Solving Industrial Cleaning Problems — *Part 1*

by:
Robert E. Miller, VP
Power Sonics,
Division of MPP
5320 Enterprise Street
Eldersburg, MD 21784 USA
www.powersonics.com

This article, along with *Part 2* in an upcoming issue, describes a four-step method for analyzing a cleaning problem, developing a cleaning process, integrating the process to production needs and selecting and sizing appropriate cleaning equipment.

The following is not intended to be a comprehensive tutorial on industrial cleaning. Rather, it is intended to guide the reader through a procedure that will expediently and accurately define the problem, devise a cleaning process and result in equipment appropriate for the application and production requirements.

Industrial cleaning today is a complex undertaking. Determining the most appropriate and successful means to clean parts for your manufacturing needs requires a thorough and disciplined approach. Each cleaning problem is unique from another because of the many variables in the manufacturing process. First and foremost, identifying all the factors that affect your application is critical to developing the optimum cleaning process. Integrating that process with production and plant requirements through proper equipment sizing and selection is what assures success in obtaining clean parts.

In today's manufacturing environment, too often there is little time allowed to investigate the best process. Generally, a short cut that is taken is to acquire a duplicate machine that is already being used. If not an identical application, this often leads to getting what is often heard as "90% clean." The 90% cleaning is relatively easy to accomplish, but that last 10% is another matter entirely.

Let us then explore a succinct four-step procedure that if followed as defined, simplifies and expedites resolving industrial cleaning problems and produces consistently successful results. The four steps are:

- Analyzing the problem.
- Developing the process.
- Integrating process to production.
- Selecting and sizing equipment.

Analyzing the Problem

Every user and most equipment companies list (or have a form to describe) the product attributes and production parameters primarily to select the equipment to be used in the cleaning process. This analysis is focused exclusively to develop the process. Process, by definition, is a summary of the following minimum factors:

- Each cleaning stage.
- Purpose and expected result of each stage.
- Type of action (i.e., spray, immersion, agitation, ultrasonics, dry, etc.) of each stage.
- Dwell times of each stage.
- Media used in each stage.

The cleaning process is the single most significant and overlooked step of industrial manufacturing. Although everyone will insist they have done the analysis and developed the process, it is actually an assumed step or at best a cursory effort. A successful result never questions that this was not thoroughly explored. But when the cleaning does not meet expectations, then the above steps are invariably followed, but in reverse order—in other words, a scramble to find out what was discounted, missed or completely overlooked.

Unless you are running an identical part on an identical machine right next to an existing line at the same production rate and conditions, assume that the application is unique and evaluate it as such. Minor variables usually considered inconsequential often lead to major problems. A thorough analysis in the beginning most often highlights these.

The Engineering Study Form (ESF) outlined in **Figure 1** is designed specifically to define the problem in order to develop the process.

First, determine who is the technical contact. Who is the individual most knowledgeable about the project who can determine, evaluate and prioritize the information in the ESF?

Once completed, a preliminary evaluation of the application can be made. Is this a viable application for soak, spray, immersion, agitation, ultrasonics, etc.? There is no one answer to all industrial cleaning problems, and thus no one method may be the right approach.

Completing the ESF serves as the "interview process." A thorough and honest job done with the ESF helps both the user and application engineer.

This is a point where there is no substitute for experience. The responses on the form show to what extent the user understands the problem and the results required. An experienced application engineer can generally determine not only the viability of a successful solution, but make a preliminary estimate of the process steps to achieve that successful result. If you do not have an experienced in-house person to consult, it is strongly recommended that you find one to involve in this process. If analysis shows viability, then proceed to the next step.

Developing the Process

The goals in the development of a proper industrial cleaning process include the following:

- To develop a reliable and repeatable process.
- Prove out as fully as is practical prior to proposal, purchase and installation.
- Use the least number of stages to accomplish the cleaning.

Engineering Study Form (ESF) Outline

Information on the item to be cleaned:
- General description
- Size - largest and smallest dimensions and weight
- Configuration - consider the range but focus particularly on the most complex
- Construction - an assembled part generally represents a more difficult problem than a single piece part
- Are there through holes, blind holes, inaccessible areas, critical surfaces or materials
- Temperature limitations

Information on the contaminant to be removed
- ID any organic soils - grease, oil, wax, flux, polymer, other
- ID any inorganic soils - oxide, scale, flux, salt, oil, draw/lap/buff compound, other
- ID miscellaneous soils - chips, fines, shop dirt, paint, other
- Soil Solubility - water, solvent, other
- Quantity of soil - amount per volume, thickness per part, etc.
- How is soil accumulated on the part

Information on the manufacturing process
- Process step prior to cleaning
- Reasons for cleaning - appearance, reliability, productivity, maintenance, other
- Present cleaning process - none, soak, spray, sonics, mechanical, manual, other
- Present cleaning media - solvent, alkaline, caustic, acid, abrasive, other
- Problems encountered with the present process
- Unacceptable cleaning process/media - do not make unacceptable for lack of experience
- Method of measuring cleanliness - measurable or must manufacturing be completed

Information on parts handling
- Production rate - volume per time, hours per shift, number of shifts, days, weeks
- If Batch operation:
  - Parts carriers and type - are they used now, parts per carrier, fixtured or not
  - Can parts - be fixtured, touch, rotate, tumble
  - Manual or automatic loading
  - Manual or automatic unloading
  - Manual or automatic transfer - horizontal, vertical
- If In-line operation:
  - In-line cell or stand alone operation
  - Continuous or indexing
  - Dedicated to single or multiple parts
  - Manual or automatic loading
  - Manual or automatic unloading
  - Incoming parts - batch load or continuous individual pieces

Information on other requirements
- Drying - none, wipe, dry, temperature limitation
- Filtration - particulate, coalescer, membrane, other
- Exhaust - fumes, moisture, demister, other
- Waste minimization - none, n-plant, other
- Other - part inspection, automatic media control, automation coordination

Information on site parameters
- Floor space available - for machine, for ancillary equipment
- Height space - for production and for plant entrance
- Services available - tap water, DI water, sewer, air, steam, gas, electric

Information of project status
- Process development - what has been done
- Proposal requirements - estimate, final,
- Funding - preliminary budget, initial request proposed, approved
- Due dates - quote, purchase, shipment
- Buying parameters - product, performance, cost, support, shipment, service, reliability
- Other - comments, future plans, other

The Engineering Study Form (ESF) is offered as a tool for your use in analyzing your application. The questions listed in the ESF are those discussed above. A copy of the ESF is available by visiting ***www.powersonics.com.***

Fig. 1 — Engineering Study Form (ESF) outline for use in defining the cleaning problem and developing the process.

- Keep the contaminants as far upstream in the process as possible.
- Apply the most aggressive mechanical power allowable.

Each is fairly obvious, but the application of the most aggressive mechanical power is often overlooked or underestimated as an integral and major element. Using the more aggressive mechanical power available shortens dwell times per stage, widens the options of media choices, allows use of less aggressive medias and chemical concentrations and broadens operable temperature ranges.

The selection of a powerful mechanical cleaning stage (or mechanical cleaning stages) helps to overcome and nullify many of the variables of the application without having to understand them fully.

Immersion agitation has customarily been used for batch applications. Since the part(s) is immersed in the cleaning solution, immersion is effective on large and small parts with complex part configurations. Cleaning while rotating is more easily accomplished with immersion equipment.

Sprays have historically been used for in-line applications and parts with large surface areas. Sprays rely on impingement at the point of contact for cleaning and are effective for removing heavy contaminants like grease and on simpler part configurations.

Immersion agitation and high-pressure sprays have been effective and widely used for years. A third method and probably the most effective and least understood form of mechanical cleaning is ultrasonics.

Ultrasound technology used for cleaning is based on sending sound waves through a liquid cleaning media. The alternately low and high pressures caused by the sound waves produce the formation and destructive "implosion" of microscopic bubbles throughout the bath at the rate of thousands of times per second (**Figure 2** on next page). This is called "cavitation," and is the mechanical scrubbing action that attacks the soil on the part surface.

While the quantity of energy in any one implosion is ex-

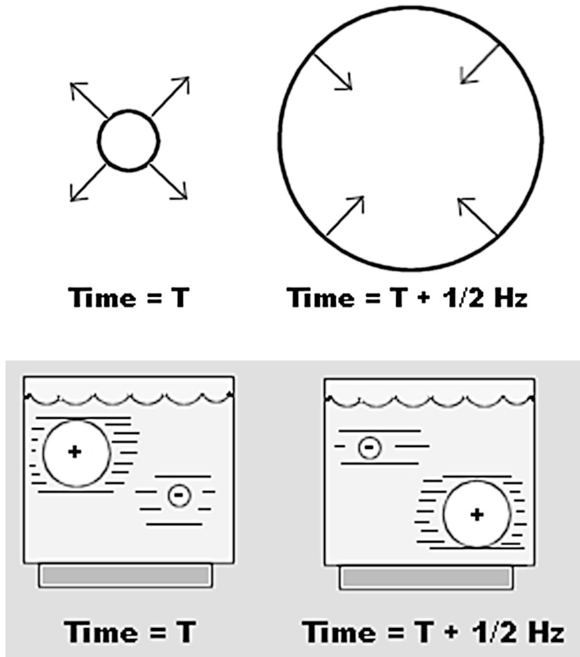


Fig. 2 — Cavitation is the alternately low and high pressures caused by sound waves to produce the formation and destructive "implosion" of microscopic bubbles throughout the bath at the rate of thousands of times per second.

tremely small, it is calculated that instantaneous pressures (on the order of 10,000 psi or 69 MPa) and instantaneous temperatures (on the order of 20,000°F or 11,100°C) are developed. The formation and implosion of these vapor pockets with their enormous pressures and temperatures do the mechanical scrubbing of the part surface virtually anywhere it can be wetted.

A basic ultrasonic system consists of a vessel to contain cleaning liquid, an ultrasonic power generator to produce ultrasonic energy and an ultrasonic transducer to convert electrical energy to mechanical-acoustical energy (**Figure 3**).

Just as there are differences between the effectiveness of a soak tank and immersion agitation or a flooding spray versus a high-pressure spray, there are differences within ultrasonic technology equipment.

Space laminated, magnetostrictive ultrasonic cleaning equipment has been demonstrated to be the most powerful type of industrial cleaning equipment. Properly applied, these equipment produces the fastest, most thorough cleaning without part damage.

Since the use of ultrasonics requires that the parts must be immersed in a liquid, it is used only as an immersion stage for cleaning. Except for continuous in-line wire and strip cleaning, ultrasonics has been used almost exclusively as a batch cleaning method.

Recent developments in ultrasound technology have resulted in equipment such that ultrasonics can now be used for continuous, high-volume, in-line parts cleaning. Systems can now be built that can utilize all methods including immersion, spray and ultrasonics.

Just as immersion and spray methods require chemistry for cleaning, ultrasonics does not eliminate chemistries. But generally speaking, ultrasonics permits consideration of less aggressive and lower concentration chemistries to do the task. This is one of the prime elements in the development of the cleaning process.

The resulting chemical solution may be vastly different when using high-power ultrasonics than when using chemicals only or when using other types of cleaning equipment. The mechanical action provides substantial cleaning force and when the chemical action is added, the combined effect of the two improves cleaning performance and lowers cleaning time. See **Figure 4** for a typical relationship of chemistry and ultrasonics.

Using the information from the ESF, an actual test cleaning replicating production conditions as closely as possible is the next step. Replicating production circumstances helps to nullify many of the variables encountered in the real world of manufacturing. Test cleaning of sample parts should consider the following:

- In lab or site test - conditions will dictate.
- Replicate production conditions - as closely as possible.
- Worst case samples - if you can't do the worst case, the problem isn't solved.
- Make each process step perform its function - wash-in-wash, rinse-in-rinse, dry-in-dry.
- Multiple small tests to determine safety margin - determine when cleaning is just met.
- Consider destruct tests - if and when does the process begin to damage parts.
- Evaluate results - not just cleanliness - what is the outcome and is it what you need.

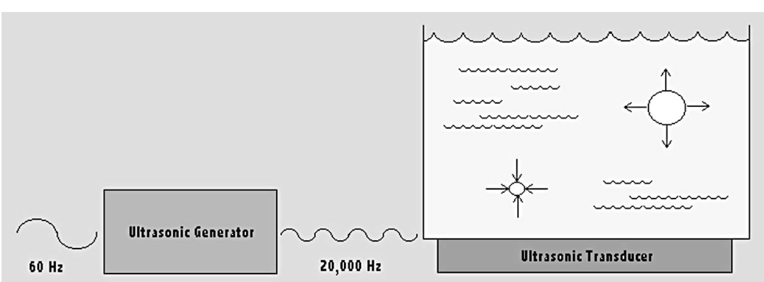


Fig. 3 — A basic ultrasonic system consists of a vessel to contain cleaning liquid, an ultrasonic power generator to produce ultrasonic energy and an ultrasonic transducer to convert electrical energy to mechanical-acoustical energy.

Once the cleaning process is determined, it is vital that the process be considered inviolate and unalterable when applying the cleaning process to production needs and when selecting and sizing the cleaning equipment.

In the second part of this article (to be published in an upcoming issue of *FTI*), discussion will center on how to integrate the process into the production requirements, ultimately resulting

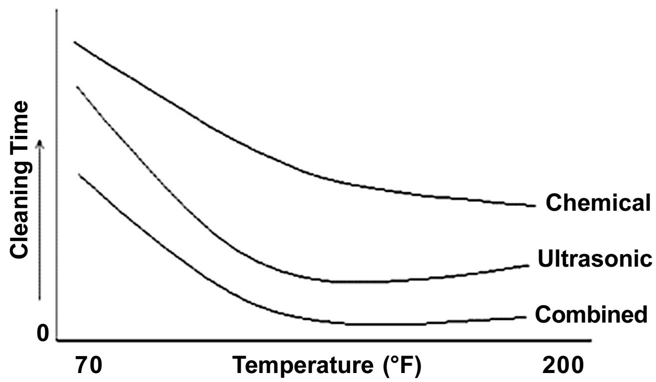


Fig. 4 — Comparison of chemical, ultrasonic and a combination of both cleaning processes.

in the selection and sizing of equipment. New technology for parts cleaning will be reviewed. A summary of the remaining two steps follows.

Integrating Process to Production

Once the process is established, it must be considered inviolate and unalterable. The goal here is to assimilate the equipment to the process. In this step, you are establishing such things as types and methods of part movement and ancillary equipment to support the process. These are objectively listed based on operational needs.

Do not specifically select and size the cleaning system equipment at this point. Doing so leads to the very common mistake of altering the process in order to accommodate available equipment. That immediately reintroduces some of those variables that were mentioned earlier, and which can often jeopardize successful cleaning.

- Rely on the information from the ESF - is it accurate to your needs.
- Assimilate the equipment to the process - not vice versa.
- Include all the process steps without alteration - do it the way it was developed.
- Insure seamless interface on both ends - operator to/from machine.
- Consider "real world" operating conditions - for your plant.

Selecting & Sizing Equipment

Now, and only now, you can select the specific industrial cleaning equipment for your particular application. You have established your needs in step one of your analysis, defined and proven the process in step two of the analysis and objectively listed the equipment and operational needs for your application in step three of the analysis.

- Consider the budget - differentiate needs against wants.
- Use standard equipment or modular components - improved cost and reliability.
- Select the appropriate options to support the process.
- Include or recommend ancillary equipment - filtration, automation, waste treatment, etc.
- Do the necessary engineering up front to properly size all components.
- Request a Proposal with a complete description, general operation and bill of material.
- Select equipment robust enough for real world production circumstances.

The result of this analysis is an industrial cleaning equipment installation that is appropriate for the intended purpose as well as one that ensures successful, predictable and repeatable results.

To receive additional technical specifications on the ultrasonic equipment and systems for aqueous industrial cleaning applications offered by Power Sonics, contact the author or **Circle 213.** FTI

Author's Note:

The Engineering Study Form (ESF) is offered as a tool for your use in analyzing your application. The questions listed in the ESF are those discussed above. A copy of the ESF is available by visiting ***www.powersonics.com.***

Company Profile...

Power Sonics*, a division of* ***MPP****, provides high power magnetostrictive ultrasonic equipment and systems for a wide variety of aqueous industrial cleaning applications requiring the highest levels of scrubbing action (cavitation). Standard products offered by the company include generators, transducerized tanks, immersible transducers, radial transducers, programmable hoists and filter systems. Power Sonics' generators are modular, solid-state designs available in various power ratings. They provide maximum flexibility in system layouts, and can be used as portable, individual units or can be incorporated into a multiple generator enclosure. Power Sonics also produces a radial transducer that is ideal for in-line cleaning of wire, strip and similar continuous products. The company can also custom engineer flexible ultrasonic cleaning systems and equipment to specific user requirements. Power Sonics' standard generators and transducers have been designed to be interchangeable with the equipment previously manufactured by* ***Westinghouse Electric****. MPP, which is owned by* ***Reid Assets Management****, Cleveland, OH, USA, consists of* ***Magnus Equipment****,* ***Power Sonics*** *and* ***Pro-Fab Manufacturing****.*

Four-Step Method for Solving Industrial Cleaning Problems — *Part 2*

Presented at
IFFI Technical Conference
IFFI 2005

by:
Robert E. Miller, VP
Power Sonics,
Division of MPP
5320 Enterprise Street
Eldersburg, MD 21784 USA
www.powersonics.com

This article is the second part of two describing a proven method to analyze a cleaning problem, develop the cleaning process, integrate the process to production needs and select and size appropriate equipment. While *Part 1* was applicable to all types of industrial cleaning, *Part 2* is of particular interest to makers of fasteners and other high-volume, small-part production items.

This and last issue's articles are not intended to be a comprehensive tutorial on industrial cleaning. Rather, they are intended to guide the reader through a procedure that will expediently and accurately define the problem, devise a cleaning process and result in equipment appropriate for the application and production requirements.

Industrial cleaning today is a complex undertaking. Determining the most appropriate and successful means to clean parts for your manufacturing needs requires a thorough and disciplined approach. Each cleaning problem is unique from another because of the many variables in the manufacturing process. First, and foremost, identifying all the factors that affect your application is critical to developing the optimum cleaning process. Integrating that process with production and plant requirements through proper equipment sizing and selection is what assures success in obtaining clean parts.

In today's manufacturing environment, too often there is little time for investigating the best process. A usual shortcut is to acquire a duplicate of a machine that is already being used. If not an identical application, this often leads to getting what is called "90% clean." The first 90% is relatively easy to accomplish, but the last 10% is another matter entirely.

If followed as defined, our four-step procedure simplifies and expedites resolving industrial cleaning problems and produces consistently successful results. The four steps are:

- Analyzing the problem.
- Developing the process.
- Integrating process to production.
- Selecting and sizing equipment.

In the last issue's Part 1 of this article, we analyzed the problem and then we developed a process to successfully clean our parts. Here it is important to remember that once the cleaning process has been determined, it is vital that the process be considered inviolate and unalterable when applying the process to production needs and selecting and sizing the equipment. In this article, discussion centers on how to integrate the process into the production requirements ultimately resulting in the selection and sizing of equipment. New technology for parts cleaning will be reviewed.

Integrating Process to Production

Again, once the process is established, consider it to be inviolate and unalterable. While the process was developed relative to parts-handling considerations, more importantly, it was developed relative to the aspects necessary to ensuring a clean part. The actions needed to clean the part may not be compatible with the current method of handling parts through manufacture.

The goal then is to assimilate the equipment to the process. In this step, you are establishing such things as types and methods of part movement and ancillary equipment to support the process. These are objectively listed based on operational needs. Do not specifically select and size equipment at this point. Doing so leads to the very common mistake of altering the process to accommodate available equipment. That immediately reintroduces some of those variables mentioned earlier and often jeopardizes successful cleaning.

- Rely on the information from the ESF (Engineering Study Form in last issue's article). It is accurate to your needs.
- Assimilate the equipment to the process, and not vice-versa.
- Include all the process steps without alteration— do it the way it was developed.
- Ensure seamless interface on both ends— operator to/from machine.
- Consider real-world operating conditions (relative to your plant).

The first consideration is to determine the production rate. In simplest terms, the production rate is quantity per time. But the quantity should be defined as the maximum quantity that must be produced during the most critical time period. If the production rate is even and steady, then it is easily defined. However, if production is sporadic and cannot be averaged out over a longer period of time, then the production rate must be defined as the peaking rate. This definition is critical to not only sizing the equipment, but may affect the actual selection of the type of equipment.

Conversely, do not confuse real-world production needs today with desired production rates targeted in the future. Seldom are those desired rates achieved. However, if a future rate increase is likely to occur, size the components difficult to retrofit, like base tank capacities, into today's system and leave components that can be more easily up-sized, like filtration systems, for tomorrow.

It is important here also to define periods of operation, for example hours per shift, shifts per day and days per week. Knowing this information, can influence and affect selection of items like tank capacities, sizing components for duty cycles, life of cleaning media, type and size of filtration, solution make-up and preventive maintenance considerations. More continuous operation of equipment must be accommodated with more robust components and ancillary equipment. If shortcuts are taken here, the process will be compromised at some point in the future, and the result will be poorly cleaned parts resulting in rejects or even premature product failures.

Resolving problems caused by undersized equipment are often difficult to do after the fact and often more costly than making the right decisions up front. If your budget is inadequate for your needs, then either pare down your needs or make a fair evaluation of the costs likely to be incurred in the future if the system fails to "keep up." If the evaluation is done properly, good capital decisions are made.

Next is to choose whether the products are to be processed in batches or continuously in a part-by-part manner. Regardless of how parts are currently handled, take time here to consider if an alternative or change is warranted. Review the process to see what it took to clean the parts. Key process factors like part orientation, nesting and masking of critical surfaces are commonly minimized and compromised at this point because of "existing practices."

Batched parts can be those fixtured into a carrier or tray or randomly nested together in a basket. Just because parts may currently be batched at some point in the manufacturing process does not mean that they have to be cleaned in a batch. Make the decision of batch operations based on needs such as fixturing or matching with other parts or unique carrier requirements. Most other batch considerations can be accommodated with in-line or part-by-part cleaning.

When evaluating options for handling parts, consider the following questions:

- Are carriers used now?
- If so, what type of carriers are involved?
- What is the carrier material of construction?
- Are parts fixtured?
- If so, how are they held?
- What material is used?
- How many and what weight is a part load?
- Can parts touch?
- Can parts move over each other?
- Can parts be rotated?
- If so, can they be tumbled or must they remain fixed?
- Will loading be manual or automatic?
- Will unloading be manual or automatic?
- Is vertical transfer to be manual or automatic?
- Is horizontal transfer to be manual or automatic?

These are the typical questions that should be asked with any application for conventional batch cleaning systems. But several things are different today. These are the same questions that apply if one would want to consider in-line parts cleaning. Additionally, in-line cleaning adds other questions not able to be asked in the past, such as:

- Is a gauging operation desirable to be integrated in the cleaning operation?
- Is 100% visual inspection to be conducted in the production cycle?
- Is part orientation at entrance and/or exit to the cleaning important?
- Would robotic interface or pick and place operation improve productivity?
- Is data acquisition by part a looming requirement?

These and other needs can often be better addressed with in-line and part-by-part cleaning systems and operations. Having the options of all of the historic batch methods and the newer technology in-line equipment described below makes it more likely to make cleaning operations not just a necessary evil, but also a revenue-generating step in the manufacturing cycle.

Only now, after we have analyzed the problem, developed the process and analyzed integrating the process to production needs, can we finally select and size our equipment.

Selecting & Sizing Equipment

Obtaining an equipment installation appropriate for the intended purpose of ensuring successful, predictable and repeatable results requires that the following points all be included in your analysis.

- Consider the budget—differentiate needs against wants.
- Use standard equipment or modular components—improved cost and reliability.
- Select the appropriate options to support the process.
- Include or recommend ancillary equipment—filtration, automation, waste treatment, etc.
- Do the necessary engineering up front to properly size all components.
- Request a proposal with a complete description, general operation and bill of material.
- Select equipment robust enough for real-world production circumstances.

We will not explore the myriad of traditional equipment available in the industrial cleaning world today. But we will describe two new technologies now available that give a whole new perspective to small-part industrial cleaning with options heretofore not available or only available as high-priced one-off custom engineered systems. While these new technologies impact the effectiveness of the actual cleaning, they are perhaps better categorized in the manner of how parts can be handled through the cleaning system.

In-Line, Continuous-Flow, Individual Part Transfer

The most common practice over the years has been to collect the dirty parts in totes, baskets or carriers for later cleaning as a batch, often as a nested batch. That was because product was typically moved through the manufacturing plant in batches. But product is created individually on a part-by-part basis. That may be a very high production rate, but still part-by-part.

In recent years, more and more companies have choosen to clean parts immediately from the previous manufacturing operation and ideally as a continuous next step before assembly, testing or packaging. Some in-line, continuous-flow, individual part cleaning advantages include:

- Reduced work in process and parts handling operations reduces labor content.
- Cleaning can often be done faster and more thoroughly.
- Complex parts configurations are easier to clean as individual parts.
- Chips are often easier to eliminate from individual parts.
- Part-on-part contact is reduced or eliminated.

Continued...

Until now, most in-line cleaning has been by methods such as sprays or in a vibratory bowl with or without media. Certainly these methods have their applications, but their costs and limitations are greater each year as production rates, part configurations, critical surfaces, part cleanliness and the like become greater, tighter or more stringent.

The biggest breakthrough is in the field of ultrasonic-based, in-line, continuous-flow parts cleaning. While in-line ultrasonic cleaning is not new (we have been building such systems for over 30 years), it has been typically limited to continuous product such as wire and rod and not suited to individual parts such as fasteners. Or they have been custom or one-off systems based on flat transducer technology, which have usually been large and expensive and less suited to cellular operations.

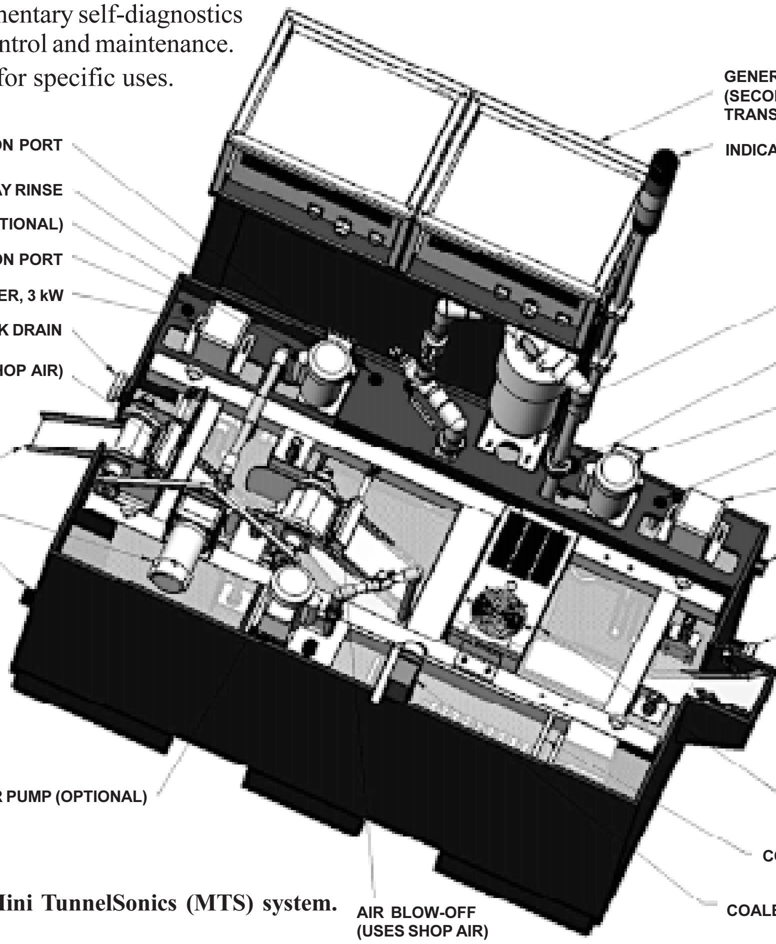
That has changed recently with the newest technology involving the development of a unique radial ultrasonic transducer and accompanying ultrasonic power supply. Developed specifically for use together, these products provide the following advantages:

- Ultra-high power in short length reduces footprint requirements.
- A 360° ultrasonic action "scrubs" each part individually.
- Shortened entrance to and exit from bath immersion reduces footprint requirements.
- Compact modular component packaging reduces footprint and costs.
- IGBT (insulated gate bipolar transistor)-based generator produces variable signal outputs for different applications.
- Generator contains elementary self-diagnostics for better production control and maintenance.
- Different sizes/ratings for specific uses.

Standard Mini TunnelSonics (MTS) system complete and integrated in 6' (1.8 m) length.

Systems can now be packaged for small cellular and multiple product line applications. Systems as small as 5' (1.5 m) long for a third the cost of previous offerings are now possible. Individual parts from screw machines, headers and machining operations can now be cleaned immediately and then sent on for further operations, assembly or packaging.

Conveyorized immersion ultrasonic systems can handle a wide range of part sizes and shapes in a random load process. Individual parts or even assemblies can be fed directly from a production machine or other means such as feeder bowls.



Labeled view of typical Mini TunnelSonics (MTS) system.

Output can be to another manufacturing operation, container, conveyor belt, inspection operation or many other options.

Such a family of machines, called Mini TunnelSonics (MTS) systems, are designed for cellular application and central cleaning. Parts slide down under solution onto a conveyor. The loop conveyor transports the parts under immersion through a 360° radial ultrasonic transducer, and then up and out through spray rinse and wipe/dry stages. The base standard integrated and interlocked design fits in a 6' (1.8 m) length. The PLC-controlled base system includes pumps, filters and heaters as well as accommodates automatic loading and unloading. Inhibitor sections and hot air dryer can be added as options.

Another machine, the Tunnelsonics system (big brother to the Mini TunnelSonics) also handles random load orientation, but also features dry load/unload for those applications where parts may need to be fixtured or otherwise specially handled, such as robotic interface at entrance or exit. This version can also provide for ultrasonic rinsing and longer tunnel drying. This version is also more typically used when special needs for inspection or packaging are encountered.

Non-conveyorized Tank-Over-Tank continuous "pusher" systems, known as TOT for their size, can be considered when the same part is to be processed in a continuous, side-by-side manner. These continuous systems take parts in a uniform orientation into a feed channel. Then they are pushed through the cleaning stages on a straight line and exit the system on the same horizontal plane and in the same orientation as they entered. This method makes inspection, packaging or other handling or manufacturing operations easier to automate.

For applications where water is bad for the process or where a batch operation is preferred, another new equipment development is offered. The VOC Compliant Solvent Systems, ML-24 and ML-24R are specifically designed for fastener and small-part cleaning. These are now available as standard-design, specific-use systems with or without rotation and in either manual transfer or fully automatic system packages. These compliance solvent systems can also overcome some of the problems mentioned above. Applications where compliance solvents may benefit your cleaning application include:

- Cleaning the blind holes of screw machine parts with internal thread blind or extremely small through holes.
- Need to clean multiple metals or materials and diverse soils.
- Cleaning water-sensitive parts such as bearing assemblies.
- Low-to-medium throughput cleaning operations (400 to 4000 lb (181 to 1815 kg) per eight-hour shift).
- Cleaning metal parts sensitive to exposure to high-temperature cleaning applications.
- Where wastewater disposal is not available or is too costly.

Remember, choose the equipment to fit the process. Don't force the process to fit the equipment you wish to have. Today's equipment options are greater than ever before. Choose the type of equipment you might like and see if the supplier has a version that suits your needs, but never compromise your process.

The Engineering Study Form is offered as a tool for your use in analyzing your application and starting you on your road to successful cleaning. It is available through the web site **www.powersonics.com.**

To learn more about the ultrasonic cleaning systems and equipment offered by Power Sonics, contact the author or **Circle 207.** FTI

Typical TunnelSonics dry load/unload system.

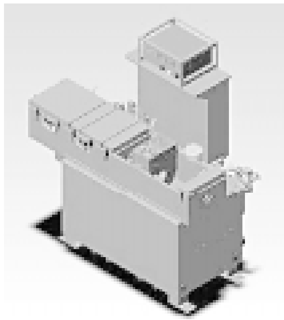
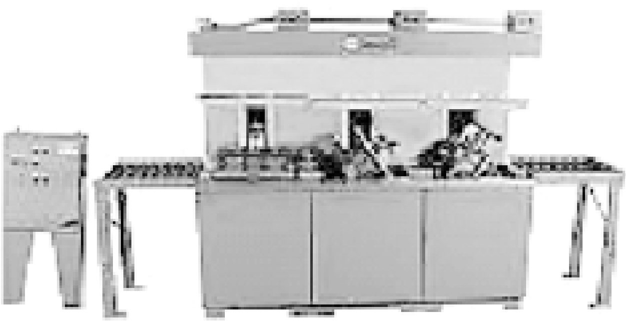


Illustration of typical TOT wash, rinse, dry system without the product channel in place.



Typical manual transfer, rotating three-stage VOC Compliant Solvent System.

Company Profile...
Power Sonics*, a div. of* ***MPP****, provides high power magnetostrictive ultrasonic equipment for many aqueous industrial cleaning applications requiring the highest levels of scrubbing action (cavitation). Standard products include generators, transducerized tanks, immersible transducers, radial transducers, programmable hoists and filter systems. Power Sonics' modular, solid-state generators come in various power ratings. They provide maximum flexibility in system layouts, and can be used as portable, individual units or can be incorporated in a multiple generator enclosure. Power Sonics also offers a radial transducer ideal for in-line cleaning of wire, strip and similar continuous products. The company can also custom engineer flexible ultrasonic cleaning systems. Power Sonics' standard generators and transducers are designed to be interchangeable with the equipment previously made by* ***Westinghouse Electric****. MPP, which is owned by* ***Reid Assets Management****, Cleveland, OH, USA, consists of* ***Magnus Equipment****,* ***Power Sonics*** *and* ***Pro-Fab Manufacturing****.*