

Ultrasound Cracks

By implementing ultrasound in its oil desulfurization technology, SulphCo not only speeds up and cheapens

By Carrie Ellis

If you were to search amongst the heaps of precariously piled paperwork in the farthest depths of your desk, you might come across your company's corporate mission statement. If it's like most, it would ultimately make mention of the word *value*. Ironically, however, it's difficult to put much stock in this term because it's inherently abstract. So, when you think value in terms of petroleum processing, what comes to mind?

Although I can't be sure what it means to just anyone, I can tell you what it signifies to SulphCo; the company personifies it with not only its equipment, but also service. In the fundamental beginning, this startup's goals were to develop and commercialize its patented (and proprietary) Sonocracking™ oil-processing technology, a newer oxidative desulfurization (ODS) form.

Sonocracking™ is unique in that it has the ability to extract more value out of a barrel of oil in a cost-effective manner. Yet, this particular type of ODS not only reduces oil sulfur levels, but it also has been shown to perform well in reacting with some of the most difficult types of sulfur compounds found in crude oil and petroleum streams. Current desulfurization processes like catalytic hydrotreating (hydrodesulfurization or HDS) typically can only treat these compounds under costly and severe condi-



tions leading to adverse energy consumption and an increased carbon footprint.

Luckily, Sonocracking™ has been launched just in time for oil processors who are trying to circumvent economic stresses spurred on by the recession. Now more than ever, processing companies need to be on the lookout for new avenues to extract greater value from each barrel. Alongside of augmenting product value, Sonocracking™ also decreases capital costs—a value-added benefit in and of itself.

Sonocracking™ ultimately also assists oil processors in realizing greater returns on investment, but also conforming product to increasingly stringent ultra-low sulfur diesel (ULSD) regulatory demands, which are calling for virtually sulfur-free motor fuels. European Union, Japan and U.S. standards currently stand anywhere from 10 to 15 parts per million with countless countries promising to follow suit. These regulations will undoubtedly tighten as the push to go green gains even more global traction.

Since its inception in 2001 SulphCo's mission has been to add value to crude oil and its distillate streams based on catalyzing chemical reactions with Sonocracking™ ultrasonic technology. It is specifically defined as the application of sonochemistry (which is described as driving and accelerating chemical reactions through application of ultrasonic energy) to petroleum-based liquids, coupling ultrasound with proprietary catalysts and oxidants.

SulphCo Chief Technology Officer Florian Schattenmann, Ph.D., admits, "Under previous management, the company was originally located in Reno, Nevada. It doesn't take a visionary to realize that Houston is the oil capital of the United States." And with that, the company settled in Texas, a place it could cozy up close with bona fide oil-processing prospects. Despite its strategic location, however, SulphCo has managed to garner global appeal, having already installed several commercial-scale test desulfurization units at customer sites around the world.

ODS Vs. HDS

Sonocracking™ provides a commercially available, cost-competitive and environmentally conscious oil desulfurization alternative to the established and prevalently implemented hydrotreating (HDS) process. A quick comparison is in order to highlight the major disparity between Sonocracking™ ODS and HDS technologies:

- ODS uses oxidants (such as aqueous hydrogen peroxide) as a reaction catalyst rather than HDS' hydrogen, which is continually facing rising costs and typically demands a proximal hydrogen-production plant.
- ODS extracts sulfur-containing hydrocarbon fractions from feedstock, as opposed to converting them into hydrogen sulfide as HDS does.
- ODS processing occurs near atmospheric pressures and at relatively mild temperatures when compared to HDS.
- ODS incurs substantially lower capital costs, as well as avoids the catalyst costs that processes like HDS can't.
- ODS consumes less energy and releases less greenhouse gas emissions than HDS, thus reducing carbon footprints.
- Sonocracking™ ODS speeds up the chemical reaction necessary to milliseconds, thus improving turnaround times.
- ODS improves oil density, viscosity and American Petroleum Institute gravity (petroleum heaviness as compared to water), while HDS doesn't make the same claim.

Down To Up Value

process, but also delivers an overall more valuable product that complies with ULSD standards.

Sono-Cracking The Technology

Sonocracking™ is accomplished by the feeding of crude oil and its distillate streams through several desulfurization units boasting commercial capacities of 15,000 barrels per day (BPDs). Whereas a single unit can process 5,000 BPDs, the company usually hauls three units integrated as one to field sites to sustain typical batch sizes. Shockingly, for equipment that appears to lend itself to large efficiency gains, this unit is only about the size of an average trailer.

This simplicity of size, however, translates into ready availability. Schattenmann points out how convenient it is to just get up and go upon arrival: “We already have our connections. We just need an oil line here and a couple hydrogen peroxide lines there ... To get it all hooked up, it takes us maybe half a day.”

In an effort to quantify a few of the company’s mobility options, excluding units also available in eastern Europe and Asia, Schattenmann says, “We can cover North America with our two moveable skids and we have another 15,000-BPD unit in storage. In addition to another 15,000 BPD unit in Europe, we also have a massive facility in Fujairah [United Arab Emirates] that has an almost 90,000-BPD capability. If anything interesting crops up, this equipment can either be put to work quickly, or disassembled and shipped somewhere relatively quickly. Between these options, we can always respond” to customers—wherever they may be.

Although evolving since the company’s inception, the premise of Sonocracking™ was based on work done by Professor Yen, a University of Southern California chemical engineer. “As is typical of a company in the development phase, as we learn and gather more results, we change course.” Schattenmann asserts, “The focus now is upgrading and desulfurizing oil and especially distillate streams, which is accomplished by combining the merits of ultrasound and its reactivity-enhancing potential with oxidation chemistry.”

SulphCo’s process is based upon the manipulation of ultrasound—or application of high-energy, high-frequency sound waves—to alter the molecular structure of crude oil in an effort to upgrade its quality by reducing sulfur. The ultrasound helps induce cavitation in a water/oil stream, which when combined with proprietary additives, allows chemical reactions to occur.

As cavitation bubbles grow, they become unstable and collapse from the negative pressure of sound wave fronts in the liquid. The implosion then generates excess heat and pressure in and around every nanometer-sized bubble, resulting in intense shear and mixing, as well as high localized temperatures and pressures. This combination permits the reactions to transpire within milliseconds, yet at relatively low temperatures and pressures.

What are some benefits specific to ultrasonic ODS? First and foremost, it’s all about easing sulfur separation from petroleum, which can be carried out by modifying the molecular structure of

the oil’s sulfur species to attain higher boiling points in the sulfur compounds. By also increasing energy within the cavitation zone, ultrasound can create more molecular surface area, so there are more opportunities for molecules to rapidly react. Although they’d eventually react without ultrasound, it’d happen much slower.

“I had to explain this technology to investors who had only financial backgrounds, so I used a dating site anecdote (which somehow rang a bell). If people don’t meet, they can’t proceed with a relationship, or in other words, react.” Ultrasound provides that extra opportunity for introductions to the molecules in question by adding surface area and mass transport to the mixture, thus literally enabling the chemistry.

Schattenmann additionally explains, “The hydrogen peroxide introduced during the process track exactly with the sulfur amounts in the oil. As a result, the solution can be cost-effective in terms of operations and capital equipment. The probes, modest utilities, some additives, that’s it ... We can help some refineries run more efficiently” with just these things.

A Package Deal

“Our current procedure is to contact a potential customer in order to introduce our technology and to obtain crude oil or petroleum samples from their facility,” Schattenmann says.

“Then at first, we screen a small volume of these samples in our lab, recording different catalysts and behaviors under changing conditions. Once we see something promising, we transfer the petroleum to a continuous-process flow-through unit in which we can better mimic reality than batch screening. If it runs well and is reproducible, we process the oil in our pilot unit.” Though typically, if the company can transfer the samples directly from a continuous-process to commercial unit, it will.

As a company, SulphCo determines success by evaluating total sulfur content in the oil before and after processing. The Sonocracking™-processed



Shockingly, for a technology that appears to lend itself to large efficiency gains, this commercial-capacity Sono-Cracking oil desulfurization unit is only about the size of an average trailer, making it extremely easy to transport.

oil is put through a unique gas chromatograph that separates various sulfur compounds by boiling points, to which Schattenmann boasts, "We immediately see sulfur compound distributions." Then the company runs through the same procedure, but with ultrasound; if the oil's molecular structure is altered, the chromatograph results certainly reflect it, while offering extra details.

As it currently stands, SulphCo strictly runs all field trials at customer sites as the process can become complicated. The company, however, is working closely with subcontractors to ensure that when training becomes available, "It's as self-explanatory as turning on a PC," Schattenmann says. The company now has a working prototype (with an interface and touch-screen), but while the technology is available, it has yet to be implemented.

Sonocracking™ Sweetens In Comparison

"Oils and its distillate streams have been desulfurized for a long time. While hydrotreating has been practiced and even improved over many years, there are still drawbacks." Schattenmann warns, "First, you need a very big plant—a multi-hundred million dollar plant, which by comparison, makes our capital equipment cheap. Secondly, HDS requires hydrogen, which often must be generated or purchased, and consumes natural gas," thereby hurting your carbon footprint.

The value that SulphCo's Sonocracking™ process can grant oil-processing plants varies from application to application. "In some applications the value difference between the higher and the lower sulfur version of a given oil tracks with the price of crude oil. In contrast, when going into gas stations, you'd notice that gas prices have generally fallen, yet diesel prices remain relatively high: It's because desulfurization regulation is tight. Whereas HDS can be expensive, you can't be out of spec or you're breaking the law." In other words, you automatically inherit desulfurization costs when taking on petroleum-processing responsibilities, and must face



SulphCo says that the continuous flow-through unit pictured above can mimic the Sonocracking™ process more realistically than its initial oil sample batch testing equipment.

regulatory standards as they pummel the pipeline.

"Additionally, hydrotreating doesn't perform equally well with all sulfur compounds. Some react easily, some don't." Schattenmann continues, "In fact, 80 percent of the hydrogen power expended is used to hydrotreat the last 10 percent of sulfur compounds. Most of those compounds that HDS has a hard time converting to hydrogen sulfide are substituted thiophenes. It just so happens that these compounds react well in SulphCo's process.

"Some times it would even make sense to position our Sonocracking™ technology behind an HDS plant, if only to treat the most difficult sulfur requiring all that capacity," Schattenmann says. Furthermore, SulphCo's equipment and service offering grants refineries that may lack the scale to invest in hydrotreating. However, the benefits don't necessarily stop here; the company believes that many applications remain unresearched, undiscovered and untapped.

"Our previous management implied that the Sonocracking™ process is a one-size-fits-all solution, and it's not. It's a chemis-


"80 percent of the hydrogen power expended during HDS is used to hydrotreat the leftover 10 percent" of processed oil that HDS doesn't easily refine. Sonocracking™ processes even the most difficult sulfur in the first run.

— SulphCo Chief Technology Officer Florian Schattenmann, Ph.D.

try process that's very application-specific and requires testing," insists Schattenmann. Therefore, potential customers must evaluate analysis results based on their own notions of value and what the ultrasonic technology can do, whether it be improved product quality, ULSD regulatory compliance, cost savings, etc.

In the beginning, the company faltered as it aimed to focus: For four or five years, the company worked on a couple different aspects of the technology, but there were not a whole lot of results, field trials or measurements. Change, however, came January 2007 in the form of current CEO Larry Ryan. Since then, the entire management team has been replaced, while adding Schattenmann, who says, "That's when the company asked itself, 'How can we scale this business up to make a process?'"

"Normally you get an end-result on a small scale, then you start to understand it, and once you understand it, you scale up and move on. That's where we are. Based on key results, we are now trying to make Sonocracking™ happen on a larger scale with more commercially interesting rates."

There is no doubt that now is a time that petroleum processors can't afford not to squeeze every drop out of their process—especially if SulphCo's sulfur compound analysis can validate a profitable cost-benefit analysis. Why not let Sonocracking™ ultrasonic technology crack down on inefficiencies in your facility, while simultaneously upping your product value, decreasing costs and allowing for compliance? It could be a *sound* decision if you know what the company means ... 

For more information, please e-mail requestinfo@sulphco.com or visit www.sulphco.com.