HERITAGE SYSTEMS

Delivering Liquid Solutions

Once Through Facultative & Aerated Lagoon Microbiology

Note: While this material is directed at once-through systems, the same principles apply to activated sludge systems.

1. Ecological Succession of Higher Life Forms - The biological population of a wastewater system consists of two groups of microorganisms -- the bacteria and the higher life forms (protozoa and rotifers). The bacteria are the primary BOD degraders in the system, converting carbon-based compounds into carbon dioxide and new bacterial cells. As the system matures, the dispersed individual cells form floc structures or biomass. The protozoa are predators that feed on the bacteria. While we may talk about the "evolution" of the higher life forms, we really are describing an ecological succession. Each type of microorganism is an individual species of the Protista kingdom. The term evolution implies that one species turns into another. This is not the case. As the food supply diminishes, the bacterial activity decreases and floc structure increases, resulting in changing environmental conditions conducive to more advanced life forms.

Throughout this maturation of the bacterial population, the type of protozoa best suited to feed on the bacteria changes. For example, when there is a lot of food available for the bacteria, they spend the majority of their time and energy in search of food. In the early part of a lagoon (i.e., wastewater influent end), you would expect to find small floc with many dispersed or free swimming bacteria. It is here that you would expect to find flagellates and fast swimming small ciliate capable of feeding on the free swimming bacteria. By the Lagoon Outlet, most of the soluble BOD has been metabolized and converted into bacterial cells that are no longer agglomerating into floc as they conserve their energy, since little food is available. Here you will find the more advanced higher life forms, such as larger free swimmers and crawling ciliates. Under ideal conditions, you may even see stalked ciliates and a few rotifers.

2. Higher Life Forms as "Indicator Organisms" -- The higher life forms are often called collectively indicator organisms. This is because they can serve as indicators and early warning of undesirable conditions that have not yet impacted the bacterial population. Bacteria are extremely hardy and resilient creatures. They can survive and even thrive at a variety of temperatures, pH's and dissolved oxygen conditions. They are also fairly resistant to toxic compounds in that they may be inhibited, but still "alive" and capable of quick recovery. The indicator organisms are the last to show up and the first to leave. The type and abundance of protozoa are certainly an indicator of general health and stability of the system. However, higher life form "counts" alone may not be

indicative of the bacterial population performance in terms of BOD degradation. For example, a slug of low pH may wipe out the higher life forms for a couple of days, but barely impact the bacteria at all. Also, most protozoa are strict aerobes and will not thrive if the dissolved oxygen levels are depressed. That being said, a significant shift in the protozoan population or the loss of higher life forms for an extended period of time should be considered cause for concern and be investigated.

Below is a passage from Jenkins, Richard and Daigger's Manual on the Causes and Control of Activated Sludge Bulking and Foaming (pages73,75):
"One of the most valuable uses of the microscopic observations of these organisms (protozoan) is for toxicity assessment. These organisms, particularly the ciliates and rotifers, are generally the first to be impacted by toxic materials and can serve as an *in situ* biomonitoring test for toxicants or other adverse stresses on the activated sludge process. The first noticeable sign of toxicity or stress is usually the slowing or cessation of cilia movement in the ciliates. Next, the predominant protozoan group shifts toward flagellates and small, free swimming ciliates which often "bloom" to high numbers. This is an indication of floc breakup and the production of large numbers of dispersed bacteria (turbidity) which are used by the flagellates and free swimming ciliates as a food source. Finally, in severe cases, these protozoans die, and their lysis and release of cell contents can cause foaming (white foam containing dead protozoans and protozoan fragments). Toxicants that can cause this chain of events include heavy metals and cyanide**. Stresses other than toxicity that induce these responses include low DO, pH outside the range of 6.0 - 8.0, and high temperature** (my emphasis). Protozoa and other higher life forms are generally absent from activated sludge systems operated at temperatures above 37-40 degrees C.