APPLICATION REPORT

LIQUID DEGASSING & DEAERATION

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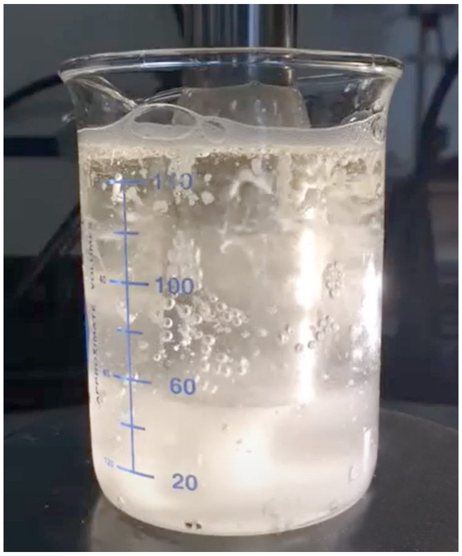
Liquid Degassing & Deaeration



Background

Ultrasonic degassing (deaeration, in the case of air) is an efficient method of removing dissolved gasses and/or entrained gas bubbles from a variety of liquids, including water, candle waxes, aluminum alloy melts, epoxies, silicone oils, adhesives, coating solutions, beverages, polymers, inks, paints, transformer oils, emulsion and suspension products, motor oils and many more. Unlike vacuum degassing, which is a batch approach, ultrasonic degassing can be done in a continuous-flow mode.

Ultrasonic Removal of Dissolved Gasses

Ultrasonic waves propagating from an acoustic emitter (e.g., ultrasonic horn) into a liquid medium produce alternating positive and negative pressure phases. During the negative-pressure (rarefaction) phase, the ultrasonic waves with sufficiently high intensity can overcome intermolecular adhesion forces and create a large number of near-vacuum microbubbles in the liquid. In the absence of dissolved gasses, the pressure in the bubbles remains low, as they contain only small amounts of vapor from the liquid medium. The bubbles briefly pulsate and then catastrophically collapse during one of the following positive-pressure (compression) phases, producing hydraulic shock waves and releasing large amounts of energy - an effect called “vaporous acoustic cavitation”. In the presence of dissolved gasses, however, the low pressure in the near-vacuum bubbles forces the gasses to diffuse into the bubbles, which prevents the collapse and leads to bubble oscillation - an effect called “gaseous acoustic cavitation”. During the oscillation, each bubble’s surface/volume ratio is greater as the bubble expands than as it contracts (the surface of the expanded bubble is much higher than that of the compressed bubble). As a result, the bubble draws more gas into its interior during its expansion then it lets out during its contraction and, therefore, quickly increases in size. This process is called “directed” or “rectified” diffusion. Since during gaseous acoustic cavitation the bubbles are well distributed in the liquid and have a high total surface area, the migration of the dissolved gasses into them is fast and homogeneous throughout the affected liquid volume. The result is the formation of a large number of oscillating bubbles containing the gasses that were previously dissolved in the liquid medium. As they are formed, the bubbles coalesce and are continuously removed from the liquid via the mechanism described below.

Ultrasonic Removal of Suspended Gas Bubbles

More than a century ago C. A. Bjerknes and his son, V. F. K. Bjerknes, discovered an interesting hydrodynamic effect: two bodies pulsating with the same phase in a fluid experience an attraction force. Due to this “secondary Bjerknes force”, gas bubbles pulsating in an ultrasonic field accelerate towards each other and coalesce, forming larger bubbles. This process quickly progresses until the bubbles reach the sizes with sufficient buoyancy to rise out on the liquid and release the previously entrapped gasses to the environment. Acoustic streaming (a steady current of fluid driven by high amplitude ultrasound, directed away from the acoustic emitter) can be used to assist the rising of the bubbles, which is especially helpful for the degassing of high-viscosity liquids.

Continuous Processing Configuration

In a production environment, the **degassing/deaeration** process is most commonly carried out continuously, which makes it possible to treat large volumes of liquid and ensure reliable and uniform results. The most common arrangement for this process is presented in the schematic on the left. The liquid is drawn from the bottom of the storage tank and pumped through the ultrasonic reactor chamber/ Barbell Horn® assembly, where ultrasonic cavitation continuously transfers any dissolved gasses and/or suspended micro-bubbles into large bubbles with high buoyancy. The large bubbles are then carried with the flow of the liquid either back to the same storage tank (recirculating configuration) or to another tank (single-pass configuration), where the bubbles can surface and release the gasses to the environment. If the recirculating configuration is used, care must be taken not to draw any of the large bubbles back into the line. Special tank features may be incorporated, such as a barrier with a narrow gap at the bottom positioned between the inlet and the outlet, a sealed lid with a vacuum connection, a surface at the inlet to force the breaking of the bubbles, etc.

ISM is currently the only company that 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.

Consult with a product specialist or request a quotation.

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