

Ultrasonic Liquid Processing Application Note 3:**Flow Through or Static Cylindrical Reactor Systems*****New Flexible Pipe-Clamp Technology***

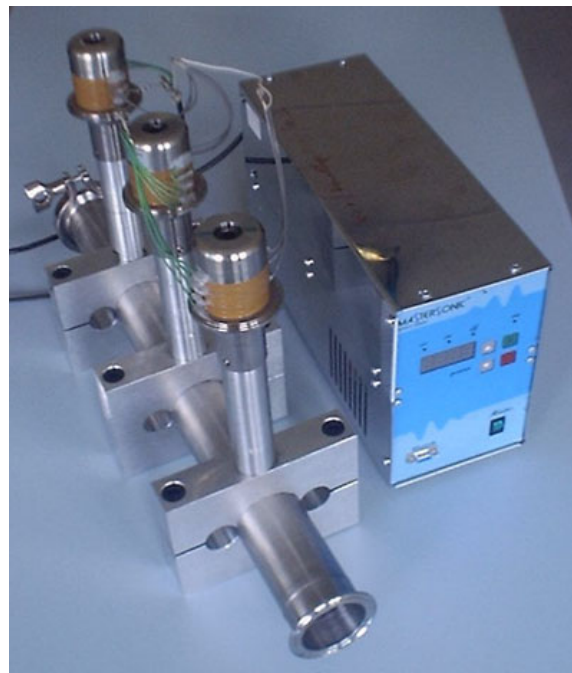
MPI offers custom inline or static cylindrical reactor systems for liquid processing applications where it is important to deliver uniform ultrasonic energy over a large radiating surface. Our systems are capable of delivering very high volumetric power to the liquid reactor system. Such power is providing strong acoustic effects, controllable cavitation, and uniform power distribution throughout the reaction chamber.

Below we review our unique Pipe-Clamp technology that offer ultrasonic characteristics similar to submersible transducers. With no internal restrictions and the possibility to use standard pipe interconnect flanges these systems provide convenient flow through systems that are easily integrated into liquid processing applications. Systems are intended for sonochemical reactions where uniform ultrasonic radiation and controllable cavitation effects are required.

The Pipe-Clamp systems must be driven by our unique Modulated, Multimode, Multifrequency (MMM) technology offering wideband multi-frequency effects. Conventional fixed-frequency ultrasonic generators from other suppliers cannot drive such arbitrary shapes efficiently or at high power.

For organic or inorganic material processing:

- **Food processing**
- **Sonochemistry**
- **Reaction Acceleration** - cavitation accelerates chemical and physical reactions.
- **Fine Particle Dispersion** - e.g. nanoparticle processing
- **Cell Disruption and Lysing** - will break open biological tissues and cells to extract enzymes and DNA, prepare vaccines. This technology provides a method for ultrasonically lysing cells and spores in a liquid flowing continuously or intermittently through a cylindrical reactor.
- **Homogenization** - making uniform mixtures of liquids or liquid suspensions.
- **Emulsification** - processing foods, pharmaceuticals, and cosmetics.
- **Dissolution** - dissolving solids in solvents.
- **Degassing** - removing gases from solutions without heat or vacuum.
- **Inline pipe cleaning**, removes scale or build/up without disassembly.
- Cylindrical **360° internally radiating** chamber.
- Internal or external **liquid atomizing or powder making** sonotrode.
- Parts Cleaning
- Water & wastewater processing
- Inline filtering and filter cleaning systems



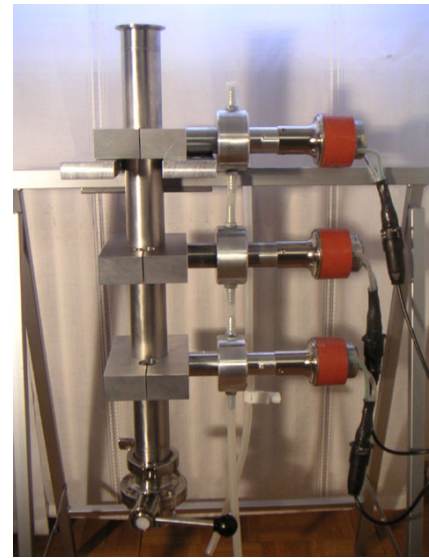
Example: 3 transducer/clamp system on 2 inch stainless steel pipe.

A new method of continuous or intermittent inline ultrasonic processing for any liquid material or food that requires ultrasonic treatment. Single or multiple transducers are connected to custom clamps designed to fit nearly any size tube or pipe constructed of aluminum, stainless steel, or titanium. Our unique MMM technology offers a highly efficient transfer of ultrasonic energy to the metal pipe or tube. The pipe / tube becomes a 360° radiating element allowing internal or external material treatment.

These assemblies will turn nearly any suitable pipe or tube into a highly efficient ultrasonic reactor. Longer pipe sections may be driven with multiple clamps powered by one or more MMM generators.

Key Features:

- Flexible system designs for **any length** of pipe.
- May be adapted to most **any diameter** pipe or tube (e.g. 25mm to 150 mm).
- Will drive most **any pipe thickness** (e.g. 1mm to 5mm) at high power.
- **Flow through design** allows easy adaptation to lab and industrial systems.
- Long wave guides options allow for very **high temperature applications**.
- Easy adaptation to **high pressure** systems.
- Wide ranging power options offer:
 - Low power non-cavitation treatment
 - High power strong cavitation treatment
 - 0 to 100% power control
 - Advanced modulation techniques to modify and improve acoustic effects.
 - PC or Microprocessor software control options.
 - Standard systems from 300 watts to 1,200 watts. Custom systems to 120,000 watts.
- **Simplified one-piece tube design without seams or joints allows easy internal cleaning and sterilization.**



Example: 2 & 4 inch pipe

Active Ultrasonics' liquid processing components are designed for heavy-duty industrial applications and can also be adapted to most general laboratory environments. The system components are described below.

MMM Generators (Modulated, Multimode, Multifrequency):

MMM generators deliver wide-band sonic and ultrasonic energy (ranging from infrasonic up to the MHz domain) through arbitrary shaped solid structures and thick or thin wall metal containers to address a variety of liquid processing applications. The secret to MMM Technology is its ability to initiate ringing and relaxing, modulated, multimode mechanical oscillations including harmonics and sub-harmonics. MMM Technology is producing pulse-repetitive, phase, frequency and amplitude-modulated bulk-wave-excitation covering and sweeping an extremely wide frequency band. Such sonic and ultrasonic driving creates uniform and homogenous distribution of acoustical activity on a surface and inside of the vibrating system, while avoiding the creation of stationary and standing waves, so that the whole vibrating system is fully agitated. The system offers fine control from a programmable interface and produces high efficiency active power (0% -100%).

Converters/Transducers: Our transducers are based on piezo-electric ceramic stacks and are originally designed for demanding ultrasonic welding and cleaning applications.

Special Clamp Systems

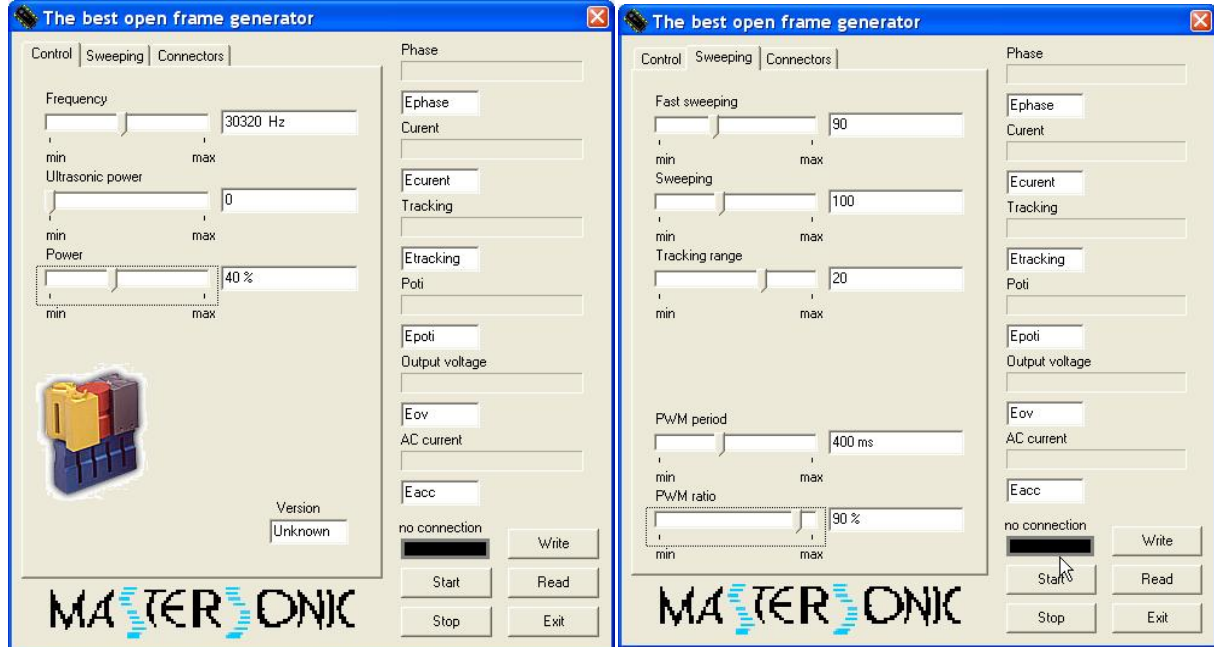
- Glass, Quartz, or Plastic Tube Chambers:
 - Using special interface materials and clamp designs we can apply ultrasonic energy directly to a glass or quartz tube for treatment of liquid materials or chemicals.
 - Alternatively glass tubes may be submersed into a water filled stainless steel pipe system for indirect 360° ultrasonic treatment.



Custom System Designs and Consulting:

- MPI provides consulting services and custom reactor designs.
- Alternative high amplitude probe flow cells also available.

System Control: MMM Wideband Generators may be controlled by a handheld “Handy” control panel or via an RS485 (or RS232 with adapter) interface for PC Control or a custom microprocessor.

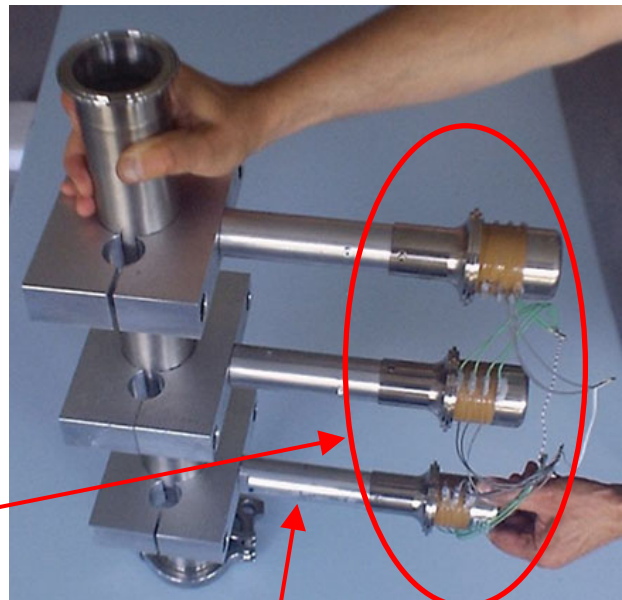


Example PC Control Windows:

Pipe-Clamp Acoustic Elements: Clamp construction may be customized to fit nearly any size pipe.

- Custom clamp systems using one or more ultrasonic converters may be externally attached to high quality aluminum, stainless steel (316L), or titanium pipes segments.
- Standard system power may range from 100 W up to 1,200 W using MMM wideband generators. Higher power custom MMM power supplies are available on request.

Flexibility to add any number of clamps & converters offers easy customization of chamber length, process volumes, process time, and delivered power.



Wave Guides of any length (e.g. 1 to 3 meters) move converters away from high temperature process.