Technical Paper

Beckett Additives LLC was formed by R.W. Beckett Corporation to distribute UltraGuard™, a premium fuel additive.

FUEL OIL QUALITY: UNDERSTANDING THE SOURCE OF TODAY'S STABILITY PROBLEMS

Catalytic Cracking and Fuel Stability

Today's refineries produce higher yields, but the life of many stored fuels has dropped from years to months.

Oilheat service professionals with many years of experience remember a time when fuel seemed to last longer. Further, they claim, unscheduled service calls due to dirty filters and clogged nozzles and strainers were rare.

Increasingly, we're realizing that those memories are well grounded and that the more recent increase in fuel-related service calls can be traced to changes in the refining process.

The increased incidence of sludge in today's heating systems is a direct result of changes in the refining process.

Until the 1970's, most heating oil was produced using the traditional distillation process. This process yielded 60% light and middle distillates and 40% heavy products. The oil crisis of the 70's pressured refiners to look for ways to increase yields of middle distillates as a way of keeping their costs lower and the Clean Air Act of 1990 added

Prior to the 1970's, most heating oil was produced by a simple distillation process. This fuel sample is almost 35 years old and has produced virtually no sediment.

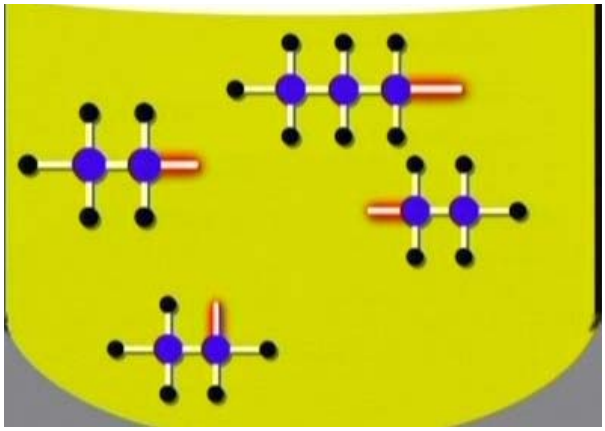
additional pressure by effectively reducing the value of heavier fuels. During this period refiners increasingly turned to catalytic cracking, a process by which long chain (heavy) oils are "cracked" into shorter chains. The result: increased yields of cleaner-burning fuels such as gasoline, kerosene and heating oil at lower costs.

But catalytic cracking has been a mixed blessing for fuel oil dealers. It increases the supply of fuel, helping to moderate prices. However, the artificially broken chains it produces are much less stable.

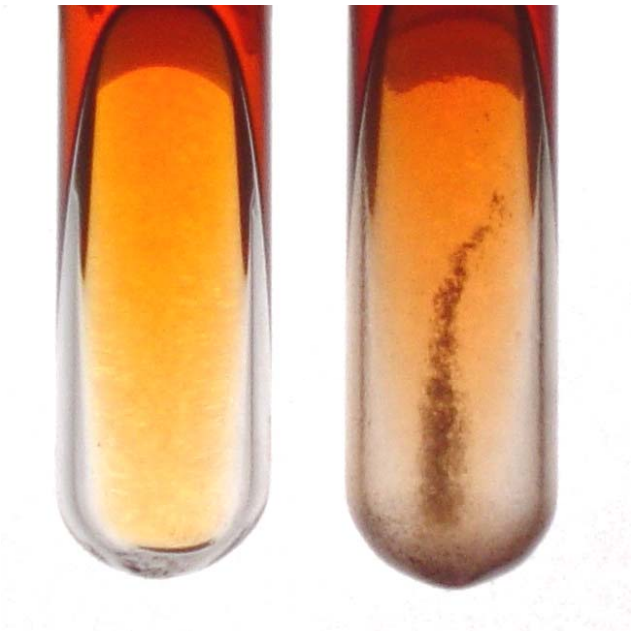
Repolymerization: A Word Every Fuel Oil Dealer Should Understand

During the catalytic cracking process long chain hydrocarbon molecules are broken into shorter chains which are refined into additional gasoline, kerosene and heating oil. However, unlike their

natural counterparts, the artificially cracked chains have “active ends” – bonds which have been broken and which are susceptible to recombining with other unstable molecules. When catalytically cracked fuel is stored, these molecules begin recombining, in a process known as **repolymerization**. The black particles that begin to form and settle in tanks or clog filters and system components are most often repolymerized chains that have joined with other chains – or “agglomerated” – into visible particles.

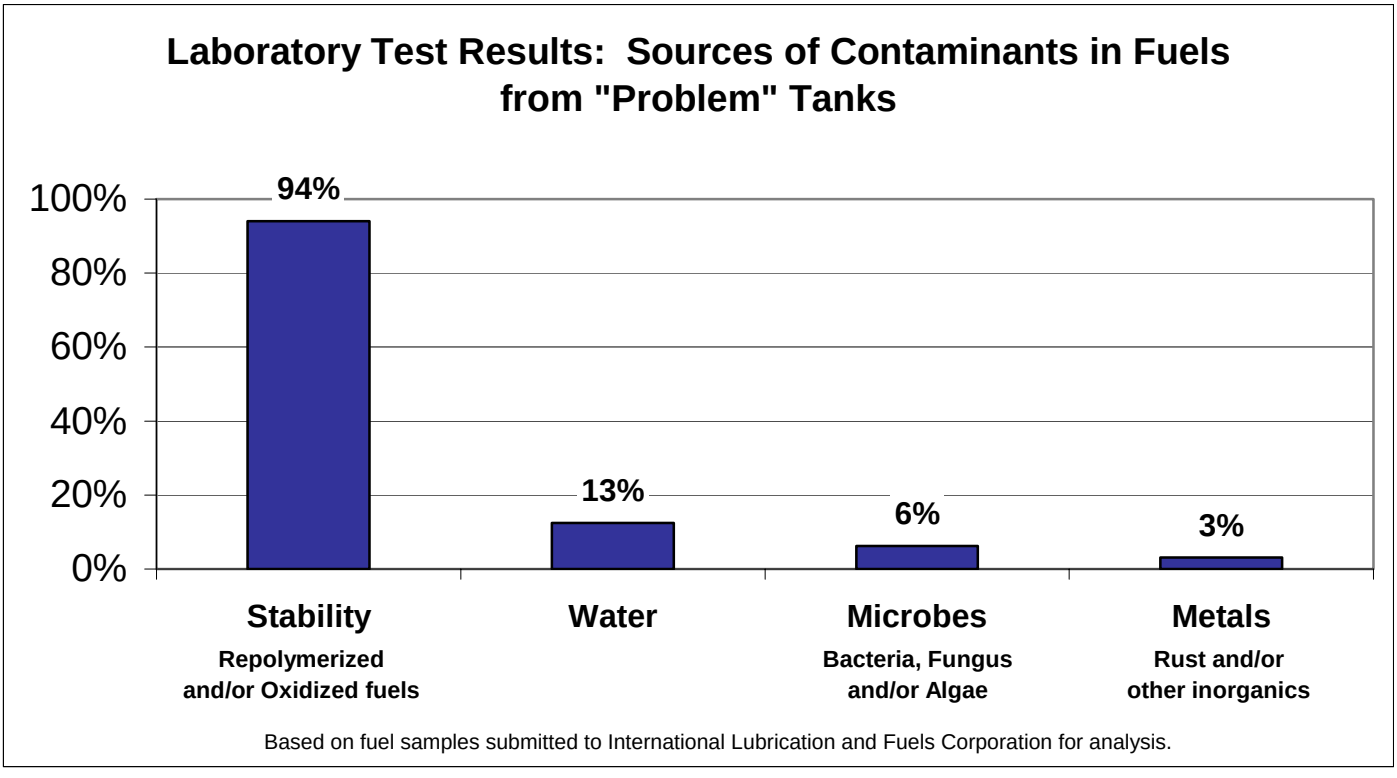


Active ends (shown in red) of artificially cracked hydrocarbon chains are the source of instability in today’s fuels. Over time, these ends recombine, forming long chain molecules (heavy oils) in stored fuel.



Although repolymerization begins at a sub-microscopic level, as long-chain hydrocarbons begin to re-form they agglomerate and form visible sediment. The sample on the right shows the result of this process. The sample on the left was treated with a stabilizer and dispersant to inhibit repolymerization.

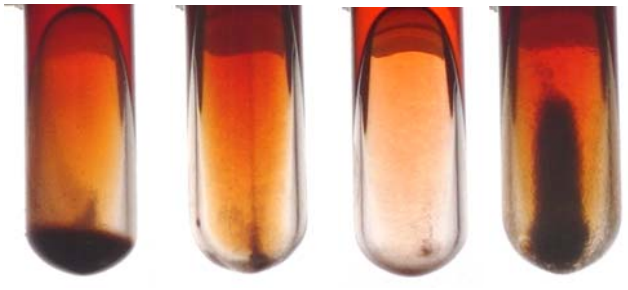
The extent of the problem is illustrated in the graph below. Water, biological contaminants and rust continue to create fuel storage problems. However, their impact has been dwarfed by problems created by repolymerization.



The One Constant: Variation

Beckett asked its field staff to send in fuel oil samples from customers' tanks around the country for testing.

Four examples are shown below.



These test tubes contain untreated fuel that was "aged" four months by a heating process. The samples, which were among many collected from around the county, show the variability in fuel stability.

One thing is certain. There is a great deal of variety in the susceptibility of fuel to sediment formation.

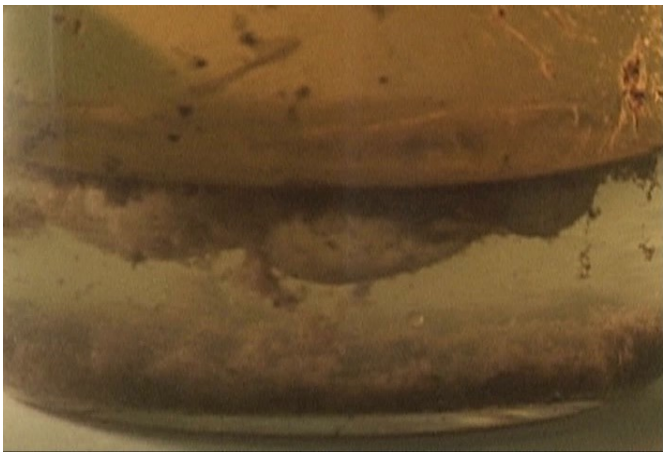
Unfortunately, we know that much of today's catalytically cracked fuel breaks down quickly unless it is treated. However, some fuels seem to have a head start. Studies show that "barged" fuel causes more service problems than pipeline fuel. Based on Beckett Additive's customers' results, we also strongly suspect that periodically "bad batches" are introduced into the fuel stream. However, by the time clogged system components prompt a service call, the fuel has passed through the system making it difficult to trace the problem to its source.

And Old Problems Still Exist

Although repolymerization is by far the most significant threat to stored fuel, other more traditional problems remain.

Oxidation. When exposed to air or water, fuel combines with oxygen. In many cases, the result is harmless darkening in color. However, oxidation can also result in sediment formation. Many older fuel stability tests still use oxidation as a key indicator. Make certain you understand the capability of any lab you use for fuel testing.

Bacteria and Fungus. Biological contaminants can grow in fuels, particularly if water is present. However, bacterial or fungal contamination as a primary cause of operational problems is much rarer than commonly believed.



Bacterial, fungal or algae growth can occur in stored heating oil. However, service problems due to microbial contaminants are much less common than are those resulting from repolymerized fuels.

Water & Rust. Water and bacteria combine to form another type of problem for the oilheat industry – tank rust. Water supports the growth of biological agents. The biological agents, in turn, increase the ionization of the water, making it more corrosive to tanks. This phenomenon is known as microbially induced corrosion (MIC).

An Industry Priority

A survey conducted at the 2004 NAOSHM trade show prompted responses from 119 service professionals:

"What percentage of your unscheduled service calls are caused by fuel related problems (clogged filters, nozzles and strainers)?"

Average answer: **46.4%**

In other words almost half of unscheduled service calls – which typically come in during the busiest time of year – are the result of unstable fuels.

NORA has identified fuel quality as a major priority, one of the single greatest contributors to operational failures.

Repolymerization and New Fuels: Biofuels and Low-Sulfur

Extensive testing has not been completed on the stability of either biofuels or low-sulfur heating oil. However B-5, the likely standard for biofuels in the near-term contains only 5% biofuel and 95% of today's catalytically cracked petroleum-based fuel. Its stability characteristics are unlikely to be different than those of today's fuels.

Low-sulfur fuels hold a great deal of promise to keep heating system cleaner downstream of the nozzle (heating chamber to flue pipe). Brookhaven National Laboratory published impressive photos showing that low sulfur fuel reduces corrosion in heating chambers. This should lengthen service intervals and reduce service time when service is performed.

However, questions remain about low-sulfur fuels' stability in storage and consequently it's impact on system components "upstream" of the nozzle. Low sulfur fuels will continue to be catalytically cracked, as they are today and ultra-low sulfur fuels may be more susceptible to breakdown due to the formation of peroxides. However, part of the process that removes sulfur includes the introduction of hydrogen to the fuel and it may improve the fuel's stability.

In other words, more research needs to be done.

Chemical Additives

Today's additive packages provide the best solution to problems created by fuel stability. In fact, most fuel-related problems have been eliminated by dealers who use premium additive packages along with proper tank maintenance and filtration practices.

The following list of terms should help you evaluate additive products.

Solvents Solvents are in many fuel additives as carriers for other chemicals or as the primary active ingredient. They break up sludge, but generally do so too rapidly, creating a rash of service problems when they are first used. Fuel oil dealers are advised to avoid solvent based additives.

Stabilizers Stabilizers reduce the formation of insolubles due to oxidation and sometimes repolymerization.

Dispersants Dispersants do not allow particulate to agglomerate and they separate existing agglomerated particles. They do this chemically and are consumed by the process.

Antioxidants Antioxidants slow the oxidation process that leads to some sediment formation.

Biocides Biocides dissolve in either the fuel or water or both and kill bacteria and fungus.

Rust inhibitors Rust inhibitors slow the process that ends in rust by forming films or by chemically neutralizing one of the rust forming chemical mechanisms.

Demulsifiers Demulsifiers change the surface tension of the fuel and/or water causing a clear separation of water and fuel.

Cold-flow improvers Products that reduce gelling and keep oil flowing when cold meet a tremendous need in the oil heating industry. However, they are an entirely separate class of products from additives that prevent sludge formation. Cold-flow improvers do not extend the storage life of fuel.

Beckett Additives

Beckett Additives, LLC offers a premium additive package that offers net cost reductions in the first year of use. For more information, call us at 1-866-645-2873 or visit our website at www.beckettadditives.com.