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As seen in the March 2009 issue of E&P

# Ultrasound applied to crude oil desulfurization

*An innovative method for upgrading crude oils will find application across multiple industry sectors.*

Following field trials completed late in 2008, Houston-based SulphCo, Inc. reported it has successfully used a 5,000 b/d mobile "Sonocracking" unit to duplicate on a commercial scale its proprietary process that applies high-energy, high-frequency sound waves, so-called ultrasonics, in conjunction with oxidation chemistry to improve the quality of crude oil and crude oil fractions.

Dr. Florian Schattenmann, SulphCo chief technology officer, said use of high-powered ultrasound can significantly accelerate the sulfur compound oxidation needed to upgrade crude oils and petroleum products into sweeter (i.e., containing less sulfur) crudes and products (e.g., diesel), potentially eliminating or reducing the need for hydrotreating.

The technology works by taking the sulfur, chemically bound to some of the molecules in the oil, and oxidizing it using hydrogen peroxide — a classic oxidant — together with the ultrasound. On a molecular level, the hydrogen peroxide donates one of its two oxygen atoms to the sulfur to form water as the byproduct. The treated oil typically has less sulfur, lower viscosity, and a higher API gravity. In addition, remaining sulfur is thereby converted to a different sulfur species that can be more easily separated.

In operation, the oil, hydrogen peroxide solution, and catalyst are introduced into a reactor, where very intense mixing happens in the cavitation zone generated by the ultrasound. The reaction takes place in half a second or less. The water and oil separate, with the water subsequently being recycled and new hydrogen peroxide added to offset that used in what is "more or less" a closed-loop system.

Applications of SulphCo's Sonocracking technology are currently being evaluated, the company said, in oil production, transportation, and refining. One reason to assume that multiple uses will be found is that an increasing proportion of the overall market consists of medium, heavy, or sour crudes. In addition, current and expected future industry regulatory requirements will exert pressure to move towards lower sulfur content in most petroleum products.

The traditional method for removing sulfur from oil involves hydrotreating, entailing capital-intensive investments in high-pressure, high-temperature hydro-desulfurization (HDS) units as well as boilers, hydrogen plants, and sulfur recovery units. The deeper the desulfurization required, or the heavier or more sour the crude used for feed, the more expense involved.

At the moment, Schattenmann said, the primary market focus for SulphCo's technology is the downstream sector of the oil industry, but upstream and midstream applications are already envisioned. "If you can reduce the sulfur content of oil before it goes into the separator or pipeline, there are many benefits. For example, you may be able to meet pipeline specifications without having to add more expensive oil blends to your stream. The upstream and mid-stream guys get really excited at the prospect of having this kind of a simple solution to increase value."

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While the base design and capacity for the technology consists of a 5,000 b/d processing line, successive lines can be added to scale capacity. SulphCo has implemented skid-mounted modular Sonocracking units with 15,000 b/d capacity and currently has 210,000 b/d of capacity constructed.

The cavitation induced as oil and additives stream through the reactor and past the ultrasonic probe leads to the creation of bubbles at the sites of refraction owing to the "tearing" of the liquid caused by the negative pressure of the intense sound waves. The bubbles then oscillate under the effect of positive pressure, growing to an unstable size as the wave fronts pass. The bubbles eventually burst, generating excess heat and pressure in and around every micrometer- and sub micrometer-sized bubble. This happens in a matter of "nanoseconds," Schattenmann said, and each bubble behaves as a micro-reactor, accelerating the chemical reaction described earlier owing to the heat released and localized pressures obtained.

Subsequent to the completion of the commercial-scale field trials in late 2008, Dr. Larry D. Ryan, SulphCo CEO, said, "Additional technical iterations and analysis will continue as we identify, execute, and evaluate the multiple processes necessary to comply with future customer requirements." E&P