CHEMICAL PROCESSING

| NNOVATION

SECURE SOLID SUCCESS

PutmanMedia®

TABLE OF CONTENTS

AD INDEX


Performance Guaranteed.
SIGNATURE SERIES™
High power, reliable performance, availability, and made in the USA. The all new SIGNATURE SERIES™ offers simplicity, reliability, clean design, ease-of-use, and an "Air-Tight Performance Guarantee™."
With more than 64 years of experience in vacuum conveying over 10,000 various powders and bulk materials, VAC-U-MAX was founded on the principles of high performance with simple and reliable operation, for process industries worldwide. Learn more.
Visit www.vac-u-max.com/SignatureSeries or call (800) VAC-U-MAX.
VAC-U-MAX
SIGNATURE SERIES™
"A Family of Solutions"
MADE IN THE USA
SINGLE SOURCE
CUSTOM ENGINEERING
APPLICATION EXPERTISE
VAC-U-MAX
DELIVERING MORE
GLOBAL SERVICE & SUPPORT
100% GUARANTEED
SINCE 1954
PNEUMATIC CONVEYING COMPONENTS & SYSTEMS • BULK BAG LOAD / UNLOAD SYSTEMS • BAG DUMP STATIONS
FLEXIBLE SCREW CONVEYORS • AERO-MECHANICAL CONVEYORS • MULTI-INGREDIENT HANDLING SYSTEMS
BATCH WEIGHING & SCALING SYSTEMS • UL-CONTROL PACKAGES • MOBILE CONVEYING SYSTEMS
69 WILLIAM STREET • BELLEVILLE, NJ USA • www.vac-u-max.com • (800) VAC-U-MAX

Stop Struggling with Your Slurry

Convert a settling solids suspension into a non-settling one

By Tom Blackwood, Contributing Editor

The problem with solids is that they don't want to move. This often results in solids settling out of slurries. The only thing preventing such settling is movement of the fluid, so we call slurries either settling or non-settling. The latter is defined by the saltation velocity or minimum suspension velocity. A 2006 *CP* article, "Avoid Trouble with Slurries," http://bit.ly/2HcQy7D, describes some primary correlations. However, these correlations don't address the issue of the pressure-drop/flowrate characteristics when working with solids that settle in pipelines or vessels. The flow of settling solids is a complicated affair.

Unfortunately, analytically based studies don't offer practical guidance. Researchers have pushed back the boundaries of the unknown only a relatively short distance. Their correlations rely on between 10 and 20 pseudo-physical properties. However, the coefficients and exponents in these correlations are based on quasi-uniform particles over a narrow range of the relevant variables.

So, we must rely upon direct scale-up methods that have proven successful for non-settling solids. Increasing the velocity beyond the settling point (saltation or choking) is an option; however, this raises pressure drop and pipe erosion/particle breakage. Converting a settling solids suspension into a non-settling suspension is a better alternative to ensure successful scale-up.

You can consider several approaches to make solids that settle stop behaving so badly:

Several techniques can make solids that settle stop behaving so badly.

- *Additives*. Introducing high-molecular-weight polymers, soaps or deflocculating agents (generally electrolytes) into a slurry can reduce pressure drop. The use of additives is common in the mineral industry (drilling mud, phosphate rock, limestone cement and coal) to cut the pressure drop while keeping the solids concentration unchanged. Small amounts of polymers (10–100 ppm) have proven to decrease pressure drop in the transport of large coal particles. Soaps provide an option that doesn't mechanically degrade as rapidly as high-molecular-weight polymers. Electrolytes reduce the zeta potential, which results in a lower head loss.
- *Vibration*. In certain situations, the oscillation of either the flow of slurry or the applied pressure can reduce head loss. Low frequency (5–10 Hz) tends to shift the peak velocity in a pipe from the center to nearer the wall, which aids in suspending the particles. This technique is most effective for non-Newtonian suspensions and decreases the terminal settling velocity. It has proven useful in inclined pipes where solids fold back on themselves. Vibration or oscillation of the pipe works but is much less effective than oscillation of the slurry.
- *Air injection.* For all Newtonian slurries in laminar or turbulent flow and for non-Newtonian slurries in turbulent flow, injecting gas into horizontal pipeline slurries will increase the pressure drop and shear on the slurry. However, this technique particularly suits shear-thinning fluids (i.e., pseudo-plastic non-Newtonian ones) because their viscosity decreases with increasing flow. The use of air injection on shear-thinning fluids can reduce the pressure drop or raise the capacity of a pipeline. Surprisingly, this technique hasn't gained wide application.
- *Fibers in suspension*. One very specialized option is using high-aspect-ratio (10:1) fibers to reduce drag. The current experimental information on this subject is contradictory but studies in the pulp and paper industry show that low concentration slurries flow as a plug with a lubricating water annulus adjacent to the pipe wall. In some cases, the pressure drop is lower than that with liquid alone.

- *Modified pipe geometry*. Many studies have indicated that a circular cross-section pipe isn't the most favorable for minimizing head losses in slurry flow. Among the alternatives evaluated are the use of segmented pipe of various geometries and the addition of helical ribs to the pipe. Some such configurations have reduced pressure drop by as much as a 20%. However, industrial acceptance has been poor, partially because these options increase both the weight of the pipe and installation costs. Also, there is fear that products may become contaminated or degraded.

If you have a troublesome settling slurry, there are many ways either to make it act like a non-settling slurry or at least increase the capacity of the pipeline. You can apply scale-up and design methods with confidence that the slurry pipeline will be trouble-free.

Make Sense of Ultrasonic Sensors

Understand the relationship among equipment, materials and environment when selecting the appropriate technology

By Dawn F. Massa Stancavish and Donald P. Massa, Massa Products Corp.

Many sensor end users believe that, to monitor solids reliably, they must either use an expensive technology, such as radar, or de-rate the distance of an ultrasonic sensor by half. In fact it has become accepted by the industry itself to do so. We challenge this concept and want to find out whether it's true or an accepted myth.

To ensure reliability and save money, understanding how to pair the proper sensor features with the application requirements and materials is key. Ask yourself and your suppliers how to determine whether a sensor is reliable for a particular application.

No model is a "one size fits all" solution, whereby the same sensor or transducer is the best match for each variation that may shift from situation to situation. Yet, it has become common to buy lots of the same type of product to outfit everything within a charge. It's okay to do this if your materials and environments are similar enough that they really don't change or if the product is the best fit with the best value because that lowers the costs along the way.

This paper examines the vast world of solids, and the general performance of ultrasonics when used with solids, while questioning the general practices of de-rating ultrasonic distance ranges by half. It also looks at the over-implementation of more expensive and complicated technologies in the place of better-valued options.

Furthermore, it focuses on how a reliable transducer and the manufacturer's expertise with the science of sound greatly affect the ultrasonic sensor's quality, reliability and performance in any environment. Ultrasonics can be employed much more effectively in a variety of environments, including for use with solids, even though the industry has misguided beliefs on how to use the technology in such cases.

Understanding which features in the ultrasonic design of the transducer and the sensor influence sensor reliability when used in or with solids can help achieve ultimate performance results. Ultrasonic sensors are a very cost-effective solution for solid measurement; recognizing how to choose the most reliable products allows control over the desired outcome, lowers cost of ownership and may minimize the need for more expensive technologies.

OVERVIEW

Unlike liquids, solids come in a variety of shapes and sizes. In industry, ultrasonics historically are the product of choice for use with both liquid level measurement and, on the other end of the spectrum, collision avoidance. However, the true functionality of how ultrasonics operate (or can best be used) in these applications is not as well-understood as believed. Likewise, it is accepted that, when there is a need to monitor a solid material, you should look at the reported distance range of an ultrasonic sensor and cut it in half to gain the proper accuracy and achieve a reliable measurement. This is an overgeneralization and often results in the customer ultimately selecting a more-costly product than is required to do the job well. More often than not, that purchase is either an overpowered ultrasonic product or a more expensive technology alternative, such as radar.

Ultrasonic devices all work in the same fundamental manner — they transmit a short burst of ultrasonic sound toward a target, which then reflects back to the sensor. These types of sensors measure the time from when the sound pulse is transmitted to when the echo returns to the sensor and then computes the distance to the target using the speed of sound in the medium.

However, not all ultrasonic sensors are created equal. In the case of solid measurement, it's more cost-effective for end users to look into better-matched products for each application. As an end user, you need to have more conversations about the materials you are monitoring and how certain sensor features can either be a help or a hindrance to both your monitoring needs and to your bottom line. In certain situations, a knowledgeable ultrasonics manufacturer can offer a new or modified product that lowers costs and outperforms in a given situation.

All aspects of the sensor must work properly and dependably to ensure that accurate distance measurements are obtained continually. True quality results in long-lasting products that continue to perform and meet specifications for years, even decades. Purchasing a well-chosen product at the outset will save money on your projects, and for your company, because sensors made with high-quality components should perform above expectation for a long time. This also will eliminate the costly downtime that comes with using inferior products.

Several factors can affect a sensor's reliability, specifically when used with solids. Transducer construction quality, beam angle type and the general nature of the solid material being monitored all are critical factors.

Some solids are dense, some are chemical-based, some have dust, some are bulky, and all have differences. Some require monitoring within a highly regulated and spec distance range, while others are not so tightly controlled. Some solids mix with liquids to create a slurry, while others are kept in low humidity.

The electroacoustic transducers that transmit the sound pulses and receive the return echoes within a product can be somewhat of an enigma to the average buyer. Just like the old maxim "Buyer beware," many fear the risk of selecting an inferior product, so they often will purchase a more powerful or more expensive product than is required.

The transducer's quality and the craftsmanship of its design can drastically affect the reliability and performance of the sensor in which it's used. The more knowledgeable an ultrasonic sensor provider is with the physics between the sensor and the materials it will work with, the better it is for the buyer. For whatever reason, customers often are not forthcoming with their monitoring situation. However, whatever can be shared with a knowledgeable manufacturer will result in a better-matched product for the application.

Two major areas affecting transducer reliability need to be considered. The first is to ensure that the transducers have the proper electroacoustic and mechanical design for each application. The second is how the transducers are fabricated.

THE DESIGN AND APPLICATION RELATIONSHIP

The sensor's acoustic and the mechanical designs are interrelated because one affects the other. A strong understanding of both is critical for proper transducer design. Some differences exist between the two as well.

The acoustic items include frequency, beam type, beam angle and sound attenuation, to name a few. The mechanical items include the materials used in fabrication, so that the transducer not only holds up, but also performs well in multiple environments, media and applications. Understanding the relationship between acoustic and mechanical design within a particular environment is imperative when assessing the reliability of an ultrasonic sensor and transducer.

Various solids can affect the reflectivity of the echo, thereby affecting the perceived reliability and performance of ultrasonic level sensors. However, it is extremely important to discuss your monitoring needs with a company knowledgeable on the sensor's applicability. A sensor manufacturer that understands the various monitoring applications can properly guide in sensor selection by taking into consideration the density and physical qualities of a solid.

Depending on your application, you may have a greater emphasis on reliability than accuracy. You may have a greater emphasis on accuracy than range. You may have a greater need to monitor within a specific range with greater reliability than is required or specified. Communicate this information when selecting a sensor. Knowledge of a solid's physical structure, density and nature and how it affects an ultrasonic's echo will help determine the type of ultrasonic needed. Some materials can affect ultrasonic performance more than others.

With use in some materials, ultrasonics may need to be de-rated for distance, but not always by the recommended 50% for solids. In some cases, they need only be de-rated by 25–30% and in other situations only by 40%. Furthermore, the amount you need to de-rate the ultrasonic sensor is affected by the beam angle, the quality of the transducer and how far away the sensor needs to be to the material in question. Some mid-range and close-range ultrasonic sensors, such as the MassaSonic FlatPack from Massa Products Corp., have broad beams designed for use with uneven sensors and do well with solids and the uneven nature of how they build up within a tank or bin.

The sound pulse from the sensor produces a well-defined echo from a smooth liquid surface. A turbulent surface, or the uneven surface produced by solid material in the tank, however, can cause the reflected echo to scatter, and it will not be properly detected by a sensor with a narrow beam angle. A broader beam angle will create echoes that are detectable. Also, solid material in the tank, such as grain, can form a sloped surface, instead of the flat level surface created by a liquid. This can cause the sound beam to reflect away from the sensor, so that the echo cannot be detected.

The design of a transducer's radiation pattern also is important. Most ultrasonic sensors use transducers that utilize the teachings of U.S. Patents 3,928,777 and 4,011,473 that were issued to Frank Massa in 1975 and 1977, respectively. Transducers of this design have a 10° beam angle (8° system beam angle) for any frequency of

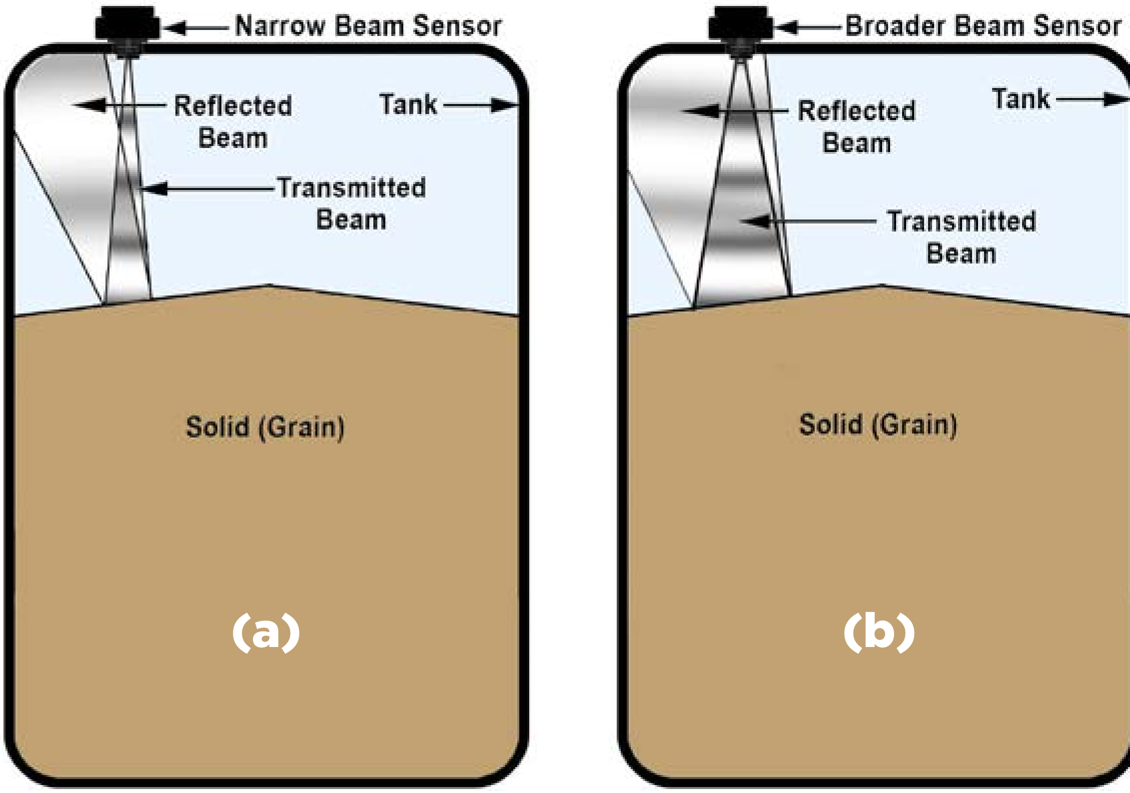


Figure 1. These narrow beam and broader beam sensors are mounted on tanks with their conical beams reflecting from the sloped surface of a solid material such as grain. The narrow beam (a) reflects away from the sensor, and echo is undetected, while the broader beam (b) reflects back to the sensor, and echo is detected

operation. This is good for flat reflecting surfaces; however, a broader beam angle is necessary if the reflecting surface is turbulent, uneven or tilted relative to the axis of the sound beam.

Figure 1 illustrates two tanks containing a solid material such as grain with a slightly sloped surface caused by the grain entering the tank from the top. Figure 1(a) shows how the echo from a narrow beam sensor reflects from the sloped surface of the material in the tank away from the transducer, so it cannot be detected. Figure 1(b) shows that the echo from a broader beam sensor returns to the transducer after reflecting from the same sloped surface of the material in the tank, and it is detected.

Designing a transducer that is adjusted for the environment will deliver more accurate results, and it will help the ultrasonic in its performance within the medium for a longer period of time.

The materials and the acoustics need to be fashioned to achieve desired operation in the environment. Again, the quality and the reliability of the sensor you are building, or using, is greatly enhanced by the quality of the transducer within. Understanding the materials and the acoustics can give you an edge.

Acoustic properties change in different media and can give a false impression that they will not work as well as other technologies. When the transducer/sensor supplier is truly knowledgeable with respect to the acoustic properties, the materials and manufacture of electroacoustic devices, you will discover many new truths regarding the success, performance, reliability and cost-effectiveness of ultrasonic and sonar measurement in a variety of applications and media. This saves time and money!

To explore this concept in greater detail, let's discuss acoustics further: Transducers can be designed to operate at different ultrasonic frequencies and have different acoustic radiation patterns. Sound energy is absorbed as it travels through the air. The higher the frequency, the larger the attenuation of the sound pressure for each inch in the path from the transducer to the target, and then back to the transducer.

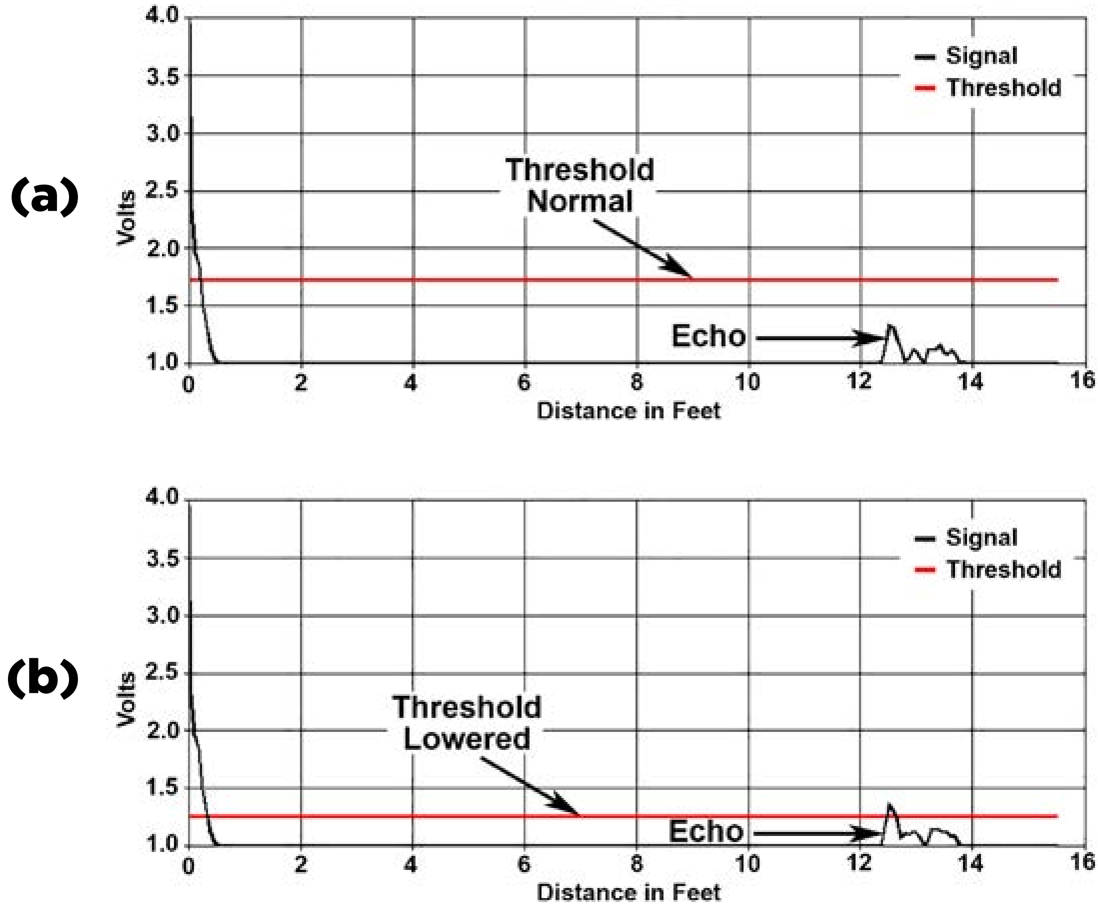
Therefore, the farther the distance to the target, the lower the frequency of the transducer will have to be. An acoustic specialist can identify what the proper frequency and beam pattern should be for any given application. It is inaccurate to assume that certain applications require some "standard" frequency or beam width. The more that a transducer designer knows about an application, the better the transducer and sensor will be — guaranteeing performance that outlasts all others.

SENSOR RELIABILITY

A sensor is actually a system. The system includes the transducer, the electronics and the sensor housing. Ultrasonic sensor reliability is greatly affected by the transducer's quality and the relationship between the electronics and the materials. This underscores the importance of working with a company that understands your application concerns and can either develop or recommend the best product for use with the solid you need to monitor. A higher quality transducer and a lower level of complexity in electronics result in a better sensor that also is lower in cost.

If a sensor is designed to allow you to capture and view the ultrasonic waveforms, they can be utilized to determine whether there are any reflecting objects that could cause false alarms or unwanted echoes. The ability to adjust the thresholds of detection allows you to account for and avoid unwanted reflectors and achieve stronger target detection in cases of scattering or poor reflectivity that might be present with the solid material.

This feature increases an ultrasonic sensor's overall reliability and increases the



SENSOR DATA
Figure 2(a). This ultrasonic waveform shows what typically occurs with scattering or poor reflectivity. Echo strength is below the threshold. Figure 2(b) displays an ultrasonic waveform from a 95-kHz MassaSonic PulStar Plus sensor with the same targets as in Figure 2(a), but with the detection threshold lowered to detect the target.

ability to get desired results without having to de-rate the ultrasonic sensor as significantly. Waveform capture also allows for troubleshooting, which enables fast assessment in real time.

Figures 2(a) and (b) depict what a target echo looks like when reflected from the surface of plastic pellets, which is a material that can scatter the sound. The waveforms show how the detection threshold can be lowered to capture a small echo when no unusually high background noise is present.

It is very advantageous to use sensors that allow the user to see a plot of the received echo vs. range This can reveal whether there is any unusual ringing, electrical noise, pickup or false targets. Thresholds normally are set higher to ensure that false echoes are not detected from possible ringing or electrical noise pickup that could occur in some installations. A smaller echo from a poorer reflecting target, such as solids, could still be above the background noise but below the "normal" target threshold detector. If the target is low because of poor reflectivity but is still above the background ringing or electrical noise for the installation, the threshold can be lowered to detect the echo.

FABRICATION

Manufacturing is more than simple assembly. To build transducers and sensors that are high in quality and reliability, it is vital to have a high level of expertise, knowledgeable and skilled workmanship and cooperation between production and design engineering. The facility should have high-quality controls and procedures in place.

The production line must contain proper tools, fixtures and processes to control the manufacturing quality. Highly qualified people also must be employed to construct instruments of this sophistication. They need to be trained in the proper techniques to build, seal and test the ultrasonics as this greatly reduces, and even eliminates, a product's failure rate.

CONCLUSION

Expertise in the design and manufacture of electroacoustic transducers is the main factor that affects the quality and the reliability of an electroacoustic sensor. Make sure the proper features of the sensor design are matched with the unique physical and chemical challenges that the solid material presents. It is only with this complete understanding that an electroacoustic sensor can be optimized to perform properly in challenging and caustic environments.

Common transducers are not as plug-and-play as once believed. Not all ultrasonics need de-rating by half for every solid measurement, and radar and other more expensive options might not be the best solution. The belief that they are is what has contributed to the common misunderstanding that ultrasonic sensors are unreliable when used in certain environments.

Mid-range ultrasonics can be a valid, practical and value-added solution to your solid-monitoring needs. If a transducer and sensor are optimized for the environment, then ultrasonic technology is a successful cost-effective choice for level measurement that will result in a lower cost of ownership.

DAWN F. MASSA STANCAVISH is new products manager and **DONALD P. MASSA** is CEO of Massa Products Corp. Email them at sensors@massa.com.

tigerflex®

Thermoplastic Industrial Hoses

VOLTBUSTER™

Superior Static Protection™

MADE IN THE USA

Static Dissipative Food Grade Material Handling Hoses

VOLT™

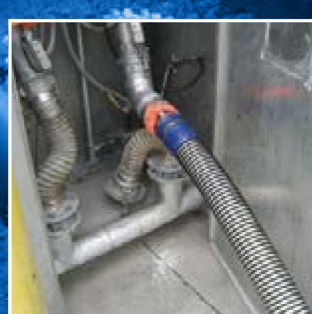
VLT-SD™

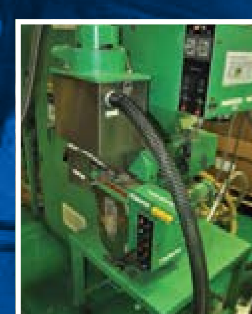
- *Superior Static Protection!*
- *Durable Abrasion Resistant!*
- *Food Grade!*
- *Light Weight!*

WINNER!

2013 VAALER AWARD

BY CHEMICAL PROCESSING





Kuriyama of America, Inc.

KURIYAMA OF AMERICA, INC. 50 YEARS SINCE 1968

NAHAD THE ASSOCIATION FOR HOSE AND ACCESSORIES DISTRIBUTION

TIGERFLEX™ ISO 9001-2000 REGISTERED Q.M.S.

Consider an Industrial Central Vacuum System

A fixed tubing network simplifies housekeeping, reduces equipment wear and eliminates trip hazards

By Vac-U-Max

Industrial hygiene equipment's value used to be measured solely by the reduction of incident-related and workers' compensation costs. Today, those measurements include impacts on the manufacturing process where shaving seconds off a single process can have a huge impact. In fact, simply shaving 3.2 seconds from a task can reduce direct labor costs by $29,000 per year, according to the American Society of Safety Engineers' (ASSE's) *ROI of Ergonomic Improvements: Demonstrating Value to the Business.*

Shaving seconds off a cleaning operation not only saves direct labor costs but also results in increased uptime. Industrial vacuum systems have become critical elements in an organization's ability to maintain comfortable profit margins by contributing to increased product quality, reclaiming materials and reducing wear and tear on equipment, which means fewer repair costs, less downtime for maintenance and, in turn, longer production runs.

Although using vacuums isn't new to industry, many companies have used shop-type vacuums instead of heavy-duty industrial vacuums to clean up dust and debris. They also have found them inadequate under the harsh demands of the industrial environment and noncompliant with safety and combustible dust standards.

In rugged industrial applications in which environmental safety, ergonomics and productivity matter, vacuum cleaners designed specifically to withstand rigorous 24/7 operation can deliver consistent performance that adds to a company's bottom line.

INDUSTRIAL VACUUMS

Powerful industrial vacuums deliver three times the vacuum rating of the highest-rated shop-type vacuums on the market today cover more area and pick up finer material. What once took users 2.5–3 hours now can be completed in less than half the time, speeding up overall productivity.

Frustrated with workers dealing with cords and cleaning filters on shop-type vacuums that needed to be emptied often, Mike Justice, plant superintendent at Valparaiso, Indiana-based AM Stabilizers, began researching industrial vacuums.

MEETS REGULATIONS
Figure 1. The Vac-U-Max 1040 central vacuum system fits within NFPA standards and OSHA regulations for indoor use without the need to penetrate walls or roofs for explosion vents.

AM Stabilizers is a global supplier of high-quality liquid and powder heat stabilizers for both flexible and rigid PVC applications. The Valparaiso plant produces powder stabilizers by blending raw materials and then packaging the finished product into a variety of containers based on customer's needs. These containers include valve bags, boxes, drums and 1,500-lb. super sacks.

"We produce about 8 million lbs of powder per year, and we needed a better way to keep the plant clean from spillages and airborne dust," says Justice. "The cleaner the area, the easier it is to identify problems in the system and head off any unscheduled downtime."

CENTRAL VACUUM SYSTEMS

A traditional central vacuum system appeared to be the best solution to a cleaner environment and to eliminate trip hazards that cords and vacuums created on the shop floor, but they also can be cost-prohibitive for smaller organizations, often requiring outdoor air permits as well as construction permits.

Stationary central vacuum systems are ideal for environments requiring continuous 24/7 operation and the simultaneous use of as many as 20 pickup points. These systems use powerful vacuum producers and high-efficiency filters connected to strategically placed piping throughout a facility connecting hoses to a common line.

While attending a trade show, Justice saw Vac-U-Max's model 1040 stationary industrial vacuum, which he considered an ideal choice for his operation (Figure 1).

Belleville, New Jersey-based Vac-U-Max, manufacturer of industrial vacuum cleaning and pneumatic conveying industries, can handle 10,000+ bulk materials, including powders, flakes, granules, pellets, fibers, capsules, gel caps and tablets. The company manufactures industrial vacuum cleaners for manufacturing and municipal facilities as well as government installations and environmental sites to improve cleanliness, working conditions and safety.

CUSTOMIZED, OFF-THE-SHELF SYSTEMS

Consulting with an industrial vacuum cleaning manufacturer often results in off-the-shelf solutions that are custom-fitted with accessories to meet a customer's housekeeping and budgetary needs.

The unit that Justice saw at the show features a powerful positive displacement pump designed specifically for high-volume recovery (as much as 5 tons per hour) and can support three operators at one time.

Because the system's filter separator and collector (or "dirty volume") are less than 8 ft3, it fits within National Fire Protection Association (NFPA) standards and Occupational Safety & Health Administration (OSHA) regulations for use indoors without the need to penetrate walls or roofs for explosion vents. The entire unit is grounded and bonded and is fitted with static-conductive filters per NFPA 77 for use with combustible, nonmetallic dusts.

The compact central vacuum system avoids much of the installation costs and delays of a traditional central vacuum system with its plug-and-play design and complete

VACUUM INSTALLATION
Figure 2. The Vac-U-Max vacuum system is easy to install and includes recommended setup schematics and a copy of its best practices booklet for piping.

UL-certified control panel, while still providing the convenience of a multi-inlet central vac, allowing multiple users in simultaneous operation.

Justice says the selection process was easy. "After some initial phone conversations, the rep came out, I showed him what I wanted, and he sent a print with a basic layout of what they recommended and how it should be run."

VACUUM SYSTEM LAYOUT AND SETUP

"It is small and compact enough with a 5 x 5 ft^2 footprint that it sits right at the side of our production line. It isn't in the way of anything," says Justice.

INCREASED PRODUCTIVITY
Figure 3. With the Vac-U-Max central vacuum system in place, AM Stabilizers has increased production because staff members no longer need to leave their stations several times a day to dump and clean the shop-type vacuum.

Justice set up 10 strategically placed pickup points throughout the facility, spanning two floors, with the bulk of them in production, a couple in the warehouse to handle raw materials spills, one near a mixer and another out by the loading docks. He also positioned several sets of hoses throughout the facility, ensuring no one needs to drag hoses around in key areas.

"Vac-U-Max provided several types of cleaning tools with the hoses, from vacuuming the floor to real thin angled pieces to get you into the corners and the nooks and crannies. It is all lightweight aluminum, so it is light and easy to handle," says Justice.

Although the vacuum is designed to handle two operators using the system simultaneously (three when less than 200 ft of tubing is run), Justice says that the "vacuum performs better than what the salesman told me." On occasion, three operators use the system at the same time. He says that although "the suction doesn't pull as hard as it can with only two users, it is still better than a shop vac pulling dust, powder and dirt from all around."

The vacuum manufacturer provided schematics for recommended setup and also a copy of its "Piping Network Best Practices" booklet (Figure 2). Justice says the system was "very simple to install with one person. It took me three or four days to install working on it a few hours a day.

"It is a great unit. It is a huge perk for us to be able to change from electrical cords and vacuums everywhere to where we just plug in with a 1.5-in. hose and vacuum up what we need right away," says Justice.

RISING PRODUCTIVITY

In fact, he says his staff members are "more productive because they no longer need to leave their stations several times a day to dump and clean the shop-type vacs. We are saving roughly 30 minutes per day."

Instead, the unit is equipped with a 30-gal. drum that is dumped at the end of each shift into a containment box that is managed by an industrial waste management company that disposes of it according to environmental regulations (Figure 3). The vacuum manufacturer also offers additional material handling choices for collected debris.

When asked about any surprises with the system or its installation aside from the increased performance, Justice noted the system is very quiet. The 1040 system is equipped with noise mufflers and guards so sound levels are less than 79 dbA, below OSHA's limit for an 8-hour period. "We still don't have to require hearing protection, and that is a big benefit," he says.

"I would recommend this Vac-U-Max system to anyone who does small manufacturing and has a lot of dust and debris they need to clean out," Justice says.

VAC-U-MAX designs and manufactures pneumatic conveying systems for bulk material handling and industrial vacuum cleaning systems for high volume recovery of many types of materials including powders and combustible dusts. For more information visit www.vac-u-max.com.

Save Time on Viscosity Measurements

The cone plate method makes the most of small sample sizes

By Robert G. McGregor, AMETEK Brookfield

Formulating new products in the chemical industry often requires working with limited sample volumes during development phase efforts. Therefore, viscosity measurement requires an apparatus that can work effectively with small amounts of newly formulated material.

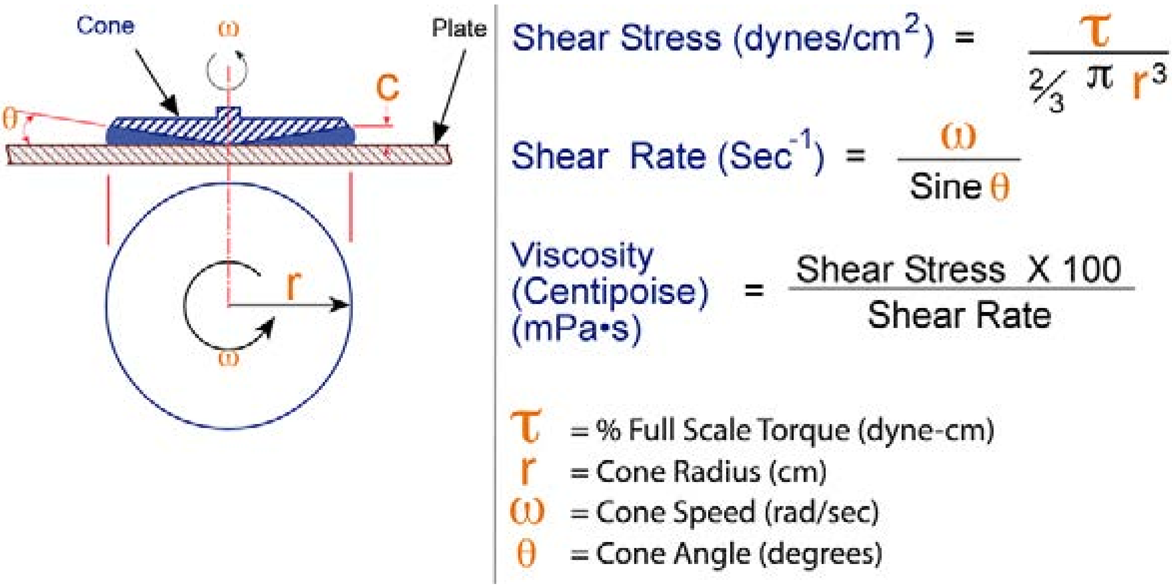
Quality control (QC) also may need to implement a similar test procedure for pass or fail determination during manufacturing, so it makes good sense to choose an instrument that is used easily by QC technicians as well as research and development (R&D) scientists.

One popular choice is the cone plate method because it works with sample sizes on the order of 2mL or less. In fact, depending on the cone spindle used, sample volume can be as low as 0.5mL, which is ideal when limited amounts of sample material are available.

Another advantage of the cone spindle is the range of shear rates that can be applied when testing the sample material. This adds value to the flow characterization work performed in R&D where processing operation simulation will model shear rates in pumps, pipes, filters and nozzles.

CONE PLATE MEASUREMENT

The cone plate measurement system consists of the cone spindle, which looks flat but is angled slightly relative to horizontal, and the sample plate on which the material is placed (Figure 1). The plate is temperature-controlled using either an external circulating water bath to provide working



CONE PLATE METHOD
Figure 1. Cone plate measurement includes the cone spindle and the sample plate on which the material is placed.

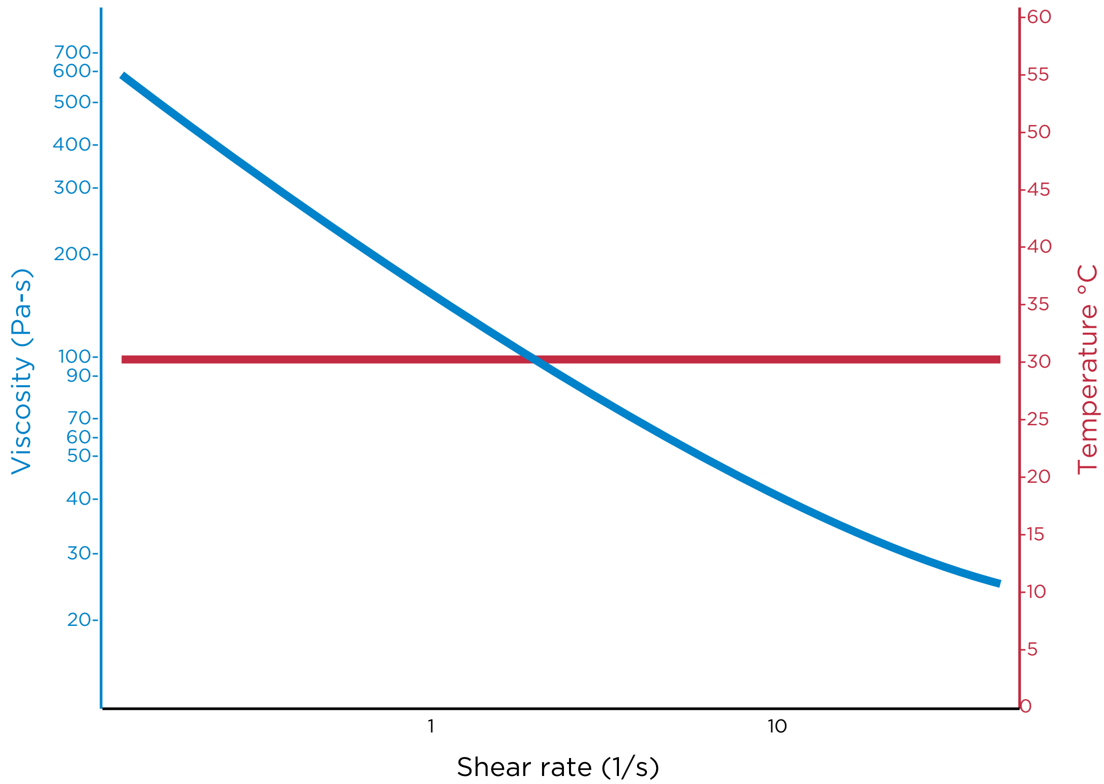
fluid at defined temperature or built-in Peltier electronics within the instrument.

Sample testing routinely is accomplished at a defined temperature, often 25°C, but frequently at additional temperatures characteristic of the chemical process or the storage facilities where final product is kept. The sample is placed on the plate, the cone spindle comes down into contact with the test material, and both are allowed to equilibrate to temperature for an appropriate time interval, usually only a matter of seconds. The cone spindle then rotates at one or more speeds, and the viscosity at each speed is measured.

CONTROL PARAMETERS

Shear rate (the cone spindle's rotational speed) and temperature are the control parameters R&D defines when performing the viscosity measurement test. The geometry of the cone spindle relative to the sample plate mathematically is defined as cone angle, usually a value between 0.5° and 2°. This makes it possible to convert the rpm value for spindle speed into a rheological parameter called shear rate with scientific units of sec^{-1} or reciprocal seconds. The choice of rotational speed(s) for the test can be based on shear rates that are relevant to how the sample material will be processed in manufacturing or used by the customer during application.

Shear rates found in pipe flow typically are between 1 and 100 sec^{-1}. Flow through a nozzle can experience shear rates as high as several thousand reciprocal seconds, depending on the aperture's diameter.



VISCOSITY FLOW CURVE

Figure 2. This table shows the viscosity flow curve. As the shear rate increases, the viscosity decreases.

Using this analytical methodology for determining shear rate, R&D selects one or more shear rates that will be appropriate for the test method. The viscosity flow curve generally will have a profile similar to Figure 2. As the shear rate increases, the viscosity decreases, which indicates there is less resistance to flowing the material at a faster rate.

PASS OR FAIL TESTING

QC, working with R&D, uses this initial viscosity data to decide which type test will work best when qualifying materials for acceptability during manufacturing. A single point viscosity test is most common in the QC world. This means that a single data point from the viscosity test is used to pass or fail the material. This data point is selected from the viscosity flow curve. The QC test is defined by spindle type, rotational speed, control temperature and length of time for spindle rotation.

Experienced QC departments using the cone plate method can save significant time compared to earlier practices when 600mL beakers containing the test sample

BENCH TOP RHEOMETER
Figure 3. This bench-top rheometer displays a viscosity test's data in graph format and determines whether the material passes or fails.

were evaluated for pass/fail. Working with a small sample size is the key factor to achieve rapid test results.

VISCOMETER CAPABILITIES

Advancements in viscometer capability make it possible for today's instruments to test automatically for viscosity at multiple shear rates and compare the resulting flow curve to a reference benchmark for acceptability.

Figure 3 shows a bench-top rheometer with built-in graphing capability that displays flow curve data quickly from a viscosity test and makes a pass/fail determination. There's no time like the present to review your QC test methodology and decide how best to take advantage of cone plate technology with its broader testing capabilities.

ROBERT G. MCGREGOR is director, Global Marketing & High End Lab Instrument Sales, AMETEK Brookfield, Instrumentation & Specialty Controls Division. Reach him at r_mcgregor@brookfieldengineering.com.


MASSASONIC®
Get Solid Measurements
with Midrange Ultrasonics
Handle Uneven Surfaces & Variable Density Material with Ease
Conveyer Blockage Detection • Chute Fill Level
Storage Pile Height • Renewables Processing
Transparent Materials • Feed Bins
Reliable and compact sensors suitable for harsh environments.
Knowledgeable application assistance.
Quality at an excellent price/performance ratio!
Harness the Value
MassaSonic PulStar® & FlatPack® Sensors
sensors@massa.com | 781-740-6117
www.massa.com
Made in the U.S.A.

Choose the Right Equipment

Certain processing technologies can help increase a powder's flow capabilities

By Matt Hicks, Federal Equipment Co.

Most active ingredients and adjuvants used in pharma manufacturing are in powder form. Handling and processing of powders is central to pharmaceutical and many chemical operations, but they pose problems because of their unpredictable and irregular behaviors. With recent technological developments, the industry can overcome powder flow hurdles to achieve a quality product.

CAUSES OF POWDER FLOW PROBLEMS

Powders will behave like both solids and liquids, which leads to product flow issues. As a metaphor, good flow can be compared to granulated sugar, while bad flow can be compared to powdered sugar.

Flow issues can result from a product's reaction to handling issues, such as settling or compaction while in storage, and process equipment issues related to product uniformity, including too much or not enough blending.

Physical characteristics and interaction with the processing environment determine a product's ability to flow.

Physical characteristics include:
- Bulk density
- Particle size, shape and consistency (or distribution, i.e. "particle size distribution")
- Surface area
- Moisture content
- Cohesiveness

Interaction with environment considerations include:

- Temperature
- Humidity
- Hold time (time spent in storage or containers before use)

DIAGNOSING THE SOURCE OF POWDER FLOW PROBLEMS

Often, the result of all powder preparations is not discovered until production. In pharmaceutical applications, that means when the tablets come off the press. While no single test method can characterize powder flow adequately, United States Pharmacopeia (USP) has identified some test methods that may help predict a powder's likelihood of encountering flow issues in production.

They include:

- *Angle of repose.* The angle of repose is a 3-D angle (cone). This is related to the friction or resistance of movement between particles. Experimental difficulties can arise as a result of material segregation, but the method continues to be used in the industry.
- *Compressibility index and Hausner Ratio.* These simple, fast and popular methods predict powder flow characteristics. They are determined by measuring a powder's bulk volume and tapped volume.
- *Flow rate through an orifice.* The most common method for determining flow rate through an orifice is based on three variables: the type of container used to contain the powder, the size and shape of the orifice and the method of measuring the flow rate. Flow rate generally is measured as the mass per time flowing from the container.
- *Shear cell.* Many shear cell test methods are available and offer a greater degree of experimental control. However, the methodology can be time-consuming and requires a well-trained operator.
- *Particle size distribution*. This is a particularly sensitive test and very predictive in terms of addressing flow and compaction problems for a given powder. A powder's target particle size distribution (PSD) can be selected, and the appropriate particle size specifications should be established to control drug product quality and ensure manufacturing consistency.

MAKING THE BEST EQUIPMENT CHOICE

Tablet manufacturing processes have a profound effect on how efficient a drug is. As a result, the global tablet processing and packaging equipment market is expected to increase from $3.45 million in 2017 to $5.26 million by 2022. Much of the increased demand for this equipment will, in fact, be for refurbished machines.

Free-flowing powders are preferred for efficient production, and most active pharmaceutical ingredients (APIs) are not free-flowing powders. The product should flow as fast as the production machine can operate.

Certain processing equipment can be used to increase a powder's mass flow capabilities by changing the product characteristics of the powder. Various types of processing equipment can be used to manufacture tablets, such as sieves and mixers, granulators and processors, dryers, mills and blenders.

Sieves. The two main types of sieves are safety screening and grading. Safety screening of powders, sometimes known as control sieving, or security or check screening, removes oversized contamination from the powder. Removing the contamination improves the quality of the powder and the final product. Grading or sizing of powders or granules separates different ranges of particle sizes to ensure the correct PSD for subsequent tablet pressing.

Granulators. Granulation is a common technique to help to improve product flow and achieve mass flow. Powder granulation can reduce inconsistency in particle size, reduce fines (very small particles), control dust and reduce the tendency of powders to segregate.

Granulation can be performed wet or dry with high-energy or high-shear mixers; medium energy mixers such as planetary mixers, ribbon blenders and paddle mixers; or low-energy mixers such as fluid bed processors, double-cone mixers and twin-shell or V-blenders.

Another common granulation technique is roller compaction in which a roller compactor compresses the powder into strips or tabs to squeeze out air and then the product is milled for consistent particle size.

Dryers. Many granulators cannot dry the wet massed granulation, so the wet granulation must be moved to the next unit operation, which is called drying. When powders are sensitive to liquids, heat or both, blend the powders with a pre-granulated dry binder.

If the blended powders will not work with added dry binder and liquid — or heat cannot be used — then dry granulation is used. This method uses mechanical force to densify and compact powders together to form dry granules.

Milling Equipment. Milling machinery is defined by low-, medium- and high-shear applications. Some milling machines allow for changes in the type of mechanical action used to reduce the powder to the proper final particle size range. Common milling equipment includes low-shear mills such as oscillators and comils; medium-shear mills such as quick sieves and hammer mills; and high-shear mills such as pulverizers and blade mills.

Blenders. Good flow is imperative to attaining a good tablet. Understanding powder characteristics will contribute to accurate blending practices. A "good" final blend often is viewed as such because it has good content uniformity and potency, not by its ability to flow. An individual powder or finished blend may flow very well under one set of circumstance and not flow well at all under another.

The most common blenders used for final blending are the V-blender, the double-cone blender and the tote blender; all use low-shear tumble blending as the most effective way to achieve good mixing with a variety of powders and granules.

Tablet Presses. Many variables can contribute to the success or failure of powder flow on a tablet press. In addition to particle size, shape and distribution, consider particle surface texture, cohesiveness, surface coating, particle interaction, static electricity, recovery from compaction and wear and attrition while in the holding container. Most powders, without the aid of granulation and flow agents, simply cannot flow at speeds required for high-speed tableting.

MATT HICKS is chief operating officer and counsel at Federal Equipment Co. Contact him at matt.hicks@fed-equip.com.

ADDITIONAL RESOURCES

EHANDBOOKS

Check out our vast library of past eHandbooks that offer a wealth of information on a single topic, aimed at providing best practices, key trends, developments and successful applications to help make your facilities as efficient, safe, environmentally friendly and economically competitive as possible.

UPCOMING AND ON DEMAND WEBINARS

Tap into expert knowledge. Chemical Processing editors and industry experts delve into hot topics challenging the chemical processing industry today while providing insights and practical guidance. Each of these free webinars feature a live Q&A session and lasts 60 minutes.

WHITE PAPERS

Check out our library of white papers covering myriad topics and offering valuable insight into products and solutions important to chemical processing professionals. From automation to fluid handling, separations technologies and utilities, this white paper library has it all.

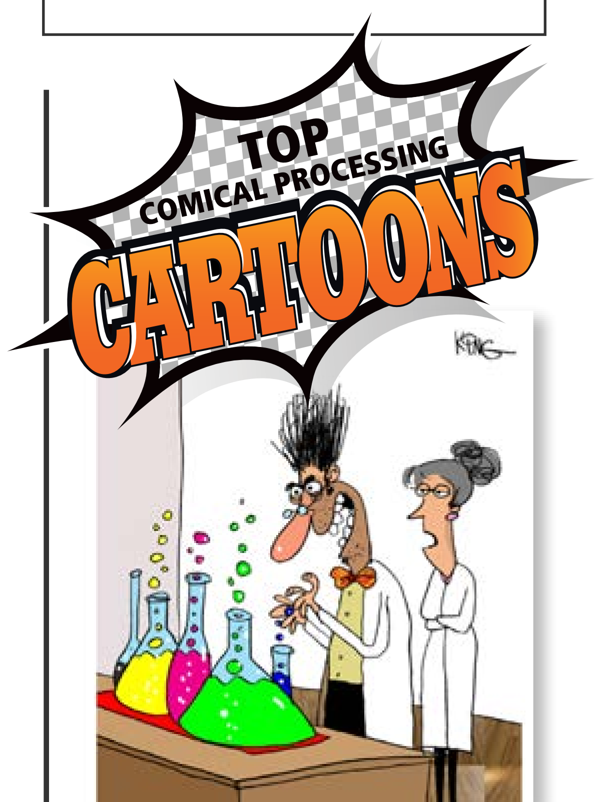
MINUTE CLINIC

Chemical Processing's Minute Clinic podcast series is designed to tackle one critical issue at a time — giving you hard-hitting information in just minutes.

ASK THE EXPERTS

Have a question on a technical issue that needs to be addressed? Visit our Ask the Experts forum. Covering topics from combustion to steam systems, our roster of leading subject matter experts, as well as other forum members, can help you tackle plant issues.

JOIN US ON SOCIAL MEDIA!



Visit the lighter side, featuring drawings by award-winning cartoonist Jerry King. Click on an image and you will arrive at a page with the winning caption and all submissions for that particular cartoon.