APPLICATION REPORT

EMULSION FUELS

INDUSTRIAL SONOMECHANICS®

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Emulsion Fuels

Industrial Sonomechanics, LLC (ISM), offers high-amplitude ultrasonic processors for the production of water-in-fuel emulsions. The processors are based on ISM's patented Barbell Horn© Ultrasonic Technology (BHUT), which makes it possible to tremendously intensify the ultrasound-assisted production of nanoemulsions and guarantees reproducible and predictable results at any scale of operation.

Background

Combustion equipment, such as diesel engines and power boilers, emits significant amounts of hazardous gasses, such as Nitrous Oxides (NOx), hydrocarbons (HC), carbon monoxide (CO), carbon dioxide (CO2) as well as particulate matter (PM) and black smoke. Due to the widespread use of this equipment, the resulting damage to human health and the environment is tremendous. Adding 5 – 25% of water to the base fuel, such as diesel or kerosene, in the form of a very fine emulsion (nanoemulsion), significantly reduces these harmful emissions. Water-in-diesel emulsion is one of the most attractive petroleum-based alternative fuels. It can be used in unmodified diesel engines and has been shown to reduce the NOx emission by up to 35% because water reduces the local adiabatic flame temperature. In addition, PM is reduced by up to 60% and black smoke commonly associated with the use of straight diesel is dramatically reduced because the emulsion fuel burns much more completely.

There is also an immediate economic benefit to using emulsion fuels. The addition of finely dispersed water reduces fuel consumption by improving its atomization and burning efficiency. Since water has a much lower boiling temperature than the fuel, it is vaporized much more readily upon heating. At the "superheat limit temperature" of about 270 C, micro-explosions of the fine water droplets occur throughout the emulsified fuel. This enhances atomization and leads to better mixing of fuel and air in the engine. The presence of a large low-tension water-oil interface improves the atomization further. Therefore, although water replaces part of the fuel, the loss in energy content is mostly compensated by the increase in the remaining fuel's combustion efficiency. The net result is a significant fuel cost reduction, which commonly exceeds any emulsion manufacture expenses.

Ultrasonic Production of Emulsion Fuels

High-amplitude ultrasound is known to be a very effective method for the manufacture of nanoemulsions. The intense shear forces necessary for the production of water-in-fuel nanoemulsions are generated by high-amplitude ultrasound through the associated effect of acoustic cavitation, which creates violently and asymmetrically imploding bubbles and causes micro-jets that impinge one liquid into the other in the form of nano-droplets. The finer the water dispersion, the smaller the amount commonly needed for good results. Smaller water droplets also result is higher emulsion stability. The choice of surfactants is critical: they must permit the formation of nanometer-sized water droplets (below about 200 nm in diameter), be sulfur and nitrogen-free, and burn readily and completely. ISM offers laboratory, bench and industrial-scale ultrasonic

homogenizers featuring extremely high ultrasonic amplitudes, and has the necessary expertise to provide consulting services on the optimization of surfactant formulations for different types of emulsion fuels.

Why ISM's Ultrasonic Technology?

It has been extensively demonstrated in the literature that high ultrasonic amplitudes of at least 80 microns are required for efficient droplet size reduction. The amplitudes directly relate to the intensity of ultrasonic cavitation-generated shear forces and must be maintained at a sufficiently high level for the emulsification to be efficient.

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-3600) 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.

Consult with a product specialist or request a quotation.

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