EXTRACELLULAR POLYMERIC SUBSTANCE, EPS FOAM PROBLEMS

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Most Operations Specialists that are responsible for activated sludge treatment systems have at one time or another experienced excessive foam production. This may or may not have been in conjunction with sludge bulking conditions. Over the years we have become used to the fact that there are two foam forming filaments. When an outbreak of foam occurs on the aeration basin, we automatically point the finger at Nocardia, or M.Parvicella. Well folks, there is a new kid on the block, so to speak. Not new in existence, however, just new in our understanding and identifying the reason for our foam problems.

Last year during several onsite technical assistance visits, I also expected to look under the microscope and see a filament as the culprit. Surprisingly, looking under the microscope revealed no significant filament abundance, and certainly no indication of floc-bridging in the mixed liquor suspended solids, (mlss). The foam slides didn't have the typical Nocardia filament, nor did they reveal M.Parvicella. Initially it was confusing to look at the foam on the surface of the aeration basin, and then not see the causing filament under the microscope.

All Foam is not created equal.

As it turns out, what we were looking at was a type of biological foam created by the excessive excretions of our wastewater treating bacteria. This can be the "good bacteria" which are the floc formers, or it could be the Zooglea type of organism. Activated sludge flocs are held together by what is commonly referred to as Extracellular Polymeric Substances, (EPS). The EPS outer layer on many bacteria allows them to adhere to surfaces and each other, which becomes the "glue" in holding the floc together. This film also offers protection from predation, freezing, drying, changes in pH, lack of nutrients, and heavy metal toxicity. It is also very hydrophobic in large concentrations, and because of this, has the potential to create a thick layer of the MLSS at the surface of the aeration tank which we see as foam.

Zooglea has been characterized with the distinct "finger-like" growth pattern, although it can also be found to grow in a globular or amorphous state as well. Zooglea or zoogleal are often used to describe the generic overproduction of EPS by any organism, just like Nocardia has been used to describe a typical foam outbreak. The difficulty in pin-pointing an actual organism for the foam event is compounded by the generic use of such terms as slime bulking, and viscous bulking, viscous sludge, zoogleal bulking, and non-filamentous bulking.

What I was seeing under the microscope this past year was severe instances of slime bulking caused by the over excretion of EPS by floc-forming organisms. To identify which conditions that were promoting the excessive release of the EPS was the challenge. Although we are taught that municipal wastewater is not typically nutrient deficient, it is my opinion that that is the underlying cause of the occurrence of this growing phenomenon. The floc forming bacteria, when subjected to an environment with an unbalanced nutrient supply or nutrient deficiency, produce substantial amounts of EPS slime, particularly when there is plenty of easily degradable food available to them.

EPS can be confirmed by performing the India ink test. Set up a microscope slide, just as you normally would with a cover slip. Place a single drop of the India ink at the edge of the slide/coverslip. The India ink will migrate across the slide. It will penetrate normal floc and the field of view will appear black. However, if EPS is present, the ink cannot penetrate as easily and the field of view will have globs of white areas.

Under the microscope certain filaments will also dominate the population when nutrient deficiency exists. If filament identification is available, look for 021N, Thiothrix, 0041 and 0675 as these types thrive in nutrient deficient conditions and will cause filamentous bulking if allowed to grow in excessive numbers or abundance.

How to overcome the problem of foam caused by excessive EPS, well that is the $64,000 question. Just like battling filaments, the underlying cause of the excessive EPS must be identified. Is it nutrient deficiency, changes in pH, or some form of low level toxicity? We used to think that toxicity meant heavy metals, or industry. We now know that pharmaceuticals from nursing homes, hospitals and the public in general, have been identified as major contributors to inhibitory effects on receiving water invertibrates and fish. Major studies are currently underway which look at how these inhibitory compounds are impacting the wastewater treatment process and its efficiency. One of the least expensive and low-tech procedures to check for toxicity in general, is the Oxygen Uptake Rate (OUR), test. The Microtox test is an acute toxicity test and has greater sensitivity, repeatability and precision, however due to the cost, the OUR test is the preferred technique.

EPS foam does not respond to chlorination as favorably as when dealing with a Nocardia foam. Like combating the Nocardia foam, EPS foam should be physically removed from the treatment system. Pumping it to an aerated digester is not physically removing it from the system, that is merely moving it to another part of the treatment loop from which it is likely to be returned during a decant procedure. **>>>**

In conclusion, if you are experiencing a foaming event and it is persistent, first take the time to identify whether or not it is caused by Nocardia or M.Parvicella. If neither of these foam causing filaments is identified under the microscope, you may be dealing with a zoogleal slime, or an excessive EPS foam. Changing the environmental condition that is promoting the occurrence will be the quickest solution. If it is nutrient deficiency, supplementing the deficient nutrient will be necessary. "Be aware that nitrogen and phosphorus requirements could vary between summer and winter. In cooler temperatures, sludge yields are higher with the bacteria utilizing more nutrients for cell growth. In warmer temperatures, sludge yields are lower and the bacteria utilize less nutrients. If the aeration basin temperatures vary between summer and winter, the nutrient requirements will change, which means the BOD:N:P ratio will differ between summer and winter." - Best Management Practices Guide for Nutrient Management in Effluent Treatment by Rick Marshall, Marshall Environmental Training and Consulting (METC) Group April 25, 2008. 💦💦💦