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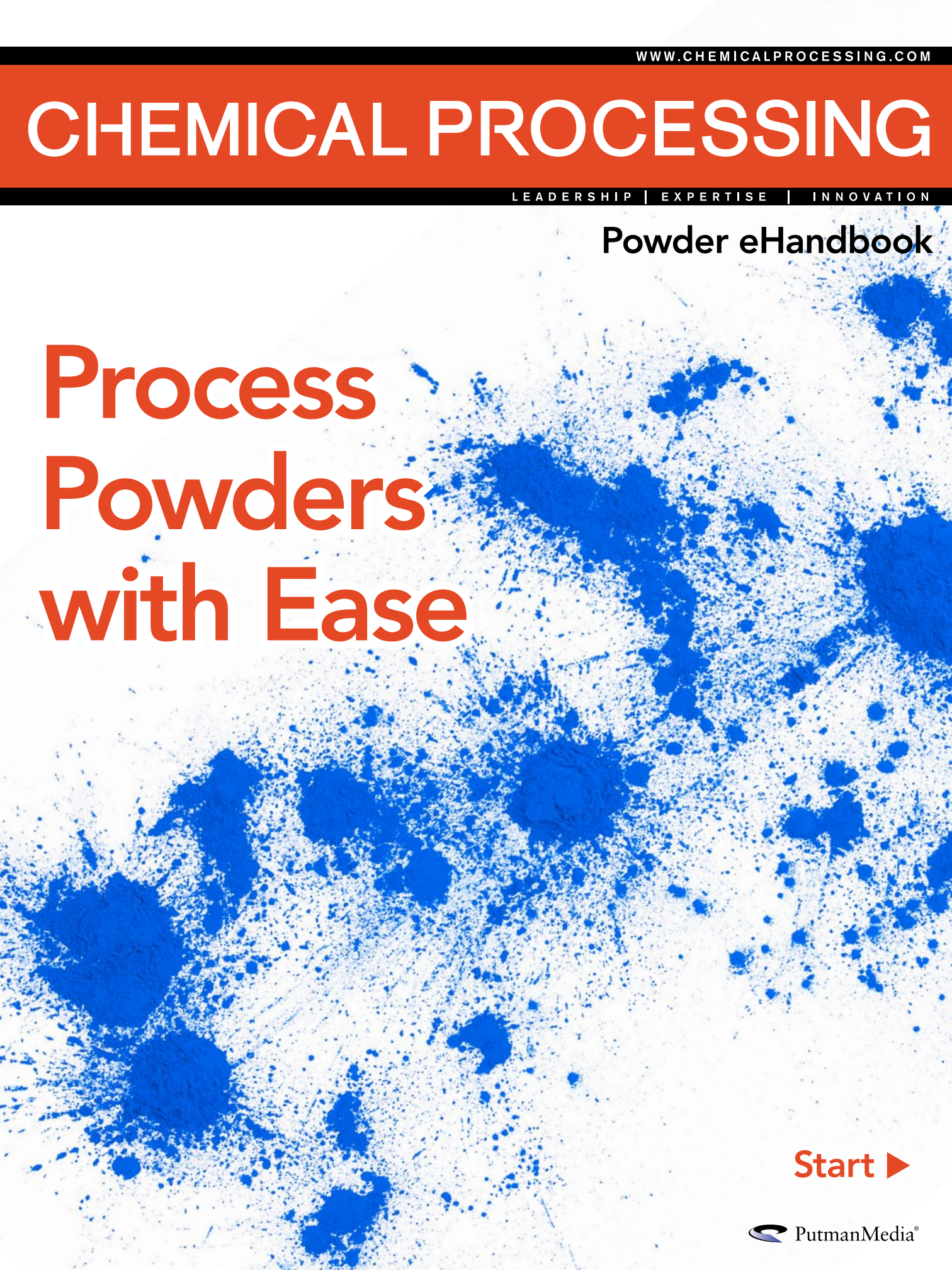

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Bob for Accurate Measurements

Cable-based sensors help simplify inventory managment

By Jenny Nielson Christensen, BinMaster Level Controls

WHETHER REFERRED to as weight and cable, plumb bob, cable-based, or yo-yo-type sensor, the principle of its operation is simple. The device works as an automated tape measure that repeatedly takes measurements from the top of the silo at a consistent location. This eliminates the need to climb silos to take manual measurements. When a measurement is taken, the sensor releases a cable with a weighted sensor probe — often referred to as a plumb bob — that stops and retracts when the probe comes into contact with material. The "brains" of the sensor convert the distance data to a measurement that can be displayed as either the height of the material or the distance to the material, referred to as headroom. The sensor takes redundant measurements, when the sensor probe is both descending and retracting, to confirm that every measurement is precise. When minimal contact with the vessel's material is acceptable, a weight and cable-based sensor is a very economical and accurate continuous level measurement solution.

Cable-based sensors are designed for single-point level measurements taken periodically throughout the day. Level measurements can be programmed to take place at predetermined time intervals or initiated as needed from a console at ground level or from a PC, depending upon the type of communication devices used. High-temperature and explosion-proof options make cable-based sensors suitable for most challenging applications. Their versatility makes them well-suited for the chemical industry where ongoing inventory management and remote reporting is required for multiple small and large vessels containing a wide array of materials.

POWDERS, GRANULES AND SOLIDS

Weight and cable-based or bob-style sensors (Figure 1) are an ideal level measurement solution for chemical processors as they work in virtually any material regardless of particle size or bulk density. Immune to most material characteristics, they perform equally well whether the silo contains light, fluffy powders; plastic pellets; fine to coarse granules; or heavy, dense lump materials. "Bobs" are a proven technology that have been in existence for decades. These trouble-free, long-lasting devices require no calibration, even if the material in the silo changes. These sensors will perform reliably and are not affected by dust, humidity, temperature, dielectric constant or fumes that may be present in the vessel. The stainless steel probe at the end of the cable makes minimal contact with the material in the silo, so there's very little risk of contamination.

Figure 1. Weight and cable-based or bob-style sensors are an ideal level measurement solution for chemical processors as they work in virtually any material regardless of particle size or bulk density.

A BAND OF "BOBBERS"

Due to their versatility in many types of materials in vessels of any construction, height or diameter, a network of multiple weight and cable sensors can meet the challenge of just about any silo measurement need in the facility. For example, if multiple

silos containing different types of processing, packaging or waste materials need to be monitored, the sensor can be adapted to the needs of each particular silo. A bob-style sensor can be used in large silos up to 180-ft tall, but also are often used in smaller, active process silos under 40-ft tall.

While a stainless steel weight is commonly used with the sensor, a round stainless steel sphere float is an alternative for silos containing light powders, slurries or liquids. A hollow, inverted stainless steel cone can be used in liquids or light powders or solids with a bulk density of at least 3 lb/ft^3. An economical choice that's often used in light or dense powders or liquids is a digestible bottle that fits through a rotary valve or screw conveyor and filled with paraffin wax or alternative compatible material.

Figure 2. For the best accuracy, the sensor should be mounted on the roof of the silo about 1/6 of the way in from the outer perimeter.

MOUNTING FOR THE BEST ACCURACY

For the best accuracy, the sensor should be mounted on the roof of the silo about 1/6 of the way in from the outer perimeter (Figure 2). When used in free-flowing material, this ideal sensor placement location accounts for the angle of repose on a center-filled vessel. When a vessel is being filled, the material forms a "cone up" in which material is higher at the center and lower near the sides of the vessel. If you draw a horizontal line at the point the sensor probe comes into contact with the material surface (1/6), there's a peak at the center of the vessel and voids at the sides. If you take the material in the peak and fill in the voids, it will flatten out the angle of repose (Figure 3).

The same is true when the vessel is being emptied and material is lower in the center and higher on the side forming a "cone down." Mounting the sensor 1/6th from the outer perimeter is proven academically to calculate the most accurate level reading for a vessel. Properly mounted on a center-fill, center-discharge bin, bob-style sensors will consistently provide 5% to 7% accuracy.

EASILY ACCESSIBLE DATA

Cable-based sensor networks can be integrated utilizing a wide variety of communication options dependent upon how you want to access and use the data. The most cost-effective and popular option is to mount a control console at ground level. A single console can be mounted at each bin, or more advanced consoles can report data from more than 100 bins at a single console. Consoles are easily programmed with silo size information and each silo is assigned a vessel number. Browsing through a pushbutton menu, the user can access information such as distance to product (headroom), height of product and percentage full (Figure 4).

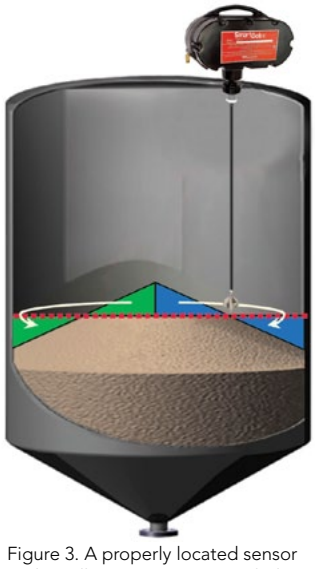

Figure 3. A properly located sensor probe will come in contact with the material surface at a point where there's a peak at the center of the vessel and voids at the sides. If you take the material in the peak and fill in the voids, it will flatten out the angle of repose.

If the preference is to have level-measurement data sent to a personal computer, several companies offer

Windows-based software to report detailed data for multiple vessels simultaneously and generate a visual that shows silo levels as a percentage full (Figure 5). Silos can be named by location and labeled by their contents. Alarms or alerts can be generated when a silo reaches a predetermined high or low level. Other communication options include the ability to send an automated email when bins reach an alert level. The measurement data can be stored on the computer and used to generate historical reports. LAN configurations are also possible to share a common measurement database with multiple users on a local area network.

Internet-based monitoring solutions are also available that enable 24/7 access to bin data from any device with an Internet connection, and also allow for managing multiple sites from any remote location.

For facilities that prefer an analog output to a PLC for monitoring bin level measurement data, some models of cable-based sensors offer an integrated 4–20-mA output. In this type of configuration, the sensor is installed on top of the silo and the measurement data is sent directly to a PLC, eliminating the need for either a console or software.

Figure 4. A control console mounted at ground level enables users to access information such as distance to product (headroom), height of product and percentage full.

MEASURING SUBMERSED SOLIDS

Sometimes chemical facilities encounter unique challenges, such as the need to measure submersed solids under water. A submersed solids sensor option is a proven solution when the requirement is to measure the level of solid material below a liquid surface, such as in brine interface applications (Figure 6). The weighted probe drops through

the liquid and makes contact with solid material settled at the bottom of a tank, such as for measuring the level of sediment under water. This sensor is an excellent alternative to relying on sight tubes and can be used in any application where solid material needs to be measured under liquid.

ACCOUNTING FOR COMPACTION OR IRREGULAR VESSEL SHAPE

Many powdered materials will have a greater bulk density at the bottom of the tank than near the top, due to the weight of material compressing downward as the vessel is filled. By entering the weight of the material at different heights in the bin, a strapping table can account for the compaction of material in the vessel. By adding valuable weight-to-distance data into a table, the estimate of material in the bin can be tailored to exactly how material behaves in a particular vessel. Strapping tables are also a useful tool when measuring the contents of cone-bottomed bins, because they can take into account the amount of material in a tapered cone. Strapping table data also allows for more accuracy in measuring irregular tanks, such as a cylindrical tank installed on its side.

Many new, innovative level measurement technologies are available for measuring powders and solids, but if you are looking for a proven, long-lasting, reliable and hassle-free solution, a cable-based sensor ensures simplicity and repeatability. This robust inventory management system can be networked using wired or wireless communications for up to a hundred vessels using just one license of software or one integrated console, making it an economical and uncomplicated choice.

Advances in software and Internet-based solutions allow users to initiate a measurement from a remote location and provide real-time inventory data from anywhere there's an Internet connection. Cable-based sensor networks cost less and present few headaches compared to other technologies, while providing a wealth of data for effective inventory management.

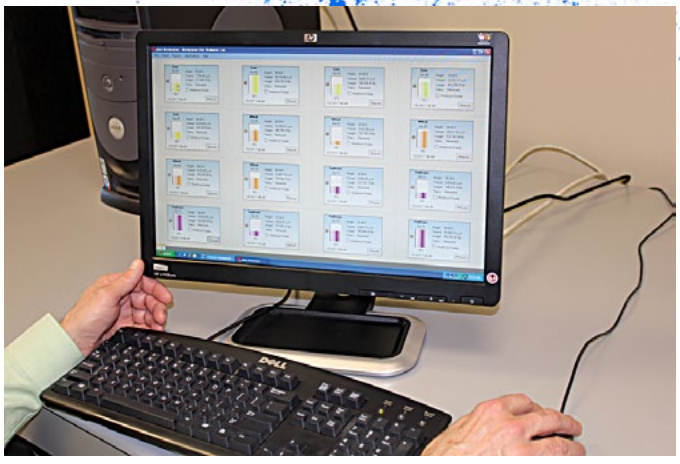

Figure 5. Windows-based software reports detailed data for multiple vessels simultaneously and generates a visual that shows silo levels as a percentage full.

Figure 6. A submersed solids sensor can measure the level of solid material below a liquid surface, such as in brine interface applications.

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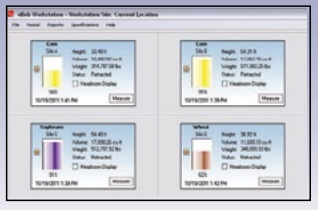

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