A Look Back

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Between 1994 and 1999, I had the opportunity to write a series of articles for *National Petroleum News* (NPN). Each article focused on one aspect of the connection between microbial contamination and operational problems in fuel retail systems. In the 13-years that have lapsed since the publication of *Uncontrolled Microbes Eat Earnings*, our basic understanding of the issue hasn't changed, but the economics have.

Beginning with *Uncontrolled Microbes Eat Earnings* this month, and continuing with each of the other articles in the following months, Total Fuel Quality is pleased to present reprints of each of my NPN articles with my comments about what has changed since their original publication.

When I wrote *Uncontrolled Microbes Eat Earnings*, and the other five NPN articles in the series, my intention was to fix an information gap. On one hand, my library of fuel and fuel system microbiology contained several thousand research papers, some dating back more than 100 years since their publication. On the other hand, none of these articles had been published in journals or trade publications that were likely to ever be seen by petroleum marketers, maintenance engineers or quality assurance managers. *Uncontrolled Microbes Eat Earnings* provided a few very simple model of the economic losses caused by microbes in fuel systems.

Reflecting my field experience at the time, my illustration in *Uncontrolled Microbes Eat Earnings* focused on bulk storage tanks. That model was based on $0.50/gal gasoline. Multiply the numbers presented in *Uncontrolled Microbes Eat Earnings* by a factor of 2 to 4 to a sense of the current cost impact.

Now consider a comparable model for retail sites. Assume that at many urban gas stations customers line up waiting to buy fuel during peak periods. For this model we'll use 2-hours per day as the peak period. Some sites experience peak traffic for 4 to 6-hours. Assume the peak hours are only an issue during weekdays. Since it takes time to reposition cars and pay for purchases, fuel can only be dispensed approximately half-of the time (30 min/hour). IF a dispenser is delivering full-flow (10 gal/min) this translates to 300 gal/hour. Using these assumptions, let's compute the effect of a 10% flow-rate reduction on sales.

(1) 10% x 300 gal/h = 30 gal/h lost sales volume
(2) 52 weeks x 5 workdays/week x 2-hours/day = 520 peak-hours/year
(3) 30 gal/hour x 520 hours/year = 15,600 gal
(4) 15,600 gal/year x $3.00/gal = $46,800/year

Note: these numbers assume only a 10% flow-rate reduction. It's not uncommon to find >50% flow-rate loss during flow-rate checks at retail dispensers. Also, the economics summarized above are for a single dispenser. For retail sites with multiple dispensers at which customers line up to wait for fuel during peak hours, the $46,000/year figure needs to be multiplied by the number of dispensers. These are just the opportunity costs (product that could be sold if flow-rate was 10 gal/min).

Since 1994 my consulting work has focused increasingly on problems at fuel retail sites. Most often I help companies perform *Biodeterioration Risk Surveys* to help them identify current and potential problems caused by microbes (visit www.biodeterioration-control.com for a description of the *Biodeterioration Risk Survey*). Typically, my clients have had problems at one or two sites. Also typically, they are convinced that they are the only retailers in their region who are experiencing these problems. Consistently, we have found that sites rated as having a high biodeterioration risk score also have the highest corrective maintenance costs. Typically, annual corrective maintenance costs at high risk sites run $2,000 to $5,000 more than at low-risk sites.

Preventing these problems can cost as little as $1,000/year. Few investments provide this type of return. In a real sense, petroleum retailers cannot afford to ignore the cost of uncontrolled contamination.

Next month's reprint – *Knowing When You Have Contamination* – will review some very easy checks for microbial contamination.

Today, even more than in 1994, you don't have to be a microbiologist to detect and control microbial contamination in your fuel systems. As equipment and operational costs have climbed, so too has the return on investment for implementing a sound microbial contamination control program.

Uncontrolled Microbes Eat Earnings

■ Frederick Passman

Unless you've had a fuel filter become so slimed-up that you couldn't pump fuel, you're probably confident that you don't have microbial contamination in your fuel tanks. Chances are you're wrong. The annual impact of low-level microbial contamination in a single 100,000-bbl. fuel tank can reach \$500,000. Even at retail outlets, the cost impact ranges from \$1,500 to \$5,000.

Plugged filters is just one of the more obvious and irritating symptoms of microbes in your tanks.

Microbes, or bugs, use fuel as food, converting distillate fractions and additives into new chemicals. Only 2% to 5% of their food becomes new bugs (*biomass*), the rest becomes byproducts (*metabolites*). Metabolite molecules range from carbon dioxide to high molecular weight polymers—slime. Some metabolites act as surfactants, accelerating the rate at which water gets emulsified into fuel. Others facilitate hydrocarbon polymerization, contributing to sludge formation. Organic acids, produced as metabolites, make fuel and associated water bottoms corrosive.

Assumptions

Tank capacity:	100,000 bbl. (4,500,000 gal.)
Layer volume; if 1% of total:	45,000
No. times drained/yr.:	4
Total volume lost/yr.:	180,000
Cost, if fuel price is \$0.50:	4 drainings x 45,000 gal./ draining x \$0.50/gal = \$22,500

If instead of thinking of microbes as particles that plug filters, you imagine them as tiny machines that convert fuel into nonfuel products, you begin to understand how low-level contamination can be costly.

Examine a slime sample taken from the layer that forms between fuel and water, near tank bottoms. The proportion of the mass that is actual bugs in amazingly small (about 0.01%). How can so few microbes produce so much slime?

All cells contain molecules, called *enzymes*. The enzymes act like machines, cutting, reshaping and joining molecules. Each enzyme performs a very specific step in converting a hydrocarbon molecule into either new cell components or metabolites, depending on the size and structure of the molecule and the product.

Not all microbes have the same enzymes. Some microbes can use chemicals and create products that others can't. A community of several different types of bugs can do things individual members can't. It's like a factory—production depends on the collective skills of the workers. Bugs are the workers; enzymes are their machines.

Microbial contamination measurements aren't included in fuel specifications. Microbial tests, when run, use inadequate techniques, essentially unchanged since the 1940s. Consequently, microbial contamination problems are often misdiagnosed.

Fuel used by microbes to make new bugs and metabolites isn't marketable. This may account for 1% of your total annual volume handled. For a jobber distributing 30 million gal., that's potentially 300,000 gal./yr. of unmarketable fuel.

The maintenance cost impact may be even greater. The cloudy, invert-emulsion (water in fuel) layer forming just above the fuel-water boundary can account for 0.5% to 3% of your total tank volume. Microbial surfactants accelerate cloud layer formation and are responsible for 90% to 95% of the total layer. A 0.5- to 2-in. layer can develop within two to three months.

An example (assumptions at left) will illustrate an approach for estimating the cost-impact of cloud-layer formation.

Complying with federal and state hazardous waste-handling regulations means that drained water bottoms must be handled by a licensed waste hauler and treater. Microbes won't affect the volume of water bottoms, just the layer volume; therefore, add the \$180,000 cost of waste removal (or treatment) at \$1.00/gal. (regional charges range from \$0.50 to \$3.00/gal.). The total cost is \$202,500/yr. Since nonbiological dispersant-additives are responsible for 5% to 10% of the layer volume, we multiply the cost by 0.90 and 0.95 to get \$182,000 to \$192,000 annual costs from bug activity. Adding the annual cost of fuel (\$0.50/gal. x 300,000 gal. = \$150,000) gives a total impact of about \$400,000.

What is the cost impact of losing customers who don't return after they receive a load of substandard or contaminated fuel? Reducing contamination costs begins with recognizing and understanding the problem. The next step is the design and execution of a well-conceived monitoring and maintenance program. Biocides, chemicals designed to kill bugs, may be part of the solution, but unless selected and applied wisely, they only contribute to operational costs.

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