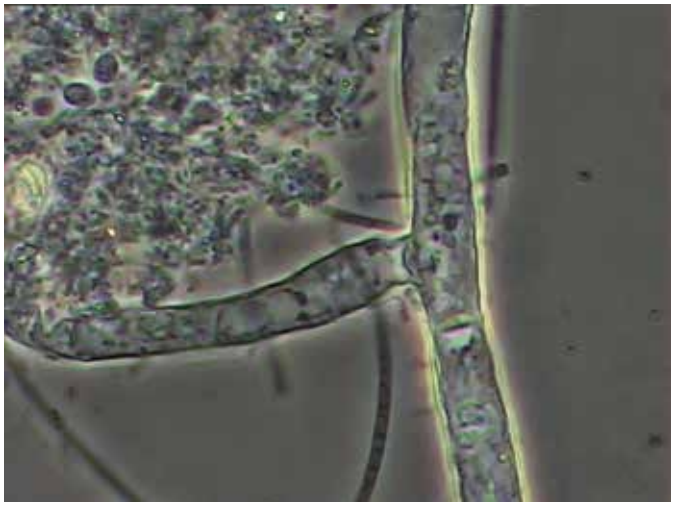
Sheath



False Branching

Algae and fungi which are photosynthetic organisms and generally do not cause problems in activated sludge treatment systems, however their presence in the treatment system usually indicate problems associated pH changes and older sludge.

Fungi image is below:



Filaments (True Branching)

About the Author

Daniel L. Theobald, Proprietor of Environmental Services, is a professional wastewater and safety consultant/trainer. He has more than 24 years of hands-on industry experience operating many variants of wastewater treatment processing units and is eager to share with others his knowledge about water conservation.