

## Ultrasonic Filtering and Inline Filter Cleaning

### Tubular Clamp-On Multifrequency Reactors

**Main Web Site:** <http://www.mpi-ultrasonics.com>

**Download Server:** <http://mastersonic.com>

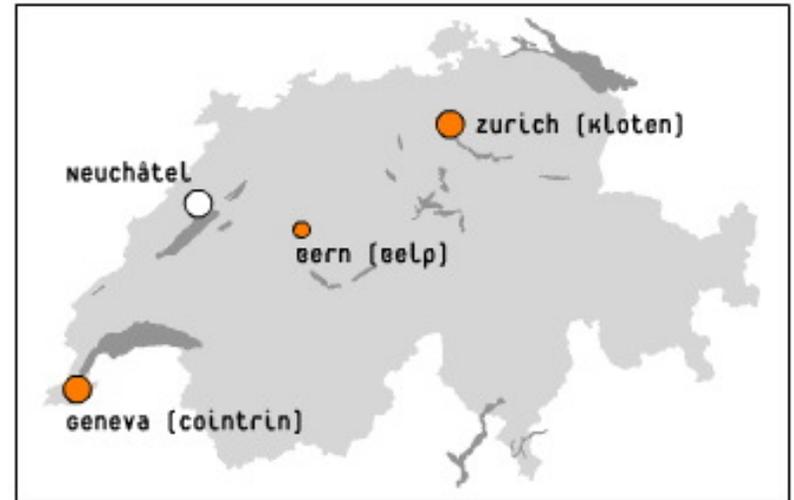
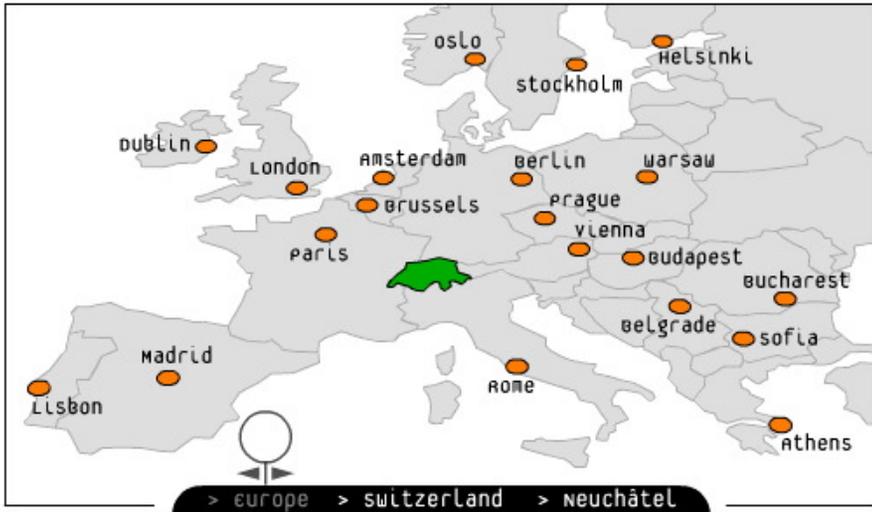
**Email:** [mpi@bluewin.ch](mailto:mpi@bluewin.ch)

**MPI** *Interconsulting*

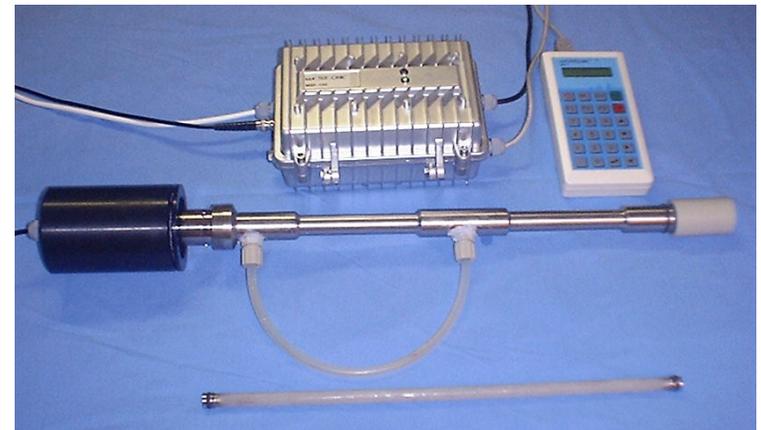
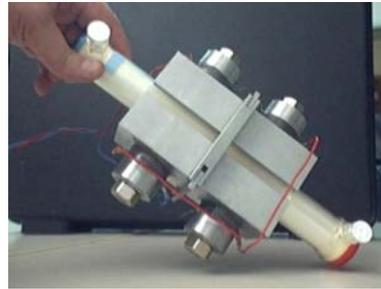
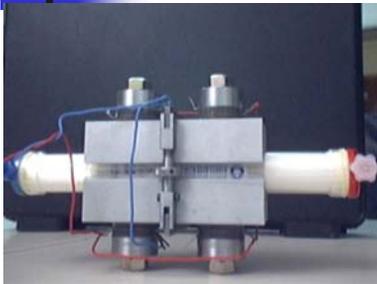
ULTRASONICS - SONOCHEMISTRY - INNOVATION

## Location:

### Neuchâtel, Le Locle, Switzerland



# Ultrasonic & Ultra-Filtration



# Inline Filtering



**In-Line Filtering, Separation,  
Mixing, Homogenizing**



**Extruders & pumps: Higher flow  
rate, reduced friction**

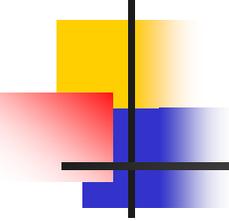
**Simple Clamp-  
On Installation**



# Ultrasonic & Ultra-Filtration

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- **Our ultrasonic technology offers new design flexibility and adaptability to most any size inline filtration system for micron or submicron materials dispersed in a liquid.**
- **Ultrasonic Filtration Advantages:**
- **Significant increase in flow rates.**
  - **Cleaner filter element**
  - **Ultrasonic acoustic effects are actively working to reduce surface tension, cohesive forces, and/or adhesive forces.**
- **Allows in process self cleaning of the filter for continuous processing.**
- **Greatly improves reverse flow filter cleaning and deblinding.**
- **Example Applications:**
- **Micron and submicron materials dispersed in liquids**
- **Metal powder slurry**
- **Ceramic slurry**
- **Biotech and Pharmaceutical products**
- **Water and wastewater processing**
- **New Technology Offers Adaptability:**
- **New transducer clamp-on technology allows easy adaptation to existing housing designs and retrofit possibilities.**
- **For any filter type: Sintered Metal Filters, Membrane, Ceramic, etc.**



# Ultrasonic & Ultra-Filtration

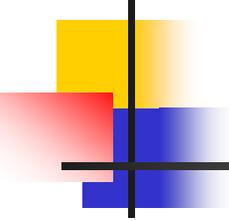
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- **New Multi-Frequency Ultrasonic Systems:** MPI now offers the industry's most advanced ultrasonic technology for liquid and liquid slurry filtering applications. Our patented MMM (Modulated, Multimode, Multifrequency) ultrasonic generators can stimulate highly efficient wideband (sonic to megahertz) acoustic energy to most any liquid filled filter chamber. Compared to conventional fixed/frequency solutions our wideband ultrasonic techniques improve filter throughput, improve inline cleaning continuously, and improve reverse flow back flush. Key benefits to the new technology are:
- Wideband (sonic to megahertz) acoustic energy provides greater acoustic stimulation to improve process flow rates.
- MMM eliminates the standing waves seen in fixed frequency systems.
  - Eliminates blinding in low amplitude nodal points
  - Eliminates damage to filters in high amplitude nodal points.
- Fully programmable power and modulation technology
  - Power adjust 1% to 100% (standard power modules in 300 watts, 600 watts, 1200 watts, and up to 100 kW on request)
  - Pulse Width Modulation Period (Period 10 ms to 1,000 ms)
  - Pulse Width Modulation Ratio (0% to 100%)
  - MMM special modulation settings (fast sweeping, sweeping, & tracking)
- Transducer from 20 kHz to 45 kHz and higher frequencies on special order.
- MMM technology will drive most any size and shape filter housing.
- MMM driven converters may be connected to most any efficient point on cylindrical stainless steel filter housing.
- A field adjustable resonant frequency option allows filter housings to be built without specific ultrasonic resonance tuning. This means filter housing designs can be simplified and produced at lower cost.

# Ultrasonic & Ultra-Filtration



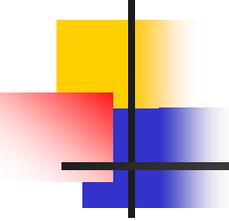
**MMM Frequency Agility:** The same DSP technology that allows the MMM generator to be adaptable to any size or shape filter housing is used to provide unprecedented frequency agility. Other fixed-frequency systems are driving the total acoustic system (converter, filter housing, & liquid) at a frequency optimized for the converter without full consideration of how the filter housing and contents are changing the whole system resonant frequency. Rather than fighting physics our systems may be adapted to the new resonant frequency when an un-tuned mass is attached to a converter. Normal MMM factory options allow for system resonant frequency adjustment within a 12 kHz window (e.g. 25 kHz to 37 kHz). Such agility allows fine tuning for optimum performance.



# Ultrasonic & Ultra-Filtration in Liquids

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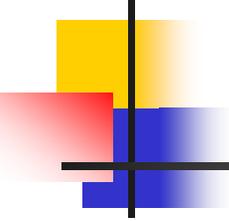
- **Principle of operations:**
- High power ultrasonic transducers are strongly (mechanically and acoustically) coupled to the external cylindrical housing of the filter element. The active filter element inside of the housing is radially stimulated (360°) by intensive ultrasonic vibrations transmitted through the liquid or liquid slurry. With sufficient power and amplitude the ultrasonic vibrations will produce ultrasonic cavitation and streaming effects within the liquid and to the filter element. Oversized particles, powders, impurities, or other materials which usually fill or blind the fine filter structure are forced out of the active filter body. Flow rates are improved by a cleaner filter element plus the ultrasonic acoustic effects are actively working to reduce surface tension, cohesive forces, and or adhesive forces.
- Coupling the high power ultrasonic transducer to the filter housing may be accomplished in two ways:
- A custom housing may be designed to allow a direct connection between the transducer and the filter housing. This coupling connection should be optimized to allow ultrasonic stimulation of the entire housing when possible. Coupling may be perpendicular or axial in orientation to the filter housing.
- A new Clamp-On technology allows easy adaptation to existing stainless steel cylindrical filter housing of nearly any size.
- To achieve a uniform (surface and 3D) distribution of ultrasonic amplitudes and ultrasonic pressure our [MMM ultrasonic generator](#) performs frequency sweeping around the optimal resonant frequency of the resonating system (e.g. 35 to 45 kHz). The speed of applied frequency sweeping is in the range of 50 to 100 sweep intervals per second. Frequency sweeping also reduces the chance that some particles or areas of the filter body remain inactive (non-vibrated).
- To eliminate the creation of standing waves and other vibration stationary (or stable) structures inside the filtering tube, low frequency, and full power On/Off pulsing is applied to the ultrasonic signals. This way, the applied pulse repetitive and transitory (mechanical) excitation is able to send shock pressure waves to the filter body. Pulsing shock pressure waves can be many times stronger than the effects of continuous operation. Such mechanical On/Off shocking also produces low frequency and very high vibration amplitudes that are superimposed and mixed with high frequency ultrasonic oscillations, thereby maximizing the effects of filter cleaning.



## MMM Fluids Processing Basics

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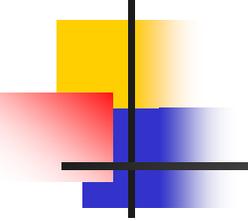
- ❑ Multi-Frequency Multimode, Modulated Sonic & Ultrasonic Technology (MMM Power Supplies).
- ❑ A totally new approach in the world of acoustic technologies.
- ❑ Unlike Fixed-Frequency systems we adapt through advanced Digital Signal Processing (DSP) of feedback waveform and new modulation techniques producing wide frequency band acoustic field. Any pipe or vessel can be agitated using MMM Power Supplies.



## MMM Technology Advantages

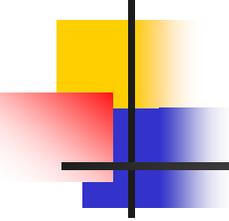
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- ❑ Sonic and ultrasonic parameters in MMM Power Supplies are fully programmable and controllable to offer high operating efficiency and effectiveness for any complex mechanical system, consisting of arbitrary resonating elements.
- ❑ MMM creates powerful 3D sonic and ultrasonic activity in liquids and solids with arbitrary shapes and sizes.
- ❑ MMM Sonic & Ultrasonic Vibrations are covering and sweeping an extremely wide frequency band to create uniform and homogenous distribution of acoustical activity inside of the vibrating medium.
- ❑ Standing waves are eliminated and the whole medium is fully agitated.
- ❑ Adapt to any kind of transducer, any number or any power.



# MMM Tubular, Clamp-On Reactors Driving

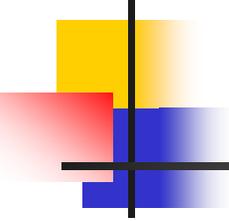
- We offer generator and transducer components for systems integrators and OEMs to make Ultrasonic Fluids Processing systems. We offer our clients the freedom to construct and supply their own pipe resonator systems.
- **Fixed Frequency Systems:**
- When matched with our Fixed-Frequency generators the ring resonators must be tuned to operate at the system resonant frequency.
- **Multi-Frequency Systems:** MPI now offers the industry's most advanced ultrasonic technology for In-Line Liquid Processing applications. When properly adjusted our patented MMM (Multifrequency, Multimode, Modulated) ultrasonic generators can stimulate highly efficient wideband (sonic to megahertz) acoustic energy to nearly any reactor shape. Key benefits to the MMM ultrasonic technology are:
  - Wideband (sonic to megahertz) acoustic energy provides greater fluid stimulation to improve any Sonochemistry-related process beyond the limitations of standard fixed frequency systems.
  - MMM eliminates the standing waves seen in fixed frequency systems.
  - Fully programmable power and modulation technology
    - Power adjust 0% to 100% (standard power modules in 300 watts, 600 watts, 1200 watts, and up to 20 kW on request)
    - Pulse Width Modulation Period (Period 10 ms to 1,000 ms)
    - Pulse Width Modulation Ratio (0% to 100%)
    - MMM special modulation settings (fast sweeping, sweeping, & tracking)
    - Center Frequency settings (large interval)
- Programmable features allows greater processing flexibility with all kinds of fluids.
- MMM technology will drive most any pipe shape (round, oval, square, rectangle), even very large mass systems.
- MMM converters may be connected to most any efficient point on the acoustic load.
- A field adjustable resonant frequency option allows rings to be built without specific tuning. This means ring resonators designs can be simplified and produced at lower cost.
- **The MMM Clamp-On system can adapt to most any other manufacturers installed pipelines systems allowing a simple field upgrade.**



# MMM, Clamp-On Applications

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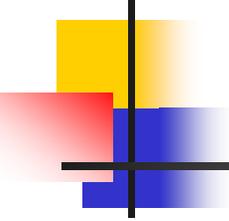
- Fluids mixing, Cleaning of internal tube area, Liquid Atomizing, Homogenizing, Tubes Cleaning in Nuclear Industry, Facilitating flow and removing fluid friction, ordinary and precession cleaning, Nano-particles production, Stress Relief, Sonoreactors and applications in Sonochemistry & Electrochemistry, 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 (surface 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 extractions, ...



# Pipe Clamp-On Applications

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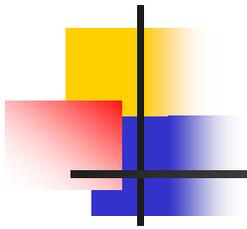
- ***Any Pipe Thickness:***
  - ❑ Although the MMM technology will drive most any pipe thickness (e.g. 1mm to 30mm) there are tradeoffs that must be considered.
  - ❑ In normal applications with pipe diameters of 25 mm (1") to 100mm (4") the MMM technology delivers the most amplitude and best multi-frequency 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 Clamp-On continued

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- ◆ 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.)

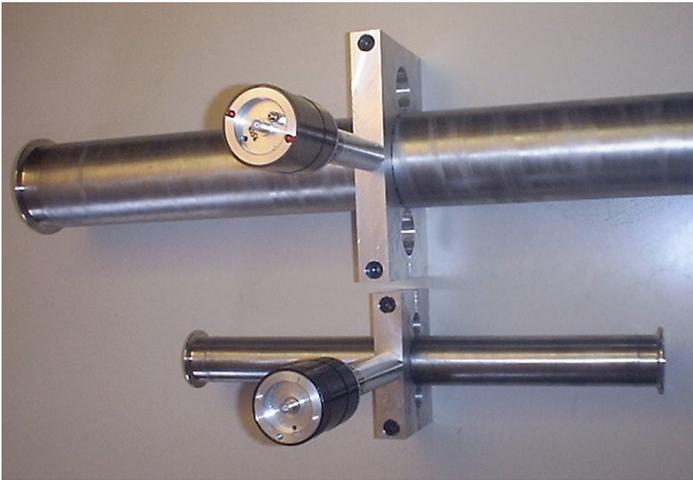
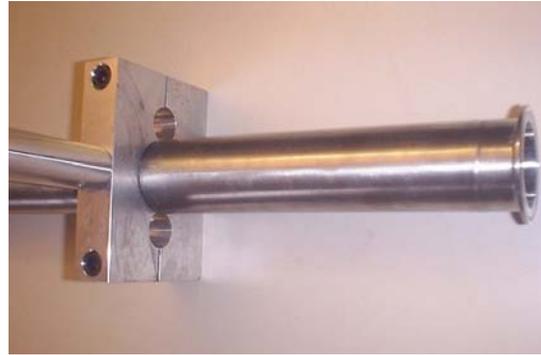
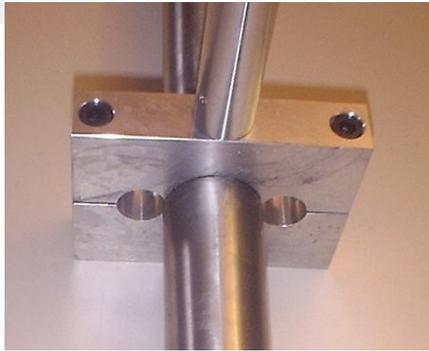


# Pipe Clamp-On continued

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- □ 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 or powder production.
- ***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 piezo-electric elements.

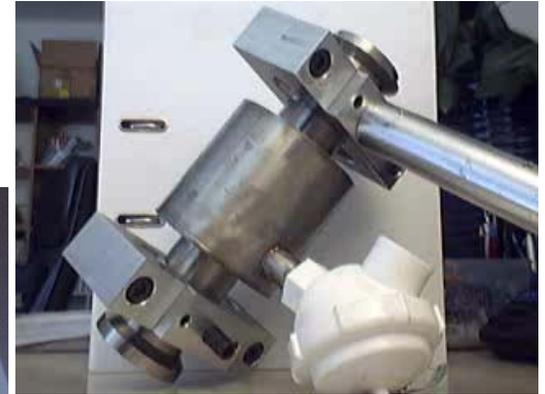
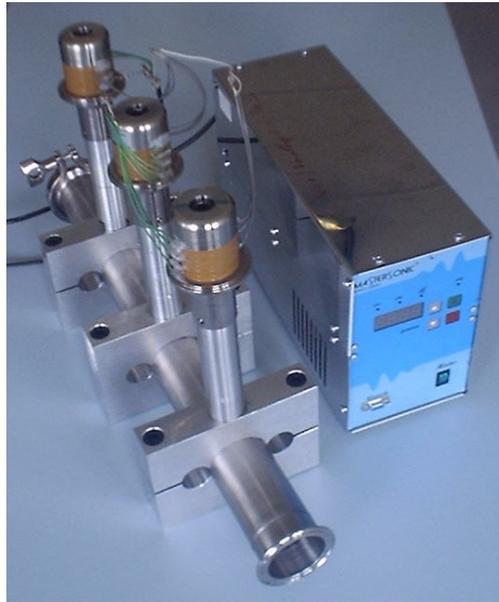
# Simple Clamp-On Design Options



## Clamp-On Reactors - Developments

- **Drive New Pipes and Reactor-Vessels Shapes:**
  - Square, Rectangle, Oval
  - Barrels, Half-Barrels
- **Fluids Filtering, Mixing and Homogenization**
- **Multi-Transducers**
- **Flexible Transducer Placement**
- **Long Wave-guide Driving**
- **Any Power for Any Size Reactors (until 100 kW)**
- **MMM Frequency Agility:** The same DSP technology that allows the MMM generator to be adaptable to any shape reactor vessel is used to provide unprecedented frequency agility. Other fixed-frequency systems are driving the total acoustic system (converter & reactor) at a frequency optimized for the converter without full consideration of how the reactor frame is changing the whole system resonant frequency. Rather than fighting physics our systems are adapting to the new resonant frequency when an un-tuned mass (the reactor vessel) is attached to a converter.
- **MMM Converter Agility:** Additional system flexibility is provided through adaptive inductive compensation that allows attachment and efficient driving of converters from other manufacturers. This allows us to improve existing ultrasonic systems through a simple MMM retrofit.

# Unlimited Clamp-On Reactors Options



(movie files)



# Water Jacket for Heavy Duty, Clamp-On Applications



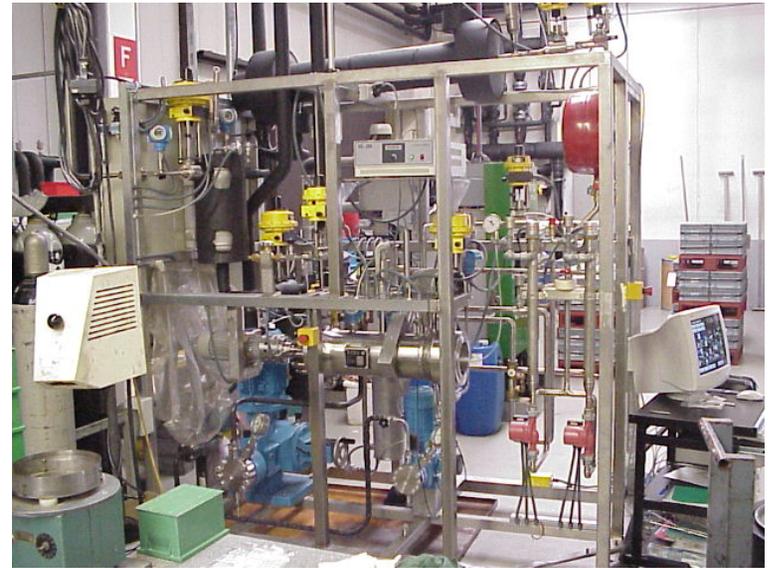
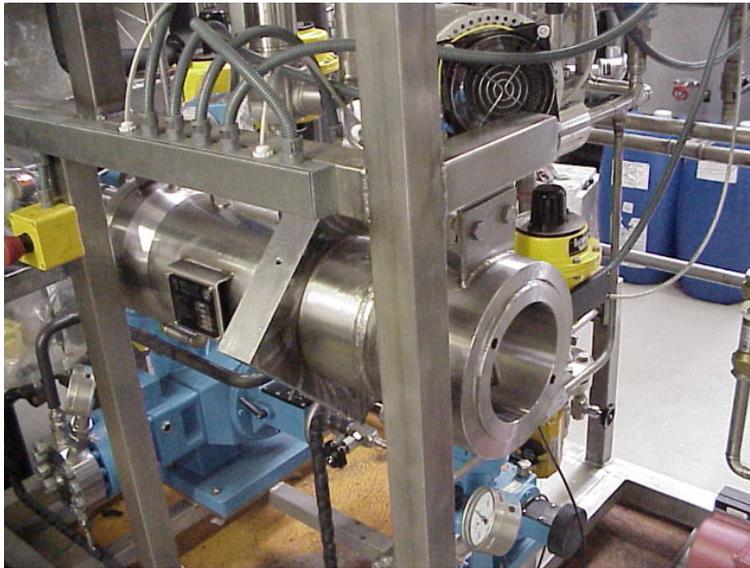
## ***Operational Heat Protection:***

- ❑ 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. Active Ultrasonics.
- ◆ In addition clients may provide additional air cooling when necessary.

# Easy & Simple Connectivity



# Supercritical CO-2 Clamp-On Reactor



**Clamp-On Agitation of the Liquid, Supercritical CO-2 Reactor (300 Bar applications, 25 mm wall thickness)**

**Applications: Extractions, Precision Cleaning**

# Examples: MMM CLAMP-ON APPLICATIONS IN PROCESS INDUSTRY



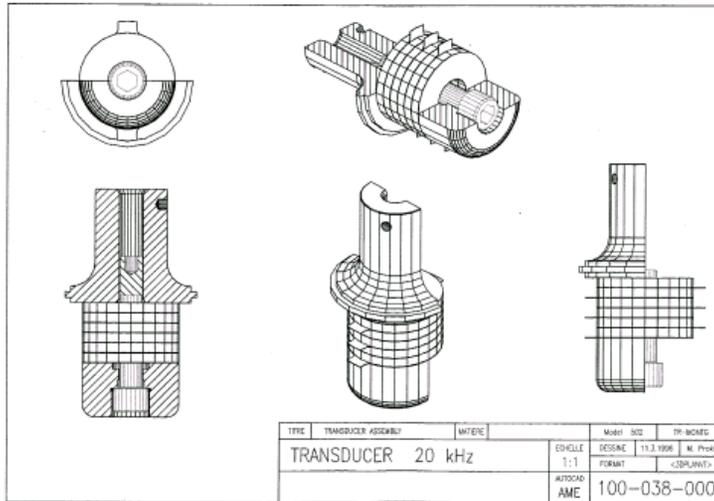
**Easier liquids flow and higher flow rate; Friction removal**

# Clamp-On & Heat Exchangers



**Heat Exchanging Applications: Longer operating life before cleaning**

# Converters for Clamp-On Applications



**Applications: Extruders, Wires & Tubes Drawing, Atomizers, Liquid Alloys Treatment, Defoaming, Mixers, Sonochemical Reactors, Waste Waters Processing, Supercritical, Liquid CO-2 Reactors, Extractions, MMM Cutting, Degassing, Clamp-On Systems...**