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# Properly Instrument Your Solids Process

Four types of measurements usually make sense

By Tom Blackwood



The dearth of instrumentation typically built into a process design involving particulate solids can lead to major challenges in effectively working with the materials. While cost certainly plays a role in limiting the amount of instrumentation, most often the primary factor is lack of understanding how solids behave differently than pure liquids or gases. For solids, measurement of physical properties and process conditions frequently is much more difficult and instrument placement more critical.

With suspended solids, restriction of the flow (orifice plates and cone meters) and attempts at measuring pressure drop are major problems. Also, suspended solids don't travel through piping at the same velocity as the fluid and have a tendency

to settle. Even fine particles, which may move at close to the fluid velocity, can bunch up due to turbulence, making them behave like much larger particles. Fortunately, important advances have occurred in instrumentation for particulate solids, whether in slurries or suspended in gas.

Surprisingly, simplicity often is better when dealing with solids. When I was teaching graduate students, I asked a class at the start of a slurry pipeline experiment how we were going to calibrate our flow meter. After discussing several alternatives, one student sheepishly noted that in his home country the only option was to use a bucket, stopwatch and scale to establish flow rate. Advances have made suspended solids measurements more reliable, primarily due

## Selection of the tube size is critical and you must consider vibration when placing the unit.

to non-intrusive or non-restrictive sensors and the durability of these devices.

Four key measurements usually are important when handling solids. So, let's look at them and some of the best devices for getting readings.

**Volumetric flow rate.** My favorite inexpensive device is still the old-fashioned Pitot tube. You must place it in the top of any pipe and purge it to prevent solids from accumulating and plugging the S-type probe. You may have to resort to occasional bursts of purging fluid to dislodge any deposits. A Pitot tube will give fluid velocities but works best at low solids concentrations, where settling is unlikely. Ultrasonic instruments can handle a wide range of concentrations: Doppler devices give the particle velocity, while transit-time devices provide an average flow rate but work best at low solids concentrations; both can be clamped on slurry pipelines. Electromagnetic flow meters suit applications with turbulent flow where

turndown is limited and, when properly calibrated, are very accurate; some can be cleaned in-situ.

**Mass flow rate.** You can convert volumetric flow rate to mass flow rate with the appropriate physical properties; you may have to make do with estimates for these. Coriolis meters avoid this issue and often can be calibrated on a pure fluid such as water. Selection of the tube size is critical and you must consider vibration when placing the unit. Thermal flow meters are inexpensive and work best when the specific heat of the fluid and solids are the same; these devices can foul and mostly suit low solids concentrations. For bulk solids, you can use impact plates on discharge points. When feeding bulk solids, I suggest loss-in-weight designs.

**Density.** Vibrating tubes (which can be straight, a U-tube design or a probe) give bulk density that can be correlated to moisture content of a slurry when the particle density is well known. Particle size



affects measurement very little but low flow rate gives slow response. Ultrasonic devices provide a rapid response to concentration. X-ray or  $\gamma$ -ray are best suited to concentrations above 5%. Because they are very expensive, electrochemical devices that give 3D concentrations via tomography seldom are used.

**Level.** Load cells are inexpensive and very accurate when calibrated for the density of the slurry system. They don't give the best indication of level for bulk solids due to the fluidity of the solids. Advances in the last few years in ultrasonic and

radio-frequency echo systems have eliminated this issue. These devices are non-invasive and unaffected by deposits. For slurries, bubblers are inexpensive but gas can cause fouling. Restrict the use of capacitive instruments to upper limit alarms and conductive materials.

These four measurements usually suffice to control your solids processing systems. Leaving them out of a design likely will cause trouble for years to come. ●

**TOM BLACKWOOD** is *Chemical Processing's* contributing editor. Email him at [TBlackwood@putman.net](mailto:TBlackwood@putman.net).

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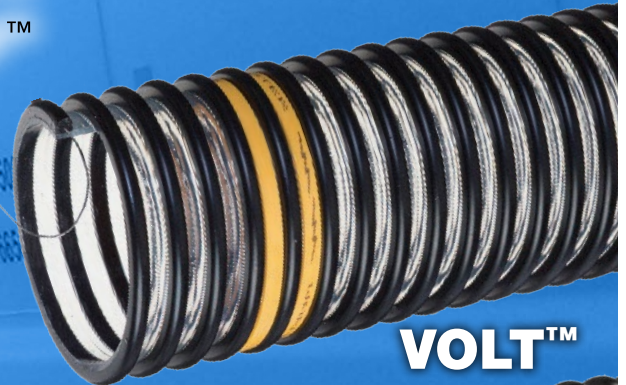
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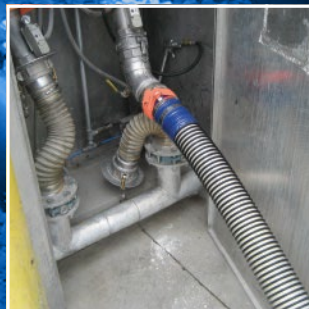
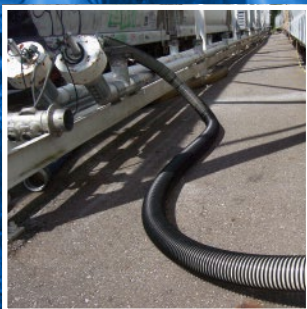
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# Bulk Bags Can Change Your Life

The containers afford advantages if applied appropriately

By Tom Blackwood

**T**he use of bulk bags to transport materials represents one of the biggest changes in the solids processing field. Particulate solids manufacturers traditionally shipped products to distributors via truck or rail with the solids in drums or pallets of bags. Truck and rail deliveries work well for large quantities but aren't suitable for many chemicals that may be hazardous because of the risk that potential releases pose. Also, such modes of transport required large storage facilities that increased inventory costs for expensive chemicals. Bags and drums kept this cost down but added the expense of used bag/drum disposal and containment systems for feeding the chemical to the process.

Then, bulk bags appeared. I recall an early Powder Show where, perhaps, two

companies offered bulk bags. These first bags were very difficult to use and often created an environmental nightmare for some chemicals. With the advent of better designs and more-convenient unloading systems, bulk bags took over a major part of the pallet bags industry. They became a more economical way to store intermediates and inventory, especially if the upstream process is slow compared to the downstream process. However, many challenges — especially for pharmaceutical and hazardous chemicals — arose along the way to making bulk bags mainstream.

Bulk bags now have gained broad acceptance — but, before converting to them, you should ask yourself four key questions:

## Not paying attention to potential clumping can prove an expensive mistake.

1. *How will you unload the material?* You must evaluate whether your current material-handling system is compatible. Consider what befell one of my customers that decided to go with bulk bags. At its site, the first step in unloading was to have the material flow over a screener. However, the bag discharge lacked a control valve, so the operator was pinching the flow. The overloaded screen failed to remove all the fine particles, creating downstream problems. Switching to a valved bag solved the problem. Fortunately, many specialized bag designs will conform to your current system.

2. *What will you do with the used bags?* If possible, return these to the supplier presuming you can resolve any potential contamination issues. Otherwise you'll need to build in the cost of sending the bags to the appropriate facility (landfill, incineration) or negotiate a material-cost adjustment from the supplier to cover the disposal cost. Selection of the type of bag, construction style and material may allow recovery of the solids by dissolving or

washing the bag as part of the manufacturer's chemical process. Many bags can find use for trash and other waste materials.

3. *How sensitive is the material to attrition, agglomeration, vibration and mechanical deformation?* I've seen cases where solids that didn't cake or deform when placed in 50-lb bags stacked 4-ft high became a rigid block after transport in a 4-ft-high bulk bag. You must take care when loading the bag to avoid excessive stress on the solids by minimizing the drop distance. Also, don't package warm solids from a drying operation into bulk bags because solvent may saturate the gas in the bulk solid voids. This solvent may condense in the bag, leading to recrystallization, agglomeration or even a phase change of the material.

Bulk bags now transport sludges and slurries. Many intermediate chemicals such as pastes get put into bulk bags. However, not paying attention to potential clumping can prove an expensive mistake. In one case, a plant shipped an

intermediate product in bulk bags to another site and clumping took an unexpected toll there. Management finally recognized the severity of the clumping issue when the receiving department requested its third forklift in a year; the previous ones had broken backing into the bulk bags so they could be unloaded. Talk about serious clumping problems! For a more extensive article on clumping issues see “Clamp Down on Clumping,” <http://bit.ly/2OD2seS>.

4. *How does the sensitivity of the solids affect bag loading?* Control of the environment is important to avoid getting moisture in the bags for the reasons

stated above. Reused bags may need a containment system to minimize workplace contamination. Getting the correct amount of solids in the bag requires a more-sophisticated weighting system than that used for normal bags. Load cells work well but the feeder may need two feeding systems to get the right amount of solids in each bag.

At any rate, bulk bags are an important tool for solids processing and are here to stay. ●

**TOM BLACKWOOD** is *Chemical Processing's* contributing editor. Email him at [TBlackwood@putman.net](mailto:TBlackwood@putman.net).

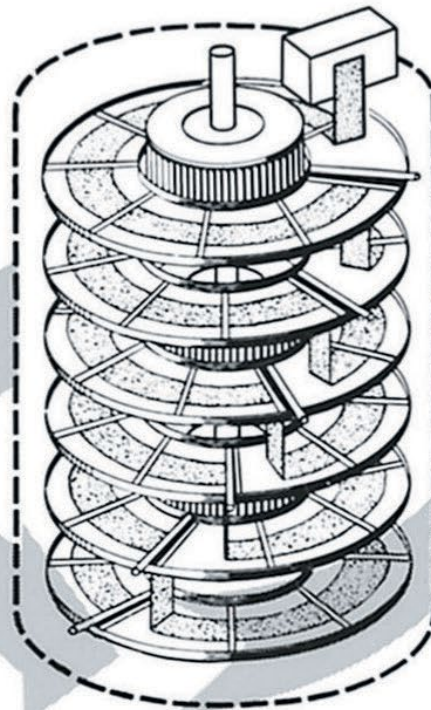
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# Smart Feeders Enhance Detergent-Making Process

New facility benefits from process controls and equipment that optimize production

By Michael Plant, Coperion K-Tron UK



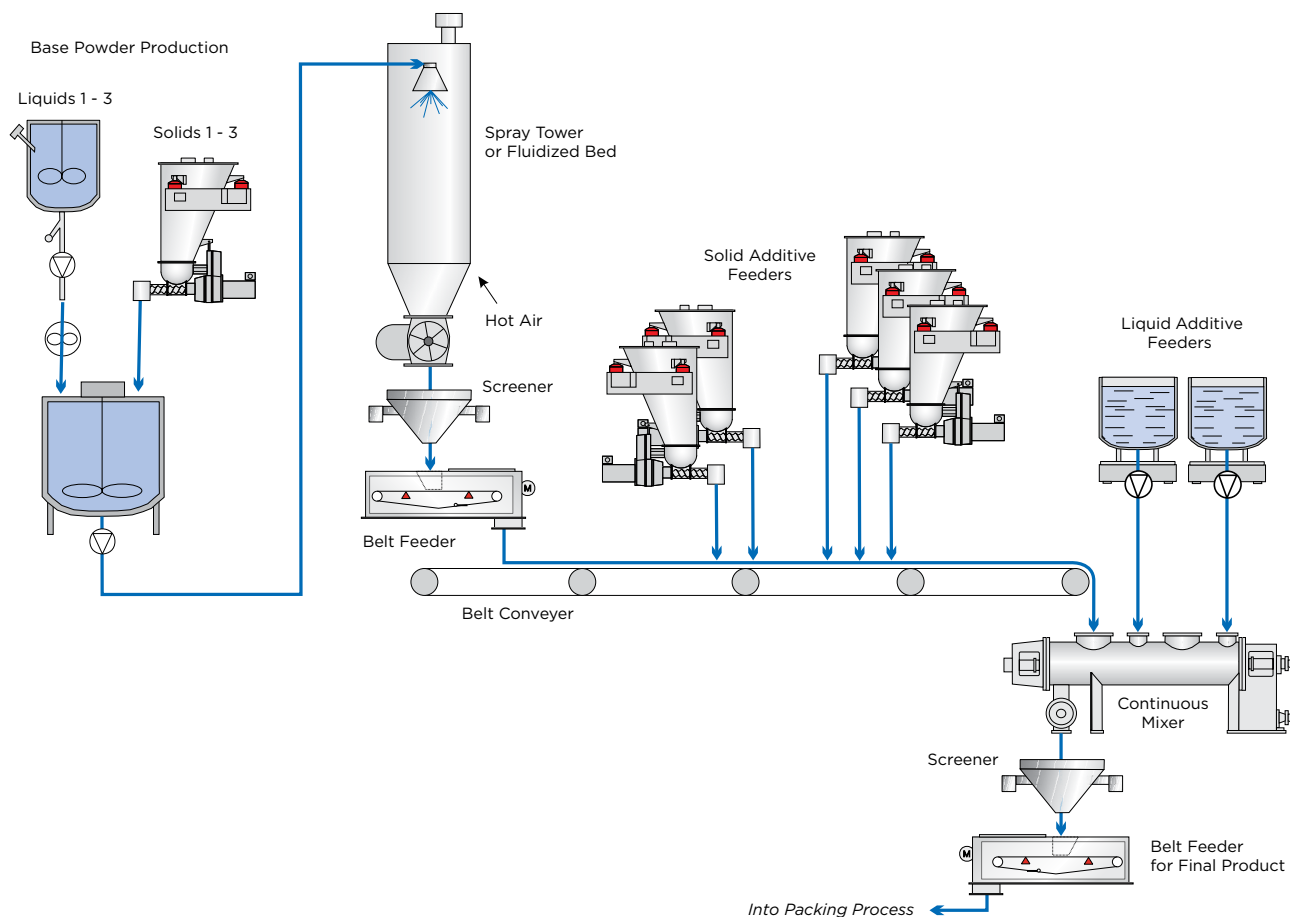
A powder or tablet's exact formulation is critical for an optimal end product and dependent on the feeding device's performance for each ingredient in the production line. So, when an international maker of laundry, household-cleaning and personal-care products began planning a new detergent plant, it contacted Coperion K-Tron to work on a solution. Denmark-based Coperion has locations worldwide and is a manufacturer of compounding and extrusion, feeding and weighing, and bulk material handling units. Part of the detergent maker's plan also included streamlining an existing packaging operation to handle more production and resolve material flow issues.

The expansion project began by forming an in-house team to plan, design, engineer

and monitor the plant's construction. The team included three engineers, a computer-aided design (CAD) operator, an accountant, a secretary and a construction site supervisor. An engineering manager led the team and controlled the basic design, with input from all operations and engineering staff from the original site.

## BASE POWDER AND ADDITIVES

As with the original plant, the new facility's detergent-making process begins at the silos, which deliver powdered raw ingredients onto weigh belt feeders (Figure 1). The weigh belts meter the powders into a fluidized-bed processor. Atomizing nozzles within the process spray liquids onto the fluidized layer, agglomerating the contents into a mixed powder. The agglomerates then pass through a sieving and metering



## DETERGENT-MAKING PROCESS

Figure 1. This scheme portrays the typical production process to make laundry detergent powder.

stage. Oversized particles and particles suspended in the air stream are recycled back into the process.

Next, other dry feeders add additional minor powder ingredients. The combined ingredients, along with a perfume, then enter a final mixer. After mixing, the detergent passes through the final sieving and metering stages. In the final step, bucket conveyors transfer the finished product to the packing operation, where it flows

either directly to packing machines or into flexible intermediate bulk containers (FIBCs) for temporary storage.

The process is continuous and allows for minor formulation changes without stopping. For major formulation changes, workers stop production, clean all product from the equipment and restart it for the next formulation. Final formulations may contain as many as 40 separate ingredients. Therefore, selecting the right



powder-metering devices and integrating the controls were crucial steps.

A large number of ingredients must continuously, simultaneously and accurately be fed into a mixer (Figure 2) or onto a conveyor belt, which in turn supplies the continuous mixer.

The powder feeders must handle a range of ingredients: sodium carbonate, sodium bicarbonate, sodium perborate tetrahydrate, sodium sulphate, sodium tripolyphosphate, sodium silicates, sodium percarbonate, anionics, encapsulated enzymes, colored beads, antifoaming powders and polymers that release soils from the fabric and prevent new stains. The liquid feeders meter sodium silicates, anionics, nonionics and perfumes.

## SELECTING THE RIGHT FEEDERS

The new plant's equipment selection was by



### FEEDERS

**Figure 2. Multiple K4G feeders grouped around a process inlet allow for continuous gravimetric loss-in-weight blending.**

competitive tender against the company's specifications, followed by on-site evaluations. The original plant used 17 screw feeders and weigh belts from Coperion K-Tron. Important parts of the technical specification were feeder accuracy for each raw ingredient, control system simplicity and operational efficiency.

The engineering manager noted the lack of complementary industry nearby, which required self-sufficiency with all equipment. Training was important as was fully integrating the feeder controls into the main process control system (PCS). The equipment also had to be easy to clean and maintain and



### WEIGH MODULES

**Figure 3.** This close-up of a weigh belt with its belt removed shows the two weigh modules, which allow continuous online taring.



### WEIGH BELT FEEDER

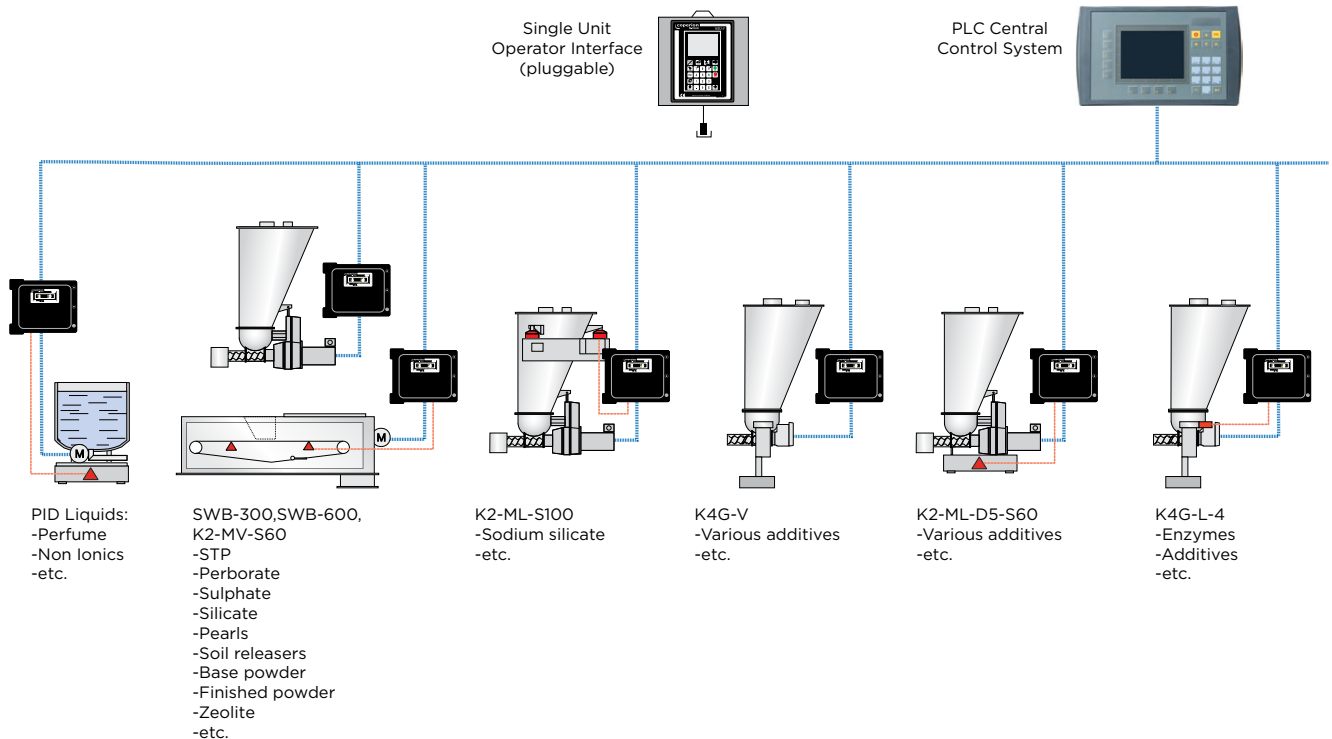
**Figure 4.** Smart weigh belt feeder with conveyor can be removed from the housing on the telescopic support for easy cleaning or a belt change.

should prevent accidental changes to feeder settings.

The detergent maker required a compact gravimetric feeder to handle large

volumes of bulk material with different flow characteristics. The Smart Weigh Belt (SWB) feeder offers continuous online taring by using two weigh modules (Figure 3).

Automatic and continuous online taring of the weigh belt reduces maintenance, line shutdowns and laborious manual calibration while improving long-term



## CONTROL SYSTEM SOFTWARE

Figure 5. The Coperion K-Tron SmartConnex system is configured for a laundry detergent process.

accuracy and stability. The conveyor belt is removable from the stainless-steel housing via a telescopic support structure (Figure 4). This facilitates the feeder's thorough cleaning.

## EASY INTEGRATION OF CONTROLS

After the evaluations, the team selected Coperion K-Tron to supply the feeding and metering equipment, as well as the controls. "The aesthetics of the overall feeders were impressive, particularly the weigh belts, with controls completely contained within the stainless steel casing," the engineering

manager said. The SmartConnex control system (Figure 5) enabled workers to connect a local keyboard and display at the feeder when necessary, while the plant's PCS still retained central control. The ability to integrate all operator-required functions into the plant's PCS was another attractive feature.

"The integration of the process controls was our greatest concern," the engineering manager says. "Our history of installing the equipment meant we had a good deal of knowledge about refill systems, isolation

The load cell system on the metering equipment also played a role in damping the effects of electronic noise within the plant.



**SCREW FEEDER**

**Figure 6. Single screw feeders are ideal for free-flowing bulk materials.**

from plant vibration, access for maintenance and calibration requirements.”

The load cell system on the metering equipment, called SFT II, also played a role in damping the effects of electronic noise within the plant. “The load cell system contains an ‘intelligent filter’ to greatly reduce the issues associated with plant vibration,” adds the engineering manager.

The new plant’s metering system includes three weigh belt feeders used as bulk flow meters, six loss-in-weight screw feeders (Figure 6), 13 weigh belt feeders, two volumetric screw feeders and 12 gravimetric liquid feeders. All are controlled via the supplier’s KCM feeder controls, which communicate with the PCS. All the KCMs are linked electronically via the SmartConnex control system, which enabled the company to minimize field cable installation. ●

**MICHAEL PLANT** is director of sales at Coperion K-Tron UK. Email him at [mplant@coperionktron.com](mailto:mplant@coperionktron.com).

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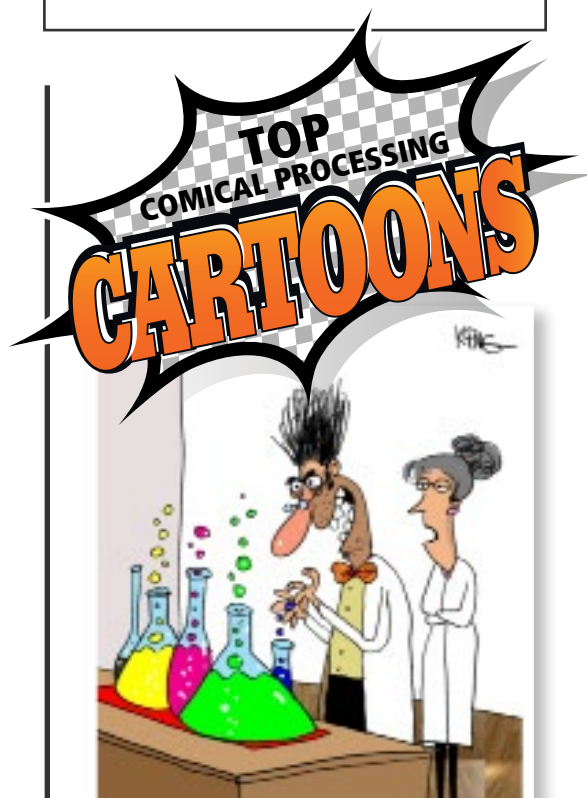
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