A Look Back #3

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This month's reprint – *Controlling Microbial Contamination* – originally appeared in NPN's January 1995 issue.

Rereading the article today, I feel that in most respects little has changed since the original publication date. However, there are a few items in the original paper that would benefit from a bit of clarification.

By 1995 the industry trend toward fungibilty was almost complete. Today, with rare exceptions, is it more difficult than ever to trace responsibility for conditions or product quality in a tank to a specific upstream source. For the most part, stakeholders at each stage of the supply chain are doing their best to practice good housekeeping. However, even under the best circumstances, downstream tanks will become contaminated. This is true even in the aviation industry where considerable effort is made at each stage of the fuel supply chain to eliminate water and other contaminants.

In 1995, I was convinced that systems with even low to moderate sludge and sediment contamination were unlikely to respond favorably to just chemical treatment. Although there are still circumstances where it is highly advisable to clean tanks before adding a microbicide (the term now preferred for biocides that target microbes), our experience over the past decade has shown that most tanks can be treated without first cleaning them.

In Controlling *Microbial Contamination* I made a distinction between lined and unlined tanks. I'm no longer convinced about the validity of that distinction. My doubts are not based on the performance of well-applied coatings and liners. The problem is that too often coatings and liners are not applied properly. Holidays (small holes) provide access for water and microbes to get between the coating and the underlying steel surface. Too often infections between coatings and the coated surface go undetected until either the coating or the tank fails. For tanks with intact liners or coatings this is not a problem. But too often the assumption of coating or lining integrity is just that – an assumption. Preventive treatment with an appropriate microbicide will dramatically reduce the risk of failure due to infections between coatings or liners and the tank shell.

In my original article I offered a calculation of the total volume of a ¼ inch biofilm covering the interior surface of a bulk (100,000 bbl) tank. Here's something else to consider. The rod-shaped bacteria typically found in fuel systems average 0.000002 in diameter x 0.000004 in long. Fungi are typically 0.00002 in x 0.0004 in. Know consider either a bacterium or fungal cell standing head-up on a surface that is covered with 1 mm (0.004 in) of water. The fungal cell is in water 10 x over its "head" and the bacterium is in water 100 x over its "head". These calculations illustrate how a "dry" tank (we can't detect 1 mm of water in a tank) can support a heavy bioburden.

My closing comment in the original *Controlling Microbial Contamination* article noted that biocides are used to kill microorganisms. I expand on this comment in my September 1995 article: *Opening Your Biocide Toolbox* (to be reprinted in *A Look Back #5*). This month I will make two important observations. In *Opening Your Biocide Toolbox* I make a case for only using universally soluble microbicides. As I'll discuss in December's *A Look Back*, the argument for choosing only universally soluble microbicides is even more compelling than the one I had made in 1995. Also, our experience over the past 12-years has consistently validated the performance of the microbicide Kathon® FP1.5. It is the only soluble, fuel treatment microbicide that is registered for use in California and other states that require performance data.

Chapter 2 of ASTM Manual 47 – *Fuel and Fuel System Microbiology: fundamentals, diagnostics, and contamination control* – available from ASTM at www.astm.org – provides detailed guidance on how to decontaminated infected tanks. If you have contamination, I strongly recommend that you read Manual 47.

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OPERATIONS MANAGEMENT

Controlling Microbial Contamination

■ **Frederick Passman**

Market participants are going to have to cooperate to ensure that the customer with the engines gets consistently good fuel.

Smaller retailers depend on the expertise and reputations of their suppliers. Traditionally, refiners' attitudes about fuel were that if it met specifications at the time of sales, but failed later, the problem belonged to the owner at that time. As we begin to see impact of the Clean Air Act-driven fuel reformulations, increased consumer awareness and increased susceptibility to contamination, all market participants are going to have to cooperate to ensure that the customer with the engines gets consistently good fuel.

Contamination at each stage of the petroleum distribution chain generates greater problems at each succeeding stage. The supply gets split up and comingled with uncontaminated product, making it difficult to trace the problem source. Access to larger tanks is generally easier than it is to the smaller tanks found downstream in the distribution chain. The economics of problem correction are easier to amortize over millions of barrels of product than they are over thousands. Product stewardship should begin at the refinery.

You've just determined that you have a microbial contamination problem. What do you do? It depends on what kind of fuel system you own. Although there will be common elements to your corrective actions regardless of whether you are responsible for multiple 100,000-bbl. gasoline terminal tanks or own a single 1,000-gal. heating oil tank, the details depend on your system.

When discussing strategies for cleaning terminal-sized tanks (typically 15,000 bbl. and larger), it's helpful to consider an analogy before getting into specifics. Consider the swimming pool.

How do pool maintenance people deal with debris in the pool and the green algal tint that develops on its walls? They don't fill up the pool, turn on the filtration systems and start pumping in chlorine. The first step is to drain the pool, then remove any debris on the bottom. The surface is inspected, and any cracks or other damage to the structure are repaired. Algae stains are scrubbed off. Then the pool is filled, the filtration unit turned on and routine chlorination initiated.

Think about your fuel tank. It's really a lot like an enclosed swimming pool, filled with a distillate petroleum product. If your test data indicate that you have only traces of sludge and sediment, corrosion inhibitors and microbicides should arrest the problem. However, if there is more than a trace of contamination, the first step is to remove it. This may not be a trivial exercise. Flat and concave tank bottoms are virtually impossible to drain bottoms contamination completely. These bottoms have no single, well-defined low-point from which sump systems can draw. Often the only solution is to remove all fuel from the tank and have a crew clean the bottom mechanically. Concave (conical) tank bottoms typically have the sump draw from the lowest point in the tank; therefore, they are easier to maintain.

Lined tanks may only need draining, followed by chemical treatment. Unlined tanks are more susceptible to microbially induced corrosion. Besides creating biomass, microbes produce organic acids, surfactants and enzymes. These chemical byproducts all contribute to corrosion processes. Consequently, bottom sediment and sludge should be checked for dissolved and particulate iron (rust products). If iron is present in the sludge, the tank should be inspected by a corrosion engineer. This means draining and cleaning the tank first. As with swimming pools, any structural damage must be repaired before the tank is returned to service.

Recalling that pool walls must be scrubbed before the pool is filled, we can again apply the analogy to fuel tanks. Most operators only consider the bulk water and sludge found in the tank's bottom. Performing some simple calculations on a 100,000-bbl. tank (120-ft. dia.), we find that the bottom surface represents about 63% of the total surface area. A 1/4-in. biofilm layer on the tank walls translates into 2,900 gal. of contamination that remains to be removed or treated.

This is another reason why just draining tank bottoms is generally an inadequate solution. Trapped water and biomass accumulate along the tank walls, as well as at the fuel-water boundary and within the sediment layer. Substantial contamination in bottom samples often suggests wall-growth as well. Inspect the tank, and, if the walls are coated with slime, clean them.

Once the gross contaminants have been removed, it is appropriate to consider treatment, which depends on the fuel grade, intended application and current condition relative to specifications. Mechanical treatment alternatives range from phase separation to filtration. Chemical treatment may include performance additives to restore critical functionalities (gasoline detergency and diesel cold-flow properties). Biocides are used to kill the contaminating microbes and to prevent regrowth. Degraded fuel may have to be processed or sold as lower-grade product.

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