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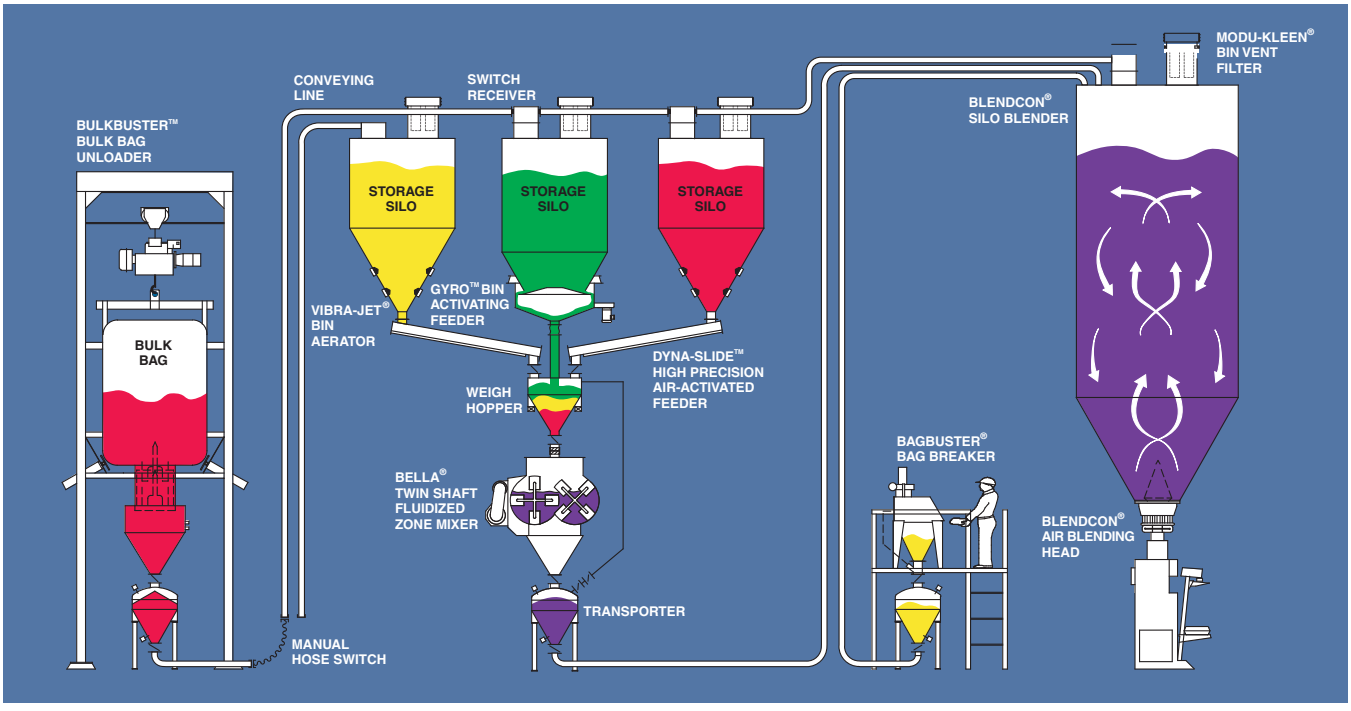

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The system is NFPA 484 compliant for handling metal powders. It is designed for ease-of-use, conveying metal powders in a closed system, eliminating operator exposure to metal dusts, thereby maximizing plant and personnel safety. The system utilizes vacuum via stainless steel vacuum receiver with 3.3m^2 of filter area. Vacuum generator includes VAC-U-MAX's Single Venturi power unit.

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PRODUCT FOCUS

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The Multi-Duty (MD) airlock is a universal airlock used to meter dry bulk materials under feeding devices, such as bins, hoppers, mixers, screw conveyors and sifters.

Providing rugged service, the airlock is suitable for use in dilute phase vacuum, pressure or combination vacuum/pressure pneumatic conveying systems. Its low mounting height is ideal for space restricted applications. With a low profile and a wide flange width, the MD airlock is able to match drill hole patterns of many competitor's valves for easy replacement.

A domed hopper cover and open bottom frame speeds and optimizes draining during and after wash-down cycles. Smooth, crevice-free product contact surfaces at 32 micro inch or better help prevent the formation of bacteria.

The MD has a cast housing and endplates with a square flange. The rotor and housing are precision machined to obtain a high degree of accuracy and close tolerances. Close tolerances hold the differential pressure across the valve to reduce air leakage. Reducing leakage saves supply gas, reduces spikes in velocity and stabilizes the system.

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Develop Drying Curves

They can provide insights for solving many problems

By Tom Blackwood, Contributing Editor

When faced with a drying problem at a plant, the first thing I ask for is a drying curve. Often, people will look at me as if I have three heads —sometimes grumbling: "Why do we need that? We know that drying the material completely takes twenty minutes." A drying curve can serve several valuable functions; determining the time to reach a certain solvent level seldom is the main one. Unfortunately, one curve doesn't tell the whole story. The number of curves needed depends on the type of problem.

Drying curves can be expensive to obtain. So, I try to balance my request against the value of the information gathered. There's no reason to study something unless you know what you'll do with the results. This underscores the crucial need to identify beforehand the specific data to collect.

The most common drying curve obtained is for oven batch operation. A better option is to use a thin bed of solids to capture something close to single particle drying — this allows for the simulation of many types of dryers. An alternative is to estimate from the oven drying curve the critical and equilibrium solvent content and then use a fluid-bed or rotary device to gather more-precise data. Product stability is best evaluated via differential scanning calorimetry (DSC) to identify any phase changes. Often, this can be conducted with a differential thermal analysis to obtain a rough drying curve. The DSC pinpoints heat flux that may impact the drying process and overall heat requirements.

It's best to calculate remaining solvent from exit gas humidity.

A batch drying curve can serve for estimating performance in both batch and continuous dryers. For high-value products, consider a small-scale continuous drying test. You can do one by visiting a dryer manufacturer or renting a pilot unit — but it isn't an appropriate method to generate a drying curve.

You require basic physical properties such as heat capacity, particle size, density and flammability of the solid and liquid. It helps to know any temperature limitation (continuous, short-term), sticky point and minimum fluidization velocity for the material because these determine the potential for product damage and clumping. One factor often overlooked is the ambient environment around the dryer. Dryers need to get rid of the solvent; high ambient humidity or not enough gas flow in the dryer can hinder this. If the gas leaving a dryer is saturated with solvent, you can guarantee that drying is limited.

A drying curve test should include at least three constant inlet temperatures that are below any temperature limitation — except perhaps for products that require a phase change or dehydration. In each test, the inlet conditions (temperature, flow, humidity and pressure) should remain constant.

You can generate the drying curve in three ways: 1) remove a sample as drying proceeds; 2) measure the loss in weight; or 3) calculate the remaining solvent from the exit gas humidity. The latter approach doesn't disturb the bed of solids and is much more accurate, especially in the later stages of drying. You must adjust loss-in-weight data for buoyancy effects and composition of the loss in weight. Removing a sample for analysis reduces the dry mass of solids under study and makes correcting the overall mass balance difficult. Also, disturbing the bed can mix the solids and promote drying, resulting in an overly optimistic drying rate.

Along with the solvent content as a function of time, you need the temperature of the bed. This may require multiple measurements due to non-uniformity of the gas flow over or through the solids.

No drying curve would be complete without an understanding of the equilibrium moisture content. Determining this can be very difficult because some materials take years to reach equilibrium. A good

approach is to maintain a constant humidity on the dried sample for an extended period of time. High humidity is most important because it has the greatest effect on final solvent content of the solids.

From these curves, you can determine the critical solvent content (there may be two or more) and local drying rate along with any limitations due to equilibrium effects. These data are worth having.

TOM BLACKWOOD is a *Chemical Processing* contributing editor. You can email him at TBlackwood@putman.net.

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Consider Laser Level Measurement Technology

Its characteristics make it ideal for level measurement of bulk solids and liquids in silos, bins and beyond

By Josee Labrecque, ABB

The laser (light amplification by stimulated radiation emission) was a remarkable technical breakthrough but in its early years was something of a technology without a purpose. Engineers then began to find uses for it. Among them were the military weapons laser rangefinder and land surveying. From these early developments, the current laser level measurement technology emerged.

Now, laser products are managing bulk solids and opaque liquid level applications across the mining, power, food and beverage, pulp and paper, petrochemical and chemicals industries. Typical applications include level sensing and control in bins or silos, positioning of conveyors/tripper cars, height control, level control in crushers or shredders, movement detection, anti-collision of overhead cranes, block chute detection and machinery positioning. These level measurement instruments serve a range of industries and offer certain benefits for measuring powder applications.

LEVEL/POSITIONING MEASUREMENT

Laser technology in level/positioning measurement brings a number of unique advantages to the table. First, its short wavelength results in a narrow beam (approximately 5 cm diameter) with extremely low divergence (<0,5°). This enables the instrument to measure accurately into silo cones or chutes, to see through narrow openings in protective grids and to be completely unaffected by

obstacles close to or moving in its area of operation (Figure 1).

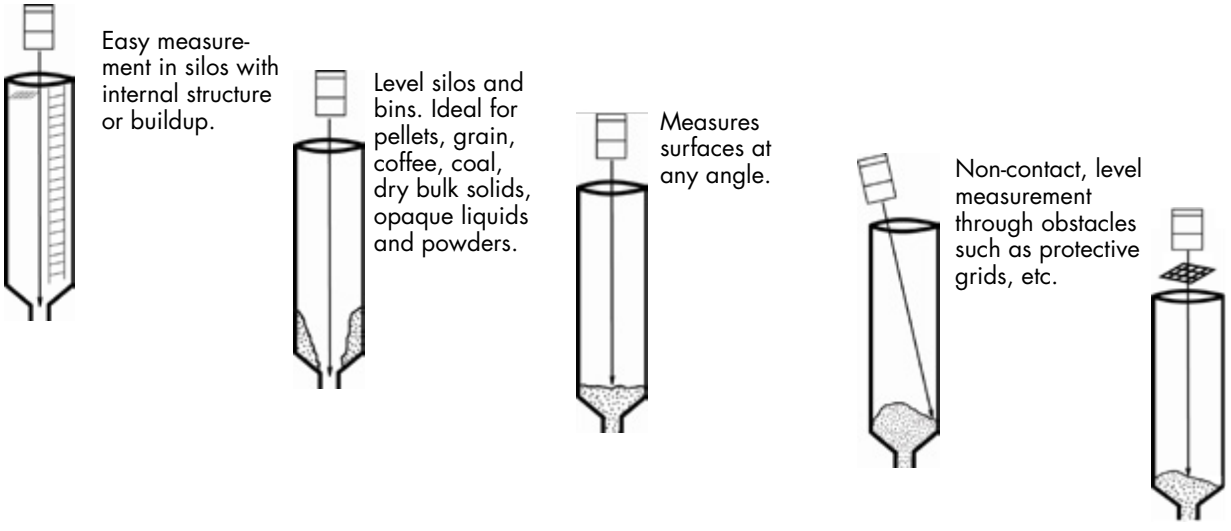
It also is unaffected by electrical noise, wind, pressure or temperature fluctuations. Laser instruments measure distance off any surface, from black coal to brown wood chips to reflective plastics, at any angle, and with no false echoes.

The non-contact laser level transmitters easily can measure distances as far as 18 m (60 ft) on coal and 150 m (500 ft) on positioning applications using a reflector plate. Some other type of lasers with enhanced optics can read at least 30 m (100 ft) on coal and as far as 400 m (1,312 ft) on positioning applications using a reflector plate. The instruments give a reading in centimeters or inches through a 4-20 mA output, are accurate within 25 mm across the measuring range, are rated as Class 3R and are completely safe.

The laser level transmitter's on-board microprocessor calculates distance by multiplying the speed of light by the time it takes for a laser pulse to travel from the instrument to a target and back. The measuring laser uses invisible, infrared light. A second, visible aiming laser helps to align the measuring laser. The laser beams have very little divergence so that accurate targeting is easy even in silos or vessels with internal structures.

LEVEL MEASUREMENT WITH LASER TECHNOLOGY

Using a time-of-flight calculation and



LASER LEVEL TRANSMITTERS

Figure 1. Laser level transmitters measure surfaces at any angle, are unaffected by obstacles and can measure off of any surface, making them appropriate for use in bulk and solid applications such as silos.

It's best to calculate remaining solvent from exit gas humidity.

knowing the height of the vessel, the laser level instrument accurately measures the distance to the target surface using the equation below:

$$\text{Level} = \text{height} - \frac{\text{speed of light} \times \text{time-of-flight}}{2}$$

The unique characteristics of laser light give the laser level instrument significant performance advantages over other technologies. The narrow, long-range beam can measure both near and far distances, while the optical wavelength makes it easy to evaluate applications. If you can see the surface clearly, the laser can measure the level.

In applications in which dust may be present (even in very small quantities), a dust tube accessory can be used. The tube is a simple and effective device, designed to prevent dust settling on the lenses by creating a static airspace. When abundant dust is present, the dust tube additionally can be purged with dry oil-free air to reduce any further dust settling on the lens.

The laser level technology is a plug-and-play instrument. The user-friendly menu makes for a quick setup on commissioning through a handheld programmer or laptop. It requires no calibration or special configuration. The laser pointer provides precise alignment and a number of mounting options providing accurate, fast, reliable level and positioning measurement.

JOSEE LABRECQUE is the business development manager at ABB. She can be reached at josee.n.labrecque@ca.abb.com.

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Stop Explosions in Pneumatic Conveying Systems

Mechanical isolation systems help mitigate explosions and protect equipment from potential damage

By Jillian Gruss, CV Technology

In plants producing or handling chemical powders, pneumatic conveying is a common form of transferring product. Two types of pneumatic conveying exist: dense phase and dilute phase conveying. Dense phase is meant to handle thicker materials through a line, usually bulk product that leaves little room for air. The material generally travels at 50 to 1,000 ft/min. As for dilute phase systems, the material is suspended in air, traveling at a much faster velocity, usually 1,000 to 7,000 ft/min. Dilute phase conveying is considered ideal for transfer of nonabrasive materials.

Both dense and dilute phase conveying can be handled by vacuum (material pulled through the line) or pressure (material handled by positive displacement through the line either by a blower or fan). Vacuum conveying advantages include allowance for easy flow of material, accessibility for pick-up points throughout the line, and can transfer heat sensitive dusts. Another major advantage is that if a leak were to occur, it happens inwards of the pipe. For pressure conveying systems, material tends to leak outwards and multiple pick-up points are harder to obtain. For pneumatic conveying, vacuum is commonly the preferred method, passing regulations of safety, security, and process handling measurements.

For vacuum systems, dense phase conveying is best for abrasive, coarse, cohesive, fine, sticky and fragile materials. These characteristics tend to bulk material together and dense phase conveying is designed to pull these thick particles from one place to another. Materials that are commonly

To properly protect a pneumatic conveying process, explosion isolation is needed throughout different points in a process flow.

coarse, lightweight, fibrous, fine, granular, and nonabrasive are best for dilute vacuum phase conveying; the dusts can easily be pushed from one pick-up point to another.

A vacuum system comprises of a vacuum blower, vacuum inlet, conveying line, and receiver. The air generator pulls negative pressure to transfer the material through the line and directly into the receiver.

Vessels handling these types of processes generally have smaller inlet lines and long convey line lengths.

EXPLOSION FACTORS

Although pneumatic conveying processes are highly effective in transporting chemical products, if an explosion were to occur, the system could be extremely dangerous and pose a threat to personnel and equipment.

A combustible dust explosion occurs with the combination of the following five elements: fuel (dust), oxygen, ignition source, dispersion, and confinement. These five factors are often referred to the explosion pentagon. During normal operation, fuel and oxygen will always be present, but if a piece of equipment has too much friction or a spark for example, a fire may start to ignite. If the particles are dispersed in a confined area like a pneumatic receiver, a catastrophic explosion could potentially happen. A pneumatic conveying system typically will have four of the five elements of the pentagon present at any given time. An ignition source is the variable factor in when an explosion can occur.

To properly protect a pneumatic conveying process, explosion isolation is needed throughout different points in a process flow. When a deflagration takes place and propagates throughout pipework connected by vessels, the equipment used to stop and mitigate the explosion from continuing or spreading is referred to as explosion isolation. If an explosion happens within a vessel it will travel back through the line spreading to other equipment, causing substantial damage. When a blower or fan is pushing or pulling air through a line to a vessel it may allow the explosion to propagate through the clean air line as well.

Explosion isolation valves can also be used in containment protection designs. This is a configuration where a set of explosion isolation valves can be placed within a process

Active solutions are fully dependent upon timely detection to activate the isolation barrier.

to protect a whole area of equipment (vessels and pipework included), with a valve in the beginning of a "loop" or inlet line and another at the other end of the loop on an outlet line. The equipment between the isolation valves is rated for containment so that it can withstand the deflagration pressures and forces.

To maintain safety regulations, NFPA 69 includes sections on how passive and active isolation devices such as pinch valves, slide gate valves, chemical isolation barriers, flap valves, and float valves should be designed and implemented. The standard breaks down that mechanical isolation devices must meet or exceed design factors including: dust characteristics, detection parameters, activation dynamics, isolation distances, process conditions for operation, and installation requirements.

Important factors in determining what type of isolation valve to use also is dependent on a vessel's P_{red} and the P_{max} and K_{st} of the material being handled. The P_{red} is the maximum reduced pressure developed in a vented or suppressed enclosure during a deflagration. Every combustible dust has a P_{max}, the maximum pressure developed within a deflagration, and a K_{st}, the deflagration index of a dust cloud. This Index value is related to the rate of pressure rise over time during the deflagration of the dust. Different classifications categorize the K_{st}; equipment is most commonly rated for ST-1 and ST-2 classified dusts. ST-1 ranges from a K_{st} of over 0 to 200 bar-m/s and ST-2 ranges from 200 to 300 bar-m/s.

ACTIVE VS. PASSIVE ISOLATION

Detectors or the inherent explosion pressure may activate explosion isolation solutions. Detection devices include explosion vent rupture sensors, pressure detectors, and radiant energy sensors.

Active solutions are fully dependent upon timely detection to activate the isolation barrier. These style systems typically need to be rearmed or refurbished after each use. Generally, active equipment is less ideal on pneumatic conveying lines due to the amount of downtime associated with an activation and the maintenance required for active solution. The most common example is chemical isolation. This type of mitigation is usually paired with chemical suppression. Chemical systems include a controller, detection and bottles with suppressant to

inject into the vessel or line. Chemical isolation systems must be recharged after each use. Sometimes, the type of suppressant being injected into the process can contaminate the process material which may lead to chemical isolation not being a favorable choice. Depending on how it is manufactured, the slide gate valve can be another active solution. Fast acting slide gate valves destroy themselves when activated by ignitors which then requires a rebuild. Active solutions generally cannot be operated in fail-safe mode due to these limitations.

Passive devices have an inherently safer design and are less maintenance intensive. Most passive isolation systems can reset after an activation without any downtime or rebuild. These systems also can be operated in a fail-safe manner which improves reliability and safety integrity.

Another common mechanical isolation device is a flap valve. This type of device must be installed in the opposite direction of the airflow so if an explosion were to occur the back pressure traveling down the pipeline will shut the flap in the valve. Flap valves also cannot handle high dust loading applications like pneumatic conveying as the process material can prevent the flap from closing. The flap in these valves also sits in the process flow which makes it susceptible to damage from the conveying speed and material impact.

The three ideal mechanical isolation devices for pneumatic conveying systems are slide gate valves, pinch valves and float valves. These valves are designed to handle the process velocities and pressures associated

ISOLATION PINCH VALVES
Figure 1. An accumulator tank, high speed solenoids and a valve equipped with a rubber liner bladder are the three major components that make up an isolation pinch valve.

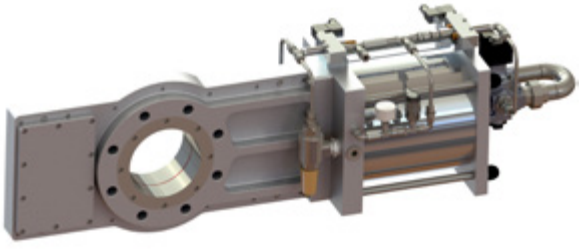
with pneumatic conveying applications. In addition, all three valves can be operated in a bidirectional manner when specified properly.

PINCH VALVES

An explosion isolation pinch valve (Figure 1) is broken down into three components: an accumulator tank, high speed solenoids, and a valve equipped with a rubber liner bladder. The high-speed solenoid valves stored air in the accumulator tank allow the pinch valve to operate faster than a traditional process valve.

Explosion isolation pinch valves need to be activated by a detector. They can also operate in a fail-safe fashion which allows them to be used in applications where SIL 2 isolation devices are needed.

Pinch valves require little maintenance, and when needed, checks and upkeep can be handled at the factory level. The rubber bladder liner can be easily replaced if needed. These valves typically handle ST-1 classified dusts and Pred values that meet or exceed design pressures of dilute phase pneumatic conveying vessels.



ISOLATION SLIDE GATE
Figure 2. An all-metal bore slide gate valve can withstand higher abrasion and dense phase applications.

SLIDE GATES

Slide gate valves (Figure 2) are an alternative to pinch valves for explosion isolation. The advantage to a slide gate valve is they can be designed with an all metal bore for higher abrasion and dense phase applications.

Some slide gates are specifically air operated. Others can be actuated from pyrotechnics. Air operated valves can be operated in a fail-safe manner and do not require rebuild after an activation. In either case, the valves are design to shut at very high speeds compared to a process slide gate.

Slide gate valve systems utilize a controller and detection technology for signaling. Some slide gates can be designed for high pressure application including use as containment isolation valves. These valves can typically handle both ST-1 and ST-2 classified dusts and work with almost any type of powder.

FLOAT VALVES

Another commonly used mechanical isolation valve for the clean air or exhaust discharge of a pneumatic conveying receiver is a float valve (Figure 3). The valve consists of a housing and a spring-loaded poppet (“float”) in the middle. The

ISOLATION FLOAT VALVE
Figure 3. The float valve can operate in the same or opposing direction as the conveying flow.

pressure of the explosion pushes and locks the poppet in place preventing any flame from propagating past the valve.

Unlike a flap valve, the float valve can operate in the same or opposing direction as the conveying flow. Once shut, the float valve signals activation. Float valves also can be designed for high pressures to be used in containment applications. Generally, these valves should not be used on the conveying line due to the high concentration of dust that can abrade the poppet or prevent it from properly closing.

CONCLUSION

Based on the advantages discussed in this article, passive mechanical explosion isolation valves are ideal for protecting pneumatic conveying processes. The passive isolation devices are extremely effective in isolating an explosion while causing little to no downtime once activated, whereas the active solutions (such as chemical isolation) halt system operations until equipment is replaced. Fail-safe designed valves offer the highest level of reliability for explosion isolation.

Protecting isolation lines with a NFPA 69-approved device can effectively save a plant from explosion propagation throughout a process. The cost of investing in explosion mitigation equipment is a small price to pay compared to the potential consequence. ●

JILLIAN GRUSS is a sales application engineer for CV Technology. Email her at jgruss@cvtechnology.com.

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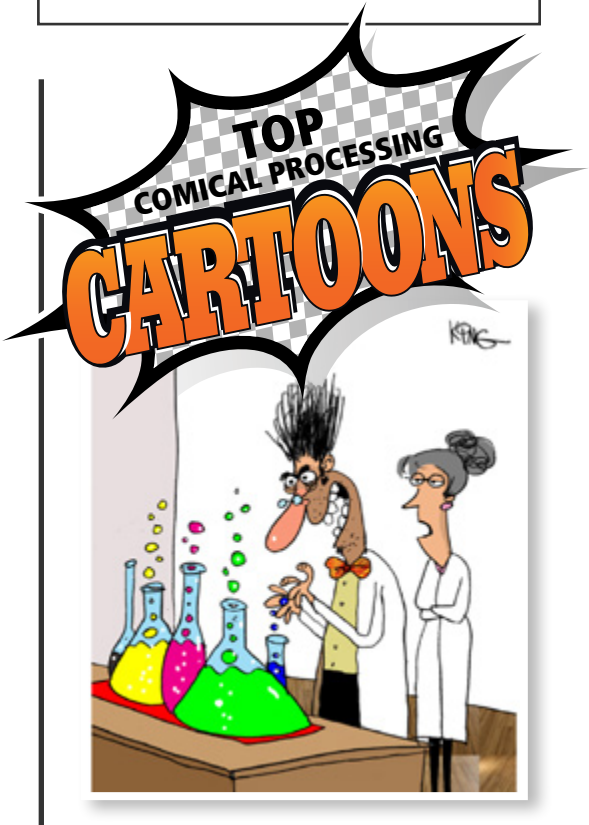

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