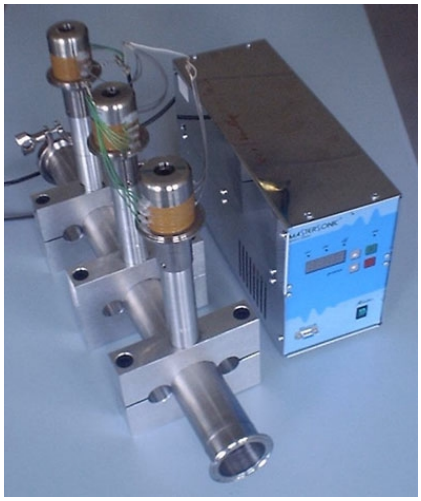
Pipe-Clamp Technology

High Volumetric Power Density (50 – 1000 W/dm^3)

MPI offers custom Pipe-Clamp solutions for liquid processing applications where it is important to deliver uniform and homogenous ultrasonic energy over a large radiating surface. Such system are capable of delivering very high volumetric power (up to 1000 Watts per liter) to the liquid however due to the large radiating surface of the active element the surface power density is usually on the order of 0.5 to 2 Watts per centimeter square. Such power is providing very good cavitation effects and uniform power distribution throughout the reaction chamber.

Below we review our unique Pipe-Clamp systems 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 gentle ultrasonic radiation and cavitation effects are required. The Pipe-Clamp systems must be driven by our unique wide band multi-frequency MMM technology.

Applications that benefit from this arrangement are:



. • Mixing/Homogenize is facilitated by uniform ultrasonic energy that generates significant cavitation distributed evenly throughout the reactor volume.

. • Sonochemical Reactions accelerated by strong cavitation within an enclosed reactor.

. • Potable Water Processing

. • Waste Water & Liquid Waste Material Processing

. • Liquid Food Processing

MPI' 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 (Multifrequency, Multimode, Modulated):

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

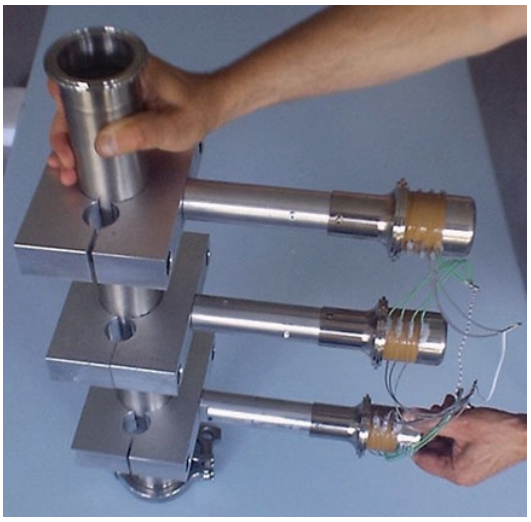
frequency band. Such sonic and ultrasonic driving creates uniform and homogenous distribution of acoustical activity on a surface and inside of the vibrating system, while avoiding the creation of stationary and standing waves, so that the whole vibrating system is fully agitated. The system offers fine control from a programmable interface and produces high efficiency active power (0% -100%).

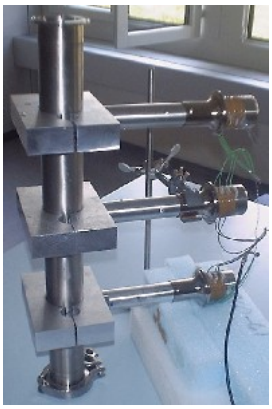
System Control: MMM Wideband Generators may be optioned for Front Panel Control, Removable Handy Panel Control, or Remote Electronic or PC Control.

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

Pipe-Clamp Acoustic Elements: We offer custom clamp construction to fit nearly any size pipe.

- ***Pipe Clamp-On:*** Custom clamp systems using one or more ultrasonic converters may be externally attached to special stainless steel or titanium pipes segments. The clamped pipe segment becomes the radiator of Ultrasonic energy to material internal or external to the pipe. Due to the large surface area the acoustic surface power density is relatively low, as in a standard ultrasonic bath, but total power input is design to create effective cavitation. These systems simplify treatment of materials in high temperature or pressurized systems. Standard system power may range form 100 W up to 2,000 W using MMM wideband generators. Higher power custom MMM power supplies are available on request.





Any Pipe Thickness:

❒ Although the MMM technology will drive most any pipe thickness (e.g. 1mm to 30mm) there are tradeoffs that must be considered.

❒ In normal applications with pipe diameters of 25 mm (1") to 100mm (4") the MMM technology delivers the most amplitude and best multi-frequency harmonic modes with a thinner wall thickness from 1mm to 2.5mm.

❒ Applications requiring a wall thickness greater than 2.5mm may also be driven with good success however more power will be required to drive the system with somewhat less amplitudes and some lesser excitation of multi-frequency harmonic modes.

Any Pipe Diameter:

❒ MMM Pipe-Clamps may be designed for most any size pipe.

❒ MPI can redesign the clamp dimensions to adapt to your specific pipe dimension.

❒ Larger pipes may require modified designs to allow mounting of multiple converters.

Any Pipe Length:

❒ The unique nature of the MMM generator technology also allows us to create flexible system design that will treat any length of pipe.

❒ The length of pipe effectively activated by one clamp is very dependent on many factors and must be tested for each application: Variables are:

♦ Pipe diameter
♦ Pipe wall thickness
♦ Free standing pipe segment or attached to other pipes or equipment.
♦ Power limit of the MMM generator
♦ The converter / transducer used
♦ The viscosity and volume of material under treatment

❒ Longer pipe sections may be driven with more ultrasonic energy through the use of multiple clamps driven by one or more MMM generators. Some application examples are:

♦ Extended atomizing or powder manufacturing through a long pipe section.

♦ Extended treatment time for liquids flowing through a pipe section.

♦ Long pipe friction and pressure reduction.
♦ Continuous cleaning (anti-fouling or anti-film) of long pipe sections (e.g. dairy applications such as milk or yogurt, heat exchangers, etc.)

❒ Example of power distribution for one 1200 watt MMM generator driving:
♦ 12 clamps = average power of 100 watts per clamp.
♦ 6 clamps = average power of 200 watts per clamp.
♦ 3 clamps = average power of 400 watts per clamp.
♦ To drive longer pipes or more clamps multiple MMM generators may be installed to work in tandem.

❒ Shorter pipe sections may also be fitted with multiple clamps to improve the ultrasonic power density for the given volume. Applications that may benefit from more intense ultrasonic energy are:
♦ Some sonochemical treatments
♦ Ultrasonic Cleaning

♦ Very high volume atomizing and/or powders production.
Operational Heat Protection:
❒ Pipe-Clamp applications that require continuous maximum power delivery should provide cooling to the mechanical system for protection of the ultrasonic converter / transducer.

♦ One of the most effective cooling methods are water cooling jackets mounted on the wave-guide.

♦ In addition clients may provide additional air cooling when necessary.

High Temperature Environments:

❒ Another key advantage to the MMM generator technology is its ability to drive variable length Wave-Guides. Normal Wave-Guides are 100mm to 200mm in length. When driving pipes that contain materials with high temperature the Wave-guides may be extended from 1 to 3 meters. This allow us to distance the converter from the source of heat, thereby helping to protect the heat sensitive piezoelectric elements.

Example: 300mm (12”) Wave-Guide

Chamber Designs Services: We provide consulting and custom design services to aid our clients in construction of reaction chambers and systems for special applications.





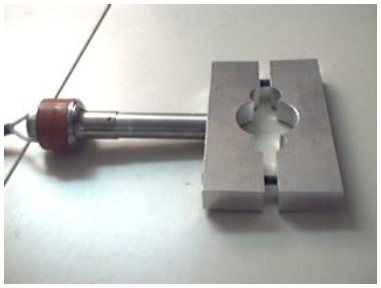

APPLICATIONS

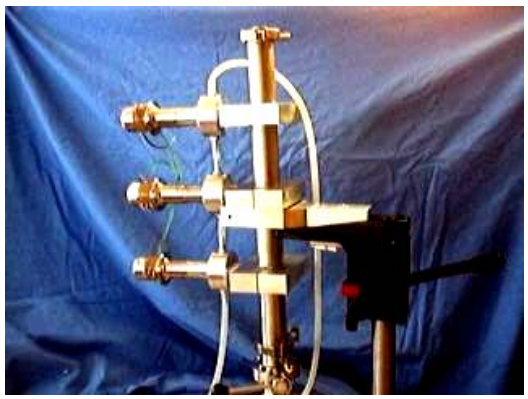
- **Fluids mixing, Cleaning of internal tube area, Liquid Atomizing, Homogenizing, Tubes Cleaning in Nuclear Industry, Facilitating flow and removing fluid friction, ordinary and precession cleaning, Nano-particles production, Stress Relief, Sonoreactors and applications in Sonochemistry & Electrochemistry, Extractions, Mining Industry, Fuels and oil mixing & blending, Facilitating powders transport in pipe conduits, Large Surfaces Defoaming, Birds and Animals Repealers, Sonar applications, Liquid Metals Processing, Extrusion, Ultra-Filtration, Waste waters treatment, Sterilization, Zebra Shells Repealing, Boilers protection and cleaning, Fuel Injection and Atomizing, Washing Machines, Pulp & Paper Technologies, Ice and snow-making, Dust Removal, Incineration of Liquids, Degassing, Cracking of petrochemicals, Fuel Cells…**

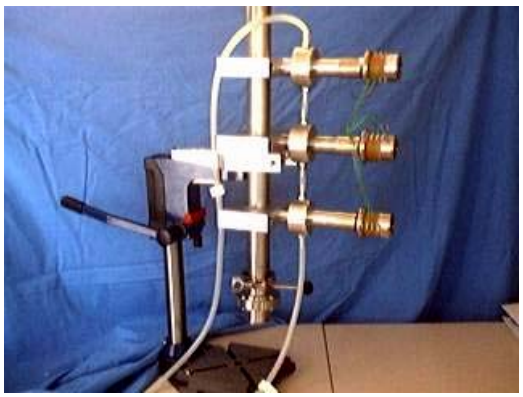
- **Industrial fluids atomizers & gas mixing (air conditioning, semiconductor technologies…)**
- **Water & fuel atomizers**
- **Liquid alloys atomizers & solder atomizers**
- **Incineration of waste and dangerous liquids by atomizing**
- **Large volume humidifiers & dust removal**
- **Air and water filtering, purification, decontamination & sterilization (nuclear, included)**
- **Micro-encapsulation, coating, surface impregnation**
- **Food and Pharmaceutical applications (sterilization & decontamination)**
- **Electrochemistry & Sonochemistry process integration (nano technologies)**

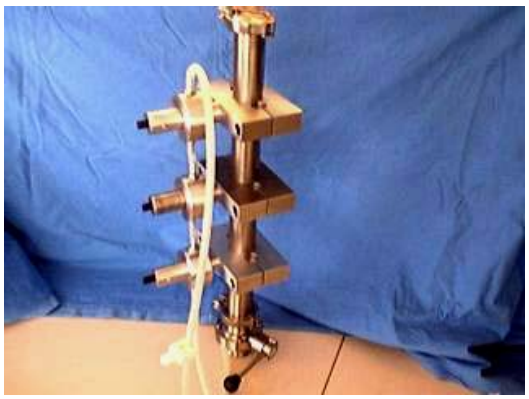
- **Extruders, Wires & Tubes Drawing, Atomizers, Liquid Alloys Treatment, Defoaming, Mixers, homogenizers, Sonochemical Reactors, Waste Waters Processing, Supercritical, Liquid CO-2 Reactors, Extractions, MMM Cutting, Degassing, Fast meat defrosting, Meat preparation before fuming and drying, Relaxation and massage therapies, petrochemicals cracking (diesel etc.), precious metals extractions, perfumes**

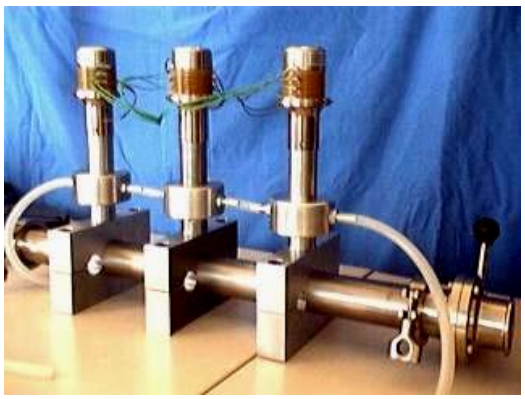
Examples of Clamp-On Tubular Reactors











Examples of Clamp-On Glass Reactors