

CRUDE OIL DESULFURIZATION

Industrial Sonomechanics, LLC ([ISM](#)), offers high-amplitude [ultrasonic processors](#) for the oxidative desulfurization of crude oil. The processors are based on ISM's [patented](#) Barbell Horn Ultrasonic Technology ([BHUT](#)), which makes it possible to tremendously intensify [ultrasound-assisted](#) oxidative desulfurization and guarantees reproducible and predictable results at any scale of operation.



BACKGROUND

Crude oil contains sulfur in the form of sulfides, thiols, thiophenes, substituted benzo- and dibenzothiophenes, benzonaphthothiophene, etc. Extensive desulfurization is required in order to comply with current environmental regulations, such as the ultra-low sulfur diesel (ULSD, 15 ppm sulfur) specification. Ultrasound-assisted oxidative desulfurization (UAOD) has been developed as an alternative technology to the traditional hydrotreating, which suffers from significant costs associated with high-pressure, high-temperature hydrodesulfurization equipment, boilers, hydrogen plants, and sulfur recovery units. Ultrasound-assisted oxidative desulfurization permits carrying out the process under much milder conditions, faster, safer and much more economically.

The oxidative desulfurization of crude oil is commonly done by mixing it with an oxidant, a catalyst and a phase-transfer agent (e.g. hydrogen peroxide solution in water, formic and/or acetic acid, quaternary ammonium). During the process, sulfur-containing compounds in crude oil are converted to polar sulfur oxides and sulfones, which are subsequently removed via selective adsorption or extraction. However, since all added reagents are water-based, they do not readily mix with the crude oil and must be emulsified. The reaction is mass transfer-limited and its rate strongly depends on the mixing efficiency and the resulting size of the contact surface area between the water and the oil phases.

ULTRASOUND-ASSISTED OXIDATIVE DESULFURIZATION

Ultrasound-assisted oxidative desulfurization is a very attractive alternative to the traditional hydrodesulfurization technology. Exposing liquids to high-intensity ultrasound greatly promotes mass transfer-limited reactions and surface chemistry of catalysts. Ultrasound creates acoustic cavitation, which produces violently imploding vacuum bubbles, causing shock waves, micro-jets and strong shear forces as well as extreme local temperatures (~5,000 K) and pressures (~1,000 atm). These extreme conditions result in exceptionally efficient mixing, yielding nanoemulsions with very small droplet sizes and enormous contact areas between all components. The oxidative desulfurization of crude oil is, therefore, considerably accelerated by exposure to high-intensity ultrasound.

THE IMPORTANCE OF HIGH ULTRASONIC AMPLITUDES

Ultrasonic intensification of commercial-scale oxidative desulfurization of crude oil requires the use of an industrial-size flow-through ultrasonic processor able to maintain high vibration amplitudes of about 80 - 100 microns. The amplitudes directly relate to the intensity of ultrasonic cavitation-generated shear forces and must be maintained at a sufficiently high level for the mixing to be efficient. Similar amplitudes are required for the production of high-quality [nanoemulsions](#) – a process which is a prerequisite for mass transfer-limited reactions.



Why ISM's Ultrasonic Technology?

ISM has significant experience in the development of continuous-flow ultrasonic liquid processors for the oxidative desulfurization of crude oil. In the past, ISM served as a consultant and equipment provider to Sulphco, Inc. – a former Houston-based company, which employed the ultrasound technology to desulfurize and hydrogenate crude oil and other oil-related products, upgrading sour heavy crude oils into sweeter, lighter crudes and producing more gallons of usable oil per barrel. During this project, commercial ultrasonic processors have been designed and implemented for the treatment of large volumes of petroleum products using relatively low temperatures and pressures, and without phase-transfer catalyst.

ISM is the only company that currently offers **high-amplitude** industrial-scale ultrasonic processors. The processors use our proprietary Barbell Horn Ultrasonic Technology ([BHUT](#)), which permits increasing the sizes of ultrasonic horns without sacrificing the amplitudes they provide. Bench-scale ([BSP-1200](#)) and Industrial-scale ([ISP-3000](#)) processors are available, both of which are designed to maintain high ultrasonic vibration amplitudes and can be configured for continuous (24/7) operation under production floor conditions.

HAVE QUESTIONS?

Request a free initial consultation
with a process specialist

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