

A Look Back #6

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This month's reprint – *Microbes and Fuel Retailing – The Hidden Costs of Quality* – originally appeared in NPN's July 1999 issue.

Microbes in Fuel Retailing was the last in my series of NPN articles. In it, I presented a more global perspective on the key issues that I had addressed in earlier articles. Since 1999 there have been some watershed changes in the industry since it was written. The most important ones all involve dramatic changes in fuel product composition.

In 1999 biofuel use in the U.S. was really still in its infancy. The National Biodiesel Board reported that U.S. biodiesel production grew from 34.5 million gal in 2001 to 250 million gal in 2006 and is on track to reach 300 to 350 million gal this year (2007). This growth is driven in no small part by the Renewable Energy Act of 2007. Similarly, MBTE – the predominant oxygenate used in gasoline in 1999 – has been virtually eliminated from the market and replaced by ethanol (ETOH). In the U.S. most ETOH-blended fuels contain 10% of the alcohol.

The trend towards biofuels has had several important impacts on the fuel distribution infrastructure. In this column, I'll address only those that affect biodeterioration risk.

Although more research is needed, work done to date suggests that not all biodiesel base-stocks are equally biodegradable. Biodiesel base stocks are all fatty acid methyl esters derived from oils that come from plants or animals. In North America, soy and canola oils are the primary feedstocks for FAME production. Biodegradability is affected by chemical properties that need a more technical discussion than this article is meant to provide. For our purposes it's sufficient to note that soy-based and canola-based biodiesel base stocks are readily biodegradable. This is great for bioremediation, but presents new challenges for fuel product stewardship. Laboratory studies also suggest that B5, B-10 and B-20 biodiesel blends (5, 10 and 20% FAME in conventional diesel) are substantially more susceptible than conventional diesel is to microbial attack. This doesn't mean we should resist the use of biodiesel. It does mean that we have to rethink distribution channel maintenance and condition monitoring to prevent biodeterioration.

Similarly, although ETOH is used as a disinfectant at high concentrations, at 10% it makes gasoline more vulnerable to microbial attack. One reason that both biodiesels and ETOH-blended gasoline are at greater risk than conventional fuels is that they hold more water. The other reason is that they provide microbes with relatively small, high-energy molecules that can kick-start population growth.

Since 1999 the trend from conventional diesel through low sulfur diesel (LSD) and on to ultra low sulfur diesel (ULSD) has accelerated – driven by Clean Air Act regulations. The reduced-sulfur fuels are at greater risk than conventional diesel to microbial attack. But this isn't because sulfur present in conventional diesel is toxic to microbes. The refining processes that strip sulfur also tend to reduce the aromatic content of those fuels. The first commercial biocides were phenols (aromatics). Reducing the aromatic content of diesel fuel increases its biodegradability.

In summary, the major trends in fuel chemistry are creating products that reduce emissions, but are at the same time at greater biodeterioration risk. The benefits far outweigh the challenges, but we can't rely on business as usual to protect product and fuel systems.

Although good housekeeping practices are important at every stage of the fuel retail pipeline, contaminants enter the system at each stage. This means that regardless of the practices upstream, it's essential for stakeholders at each transfer point (primary terminals, small bulk facilities and retail site) to take ownership of the contamination control challenge. At the end of the day, the retailer has the most critical role. The retailer's point of sale relationship with the consumer makes the corporate image that drives sales and profitability. Slow-flow at the dispenser, or engine problems shortly after a fill, drive customers away (one survey determined 15% customer loss due to these two quality issues). As discussed in the other articles in this series, uncontrolled microbial contamination also increases maintenance costs.

Looking back, microbial contamination is a serious cost issue. Looking forward, the cost of not controlling microbial contamination is likely to grow dramatically.

Microbes and Fuel Retailing - The Hidden Costs of Quality

Is there a problem?

Whether we admit it or not, most of us believe that if we don't sense something directly, it's not there; it's not a problem. We don't worry about high blood pressure or clogged arteries until our hearts threaten to go on strike. A couple of decades ago, people in the metalworking industry never had microbial contamination problems, they just dumped their coolant (fluids recirculated through metalworking systems to cool and lubricate tool and work-piece surfaces) every 8 to 12 weeks, as putrid odors drove workers from their stations. Once that industry identified their costs-of-quality, and began exercising microbial contamination practices, typical coolant change-out frequencies extended to multiple years. Reduced coolant, waste treatment and opportunity costs (primarily lost productivity during downtime) saved the metalworking industry tens of millions of dollars annually. Is there a lesson here for petroleum marketers?

Four major trends are driving a growing need to understand and control the costs-of-quality due to microbial contamination at retail sites. Changes in fuel formulations, driven by new Federal regulations regarding fuel and fuel additive chemistry (40 CFR 79 *Fuels and Fuel Additives Registration Regulations*, revised June, 1994), make fuels more susceptible to microbe attack than ever before. At the same time, the petroleum industry distribution infrastructure is changing dramatically. Pipeline and terminal operations are consolidating as producers try to increase their profitability through greater throughput rates. With tank capacity shrinking at a rate of 7 to 11 percent, while consumption is increasing at a rate of 3 to 5 percent annually, the net throughput rate increase is 10 to 16 percent. This means that there's less time for water and particulates to settle out of product before it's pumped at the rack. Moreover, the trend towards common terminals means that individual producers have less control over product quality, once it leaves the refinery.

Increased dispensing system sensitivity to contamination effects is the third major trend. System component manufacturers have been evaluating new materials to make their products less vulnerable to corrosion. To protect their customers from particulate contamination, marketers are using smaller pore-size filters on their dispensers. However, these strategies address problem symptoms, not causes. The fourth major trend is within the automotive industry. The universal shift from carburetors to injectors have made gasoline engines more vulnerable to fuel contamination problems.

Who's responsible?

As I work with petroleum marketers, I find that the most common impulse is to blame terminal operators for providing bad fuel. Although the key to controlling microbial contamination problems is through cooperation among all participants in fuel distribution, from the refinery to the retailer, the primary responsibility for contamination control rests with the retailer. The reason for this is that underground storage tanks (UST) act as coalescers.

In the typical retail setup, the submerged turbine draws fuel from approximately 6 in off the tank-bottom. In a 10,000 gal UST this translates into approximately 257 gal (3 percent) of bottom fluid that may not turn over (turbulence at the base of the fill-pipe is not sufficient to blend "old" bottom-fuel with fresh product). Water and particulates carried over with delivered fuel in a UST with an average monthly throughput of 40,000 gal, have up to a week to settle to the UST bottom. Over the course of time, trace contaminants, well within fuel quality specification limits at the terminal rack, accumulate in the UST. For example, 100 mg water/kg fuel (0.01% by weight) equals 7.3 gal water/10,000 gal fuel. At four deliveries per month, this adds up to nearly 90 gal water carried-over per quarter. Most of this water will remain dissolved or dispersed in the fuel. Some will condense onto UST walls and some will drop out; contributing to bottom-water accumulation. Microbial populations in excess of 10-billion organisms per gallon bottom-water are not uncommon. Traces of water can support tremendous microbial contaminant loads. The only place to control these contaminants is in where they are growing; in the UST.

Why not treat at the refinery or terminal?

I discussed biocide use in an earlier article in this series (NPN, September, 1995, p. 54). Biocides are used up as they kill microbes. Biocide treatment at the refinery can reduce the number of microbes entering the pipeline, but is unlikely to prevent re-growth downstream in the pipeline or terminal tanks. Biocide treatment at the terminal may further reduce microbial loads transferred to retailers, but vapor recovery systems, tank vents and fill-well drains provide plenty of opportunity for system recontamination at retail sites. In other words, regardless of contamination control measures taken up-stream. Microbial contamination in UST is a fact of life.

So What?

If microbial contamination didn't create a cost-of-quality, we wouldn't have any reason to care about contamination control. The term *cost-of-quality* refers to the sum of the costs of all of the negative effects plus the cost all of the control measures. A system with no quality control measures and significant negative effect costs represents the worst case scenario. In the best case scenario, the marketer knows how to measure the costs-of-quality, understands which of those costs are controllable, and invests in a control program that results in a net decrease in the cost-of-quality.

Costs-of-quality due to microbial contamination, include increased dispensing system component replacement costs (from plugged dispenser filters to leaking UST), site remediation, opportunity costs (lost customers due to dissatisfaction about slow dispensing rates or poor fuel performance) and contamination control costs. One proprietary study with which I am familiar estimated that retailers lost an average of 10-percent of their customers due to quality problems annually. You may argue that since this is a zero-sum game, you'll probably gain an approximately equivalent amount of new business from customers who've had quality problems with product from your competitors. What would be the economic impact of your reducing your product-quality related customer losses while capturing new customers? This is where understanding the cost-of-quality, and minimizing it, pays off.

What's the answer?

The first step is to identify and measure your microbial contamination cost-of-quality. There are some easy ways to do this. First, monitor filter change frequency. Filter-life shorter than 100,000 gal fuel is an early warning signal. Also keep records of other system component replacements (leak detectors, valves, etc.). Next, make certain that you know how your UST are lying. Most operators check for water at the fill-end; assuming that it's the low end. If your tank is actually low at the pump-end substantial water accumulation can go undetected (at one site, where the operator "knew" his UST was low at the fill-end, we pulled over a 60 gal of water from the pump-end). Be certain to check for water periodically at the tank's low-end. Once each quarter, pull a bottom sample and look at it. If you see only clear and bright fuel, great! If you have two phases (fuel over water) microbial contamination is unlikely. If you see three phases, then you have significant microbial contamination. The third phase, often called the *rag-layer*, is a combination of microbes, their waste products and emulsified water in fuel. If your UST bottom-sample has a rag-layer, it probably has microbial slime coating the UST walls.

If you have significant contamination, you should contact a reputable service company with expertise in microbial contamination control. Working with your service company, develop a plan that will maximize your return on your contamination control investment. Remember, your objective is to see a net decrease in your cost-of-quality, thereby improving your competitive position and increasing your profitability.