As part cleaning focuses on environmentally sound technologies, ultrasonic cleaning action has gained wider acceptance when used in the appropriate applications. Ultrasonic cleaning systems are able to clean a wide range of parts effectively and efficiently in batch style arrangements. They are even more successful when the mechanical action of ultrasonic sound waves are introduced.

Aqueous and semi-aqueous solutions are now commonly found using ultrasonic action, although these chemicals are often not as effective in breaking the surface tension between soil and metal as solvents like perchlorethylene.

Ultrasonic sound waves are those above the threshold of human hearing. Their pitch is so high that humans cannot distinguish it. Waves above 18 kHz are designated as ultrasonic- the waves used in industrial cleaning range from 20 to 50 KHz, with higher frequencies used for smaller, table top ultrasonic washers used in homes and doctor offices.

Ultrasonic cleaners utilize sound waves to remove particles from contaminated parts through the process of compression and rarefaction. Manipulating these waves, the cleaner can operate in a number of different manners. Any point in a sound-conducting medium is alternately subjected to compression and then rarefaction. At a point in the area of compression, the pressure in the medium is positive. At a point in the area of a rarefaction, the pressure in the medium is negative. When the amplitude of the wave is increased, the negative pressure in the rarefaction area causes liquid to fracture, which is the process of cavitation. The cavitation "bubbles" are created at sites of rarefaction because of this fracturing, When the wave fronts pass, the cavitation "bubbles" oscillate under the influence of positive pressure, eventually growing to an unstable size. Then, the violent collapse of the cavitation "bubbles" results in implosions, which cause shock waves to be radiated from the sites of the collapse. Temperatures of over 10,000F and PSI of 10,000 have been observed at these sites of cavitation.

Cavitation benefits the cleaning process. In order to clean, cleaning chemicals must reach the contamination of the part. After initial exposure however, there is often a buildup of residue on the part that prevents further cleaning. Through cavitation, ultrasonic cleaners are able to displace this buildup and allow fresh chemistry to reach the part. Other parts are contaminated by particles that are loosely attached to the surface of the part- the vibration of the ultrasonic waves is enough to break the attachment of the particles and remove them from the part.

Using ultrasonic technology in a washer requires the installation of an ultrasonic transducer and a generator. These devices create the ultrasonic waves that travel through the bath. The generator supplies electrical energy at the desired ultrasonic frequency. The ultrasonic transducer converts the electrical energy from the ultrasonic generator into mechanical vibrations. The three most common types of ultrasonic energy used are square wave outputs, pulse, and sweeping.

The square wave output results in an acoustic output rich in harmonics, and it creates a multi-frequency cleaning system that vibrates simultaneously at several frequencies. It combines all the necessary frequencies into one single tank.

In pulse operation, the ultrasonic energy is turned on and off at a rate that may vary from once every several seconds to several hundred times per second. Slower rates allow for quicker degassing, while faster rates result in the part receiving multiple high energy bursts from the waves.

In sweep operation, the frequency of the output of the ultrasonic generator is modulated around a central frequency that may itself be adjustable. Sweep may be used to prevent damage to extremely delicate parts or to reduce the effects of standing waves in cleaning tanks. Sweep operation may also be found especially useful in facilitating the cavitation of terpenes and petroleum based chemistries.

Transducers come in two varieties, magnetostrictive and piezoelectric. Magnetostrictive transducers utilize the principle of magnetostriction in which certain materials expand and contract when placed in an alternating magnetic field. Using a coil wire, energy from the generator is converted into an alternating magnetic field. The alternating magnetic field is then used to induce mechanical vibrations at the ultrasonic frequency in resonant strips of nickel or other magnetostrictive material, causing vibration. Due to restrictions in the technology and with magnetism, these transducers do not operate at much higher than 20 kHz.

Piezoelectric transducers can operate at much higher frequencies. They convert alternating electrical energy directly to mechanical energy through use of the piezoelectric effect in which certain materials change dimension when an electrical charge is applied to them. The electric energy from the generator is applied to the transducer, where piezoelectric elements vibrate. These vibrations are amplified by the resonant masses of the transducer and directed into the liquid through the radiating plate. While they were once difficult to operate and prone to instability, the piezoelectric transducers are now the most common transducers used in ultrasonic cleaning.

When properly utilized, ultrasonic cleaning can significantly increase efficiency and speed of a cleaning operation with minimal environmental impact. Ultrasonic cleaning greatly enhances the cleaning ability of aqueous solutions, as well as giving added punch to the exacting specifications used with solvents. As the technology continues to be refined, ultrasonic cleaning will continue to gain in popularity.