How do ultrasonics work?

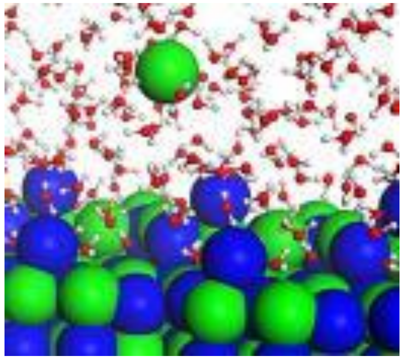
A Guide Ultrasonic Cleaning

The employment of ultrasonic agitation in both aqueous and solvent cleaning systems is a well established principle. Some users may wish to understand how the effect is produced and how it can aid and speed up the cleaning process.

Cleaning Principles

The cleaning of any component is achieved by a combination of 2 processes:

- The dissolution of soluble contaminants into the liquid.
- The detachment and suspension of non-soluble particulates.



Dissolution in a Liquid

In a standard, static immersion system, this process is slowed, or even halted, by the following:

- The solvent at the material/contaminant/liquid interface becomes saturated and forms a barrier
- Non-soluble particulates remain on the surface by means of ionic or low cohesive forces, preventing any further reaction.

Applying ultrasonics imparts energy, evenly throughout the tank and to all the surfaces, external and internal, of any component immersed in the liquid, in effect, a “scrubbing brush.” This loosens the insoluble particles, exchanges the surface chemistry and rapidly accelerates the entire cleaning process.

Theory

The liquid, whether aqueous or solvent based, is a non elastic medium. The ultrasonic emitter sends a series of waves producing alternate high and low pressure areas. Where a low pressure state exists, the liquid shears and produces a microscopic vacuum bubble which grows over nanno-seconds. When the subsequent high pressure wave arrives, the bubble implodes releasing a substantial amount of energy.

Formation, growth & Implosion of

Ultrasonically induced micro-bubbles

It is this energy, applied to the solid/liquid interface which accelerates both cleaning processes.

Method

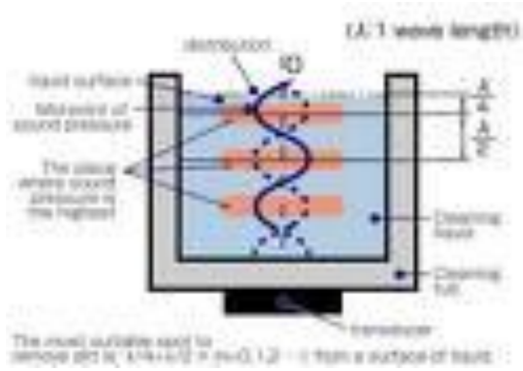
Generator & Immersible Set

High frequency, alternating electrical energy is produced in a generator, usually by means of a Gallium Arsenide chip, similar to a Silicon chip. This is fed, through wires, to a series of piezo-electric crystal which convert the electrical signal to a mechanical force at the same frequency. The crystals are assembled into emitters which are fixed to the base or wall of the tank. This induces the energy waves in the tank liquid.

For more information

www.laytontechnologies.com

Tel +44 (0) 1782 370400



Design & Operating Considerations

Frequency

Lower frequencies generate fewer but larger micro-bubbles which produces a coarser “scrubbing” action than higher frequencies (more, smaller bubbles). A typical frequency for general cleaning is 40kHz but alternate systems are available at lower and much higher frequencies. Smaller bubbles are preferred where gentle action or fine bores are a consideration.

Intensity

There must be sufficient energy induced in the liquid for the process to be effective. There is a direct correlation between the energy (watts) and volume of the tank (litres) whilst considering the nature of the solvent and material, mass & geometry of the component(s). Some “soft” metals, such as aluminium, can be damaged if the ultrasonics are too intense.

Sweep

A fixed frequency will be characterised by nodes, or areas of zero energy at certain distances from the emitter. This is usually overcome by adjusting the frequency slightly, on a continuous basis.

De-Gassing

In some circumstances, the solvent will evaporate into the vacuum bubble. This will reduce the effectiveness of the subsequent implosion. Periodically, the frequency should be reduced or switched off completely to allow the tank to de-gas.

Temperature

Liquids are more viscous and sluggish to cavitate at lower temperatures. At higher temperatures, the vaporisation or gassing effect increases. There is usually a happy medium, dependant on the solvent in use, at which the process is optimised. In aqueous systems this is usually in the 60-70°C bracket.

The operating temperature may also be influenced by other considerations such as the chemistry in use, nature of the contaminant(s) and cycle time. This often requires some clever balancing, qualified by trial and error.