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PROCESS INSTRUMENTATION

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Although the U.S. continues to face economic uncertainty, the chemical industry has seen significant investment and growth. As production expands to meet the world's future demands, growth in the chemical industry is projected to double what it is today by 2035. This seems far away but before you know it, you will be saying the future is here! The question you need to ask yourself is, "Will your processes be completely automated or are you going to be caught having level instrumentation in some vessels and yet continue taking manual level measurements in others - let's say five years from now?"

The chemical sector differentiates from other industries for its wide range of diverse processes ranging from small to large production scales and production demands calling for batch to continuous processes. In a competitive environment, having an efficient process is a must. If you expect to survive, you might want to take look at where you are today and where you want to be a few years from now. Being able to adapt quickly to process changes, production demands and customized customer requirements will dictate the level of investment and instrumentation you will need to achieve optimal output without risking efficiency.

The future outlook requires a comprehensive evaluation of your process and defined goals that need to be achieved. However, getting an insight into the various level measurement solutions can help you understand that there is not a "one technology fits all" approach to solving your level measurement needs. Although this can be one small part of the puzzle, having the right level instrument in a given vessel can definitely improve your process by maintaining the right inventory levels that your process requires.

With the right level instruments in place, you can be rest assured that your personnel is not exposed to harsh environments or weather conditions that hinder proper manual level measurements. Furthermore, process instruments can add peace of mind by mitigating unwanted, messy and costly spills.

The scope of this article will review the popular level technologies used to control and/or manage the correct level of your liquid and solid ingredients used in process vessels or silos containing dry bulk solids materials. The intent is not to compare level technologies, but instead to point out some application conditions that make certain level instruments more favorable to use than others. The approach detailed below will be based on general characteristics of the product or media being monitored such as process temperature, pressure, steam, dust, vessel type, desired outcome (e.g. continuous or point level measurement or both when sound engineering practices are implemented), etc.

With that said, let me start with a couple of level technologies that have been used extensively in the industry: ultrasonic and radar based level instruments. Of these two instruments, radar continues to gain popularity because it can tolerate higher temperatures and pressures than ultrasonic level instruments, and it can also operate in a vacuum. However, ultrasonic level instruments, for the most part, are more economical than radar transmitters and are more reliable in applications where vapors from solvents are not present. Ultrasonic controllers offer built-in functions for alarms and pump control. Some advanced controllers are perfect to monitor industrial waste water and are used to manage the water discharge to the public utility collection system.

With respect to radar transmitters, some are well-suited for turbulent conditions, hot temperature, and high pressure environments. Some are best for storage and process vessels and tank farms. The latter types offer a variety of antennas that can fit into many process connections. These radar transmitters operate in the 25 GHz range (K-Band) and this frequency allows them to have a signal that is well focused. The smaller the signal beam angle, the less signal degradation from tank walls, narrow and tall process connections, and/or standpipes. These transmitters are commonly used in liquids and slurry applications such as resins, pigments, paints, coatings acids and solvents. They can be applied across a wide range of process connections and flange sizes. The vast majority utilizes a horn antenna design. The encapsulated antenna designs are also available for applications where corrosive or aggressive media is present. The lens at the end of the antenna essentially seals the process connection and this lens is the only wetted part exposed to the media. With a high degree of chemical compatibility, this is truly an attractive economical solution to alternative, expensive metal alloy horn antenna designs. A key requirement when using any radar transmitter is the minimum relative dielectric for the media being measured. Today, most radar transmitters can detect media with a 1.6 or greater relative dielectric. This minimum requirement covers a wide spectrum of conductive and non-conductive media.

Radar transmitters operating around 6 GHz frequency (C-Band) have a larger wavelength and are better suited for turbulent level applications. Because of the lower frequency, the horn antenna designs are larger and require wider openings for installation than the ones operating in the K-Band. There are TEFLON and Polypropylene rod antenna designs available that can be installed in small process connections. These options offer great chemical compatibility. However, be cautious when using rod antennas as most of them approach 20 inches in length and in short vessels this can present a span problem because product should not come in contact with the antenna. Rod style antennas have a signal with a broad beam angle and close attention is required when choosing an installation port. These transmitters are suitable in applications with vapors, solvents, temperature gradients, vacuum or pressure, and are suitable for the same media types mentioned above.

There are radar transmitters designed for bulk dry solids level applications. Level measurements of solids tend to be in dusty environments and are frequently long range. There are designs that operate around 25 GHz and 78 GHz (K-Band and W-Band). Both types can handle dusty conditions very well and some have range capabilities exceeding 300 feet. The higher frequency ones (W-Band) have a very narrow beam angle and are excellent for materials that exhibit a steep angle of repose like fertilizers or sand-like materials. These transmitters are successfully used in plastic pellet level applications and especially in very tall metal silos. Metal silos can be acoustically intense depending on the mechanism utilized to fill them. This acoustical noise can interfere with the signal of ultrasonic technology-based level instruments. However, ultrasonic technology level transmitters have been used with great success in short to mid-range level applications where noise level is moderate, and the environment is not dusty as it is in the case with bulk powders.

The above radar instruments are non-contacting instruments and because they don't come in contact with the media being monitored, they are preferred over contacting technologies. Guided Wave Radar (GWR) is a contacting technology. As long as there is not issue with the level device touching the liquid or solid, GWR technology is a great solution for applications with extreme temperatures, steam and very high pressures. GWR is the best choice for interface and level measurement of oil and water, ammonia; drum level feed water applications and steam boilers. These instruments offer great process connection flexibility from ¾ inches (NPT) to large flanges. The rod style probe designs are well-suited for small tanks while flexible cables are better for vessels exceeding 15 feet. If GWR is being used for solid level applications, it is best to switch to non-contacting technology beyond 50 feet. The pull forces exerted by the cable, due to material dragging on it, can cause severe damage to the silo's roof if it is not designed

to withstand the effect of the material weight. Although new designs can handle build up on the rod or cable, it is best to avoid applications where material buildup can be a source for high maintenance.

Continuous capacitance level sensors are also a contacting technology. They find applicability with liquids and solids level applications in the chemical industry as well, especially if you are looking for low cost solutions for small tanks and intermediate bulk containers or totes. Powders, granule additives, lubricants and even emulsions can be monitored reliably using continuous capacitance. There are options that can handle extreme pressures too. When dealing with media with low dielectric or non-conductive media, electrically grounding the vessel is a must to prevent erroneous level measurements.

Pressure transmitters are also popular for level measurements. This too is a contacting technology and pressure technology comes with an extensive variety of cell fills and remote seals options for measuring viscous, corrosive or fibrous media as well as media at extreme temperatures. With radar, we need to know the relative dielectric of a material to make sure a good signal is reflected. Additionally, for solids level applications, the bulk density of the bulk solid plays a role in the quality of the returned signal. With pressure, being that it is in contact with the media being measured, chemical compatibility and the specific gravity are factors that need to be considered when choosing this technology. A changing specific gravity would yield inconsistent level measurements

For less complex level applications, there are ultrasonic transmitters and controllers for continuous level monitoring at your disposal. By less complex applications, I mean applications where temperature gradients, extreme pressure or temperature extremes (excess of 200°F) are not the norm. There are many short to medium-sized vessels that contain solutions (media) and even acids that can be monitored using ultrasonic transmitters. Most transmitters fit into a two inch process connection and, similarly to radar transmitters, are also used in liquids and slurries and they provide an output proportional to the level in the vessel. Controllers, on the other hand, have additional capabilities for pump control, low and high level alarms, and discrete inputs. Some controllers have dual-point capabilities; meaning that they can monitor two separate vessels. Dual-point capability devices can be used for liquid, slurries and solids in short to moderate range applications. These devices are the best option to use for open channel flow (discharged water) monitoring, particularly if you have a water treatment process in your chemical plant.

The measurement range of the ultrasonic level controller is dependent on the transducer used. Transducers offer great chemical compatibility due to their TEFZEL or KYNAR material of construction. There are also some designs that are hermetically sealed, which gives the transducers excellent chemical ingress protection. Key applications include sump reservoirs, liquid storage of chemicals where solvents or vapors are not present, water, resins, o vapors, dry bulk solids storage, and, as mentioned above, plastic pellets.

So far, the various level instruments discussed are for continuous level measurement using a non-contacting or a contacting method. There are a number of point level devices that can be used detect a specific level of material in a vessel. In other words, is the vessel empty, full or somewhere in between? A good engineering practice is to use alternative technologies to avoid running out raw materials and avoid costly and messy spills.

Point level detection comes in many flavors. Some popular types include capacitance, vibrating forks and paddle switches. The type used will depend on the characteristics of the material being detected, space restrictions, process connections availability, media abrasiveness, material bulk density and output function requirements.

There are capacitance switches that come with small insertion probe lengths. This switch type is perfect for constricted spaces and pipes, and it can be used to detect liquids, slurries solids, and foam in vessels. The wetted part is non-metallic and the probe coatings make them compatible with many chemicals. Some models are completely potted, making them resistant to vibration and agitated applications. Some capacitance switches offer longer rigid or cable extensions to reach down to a desired point of interest. With continuous capacitance, a reference electrode (e.g. a conductive metal tank wall) is required for a stable output. Capacitance level switches (or point level switches) operate independently of the tank wall or pipe, so they do not require an external reference electrode for level detection in a non-conductive vessel such as concrete or plastic.

Vibrating level switches can also be used in liquid and slurry applications for high or low detection scenarios. There are options that are well-suited for confined spaces since their insertion length is less than two inches. They can be used to measure products with a minimum density of >0.5 g/cm^3. They also perform well in difficult conditions including turbulence, air bubbles, foam generation, buildup and/or strong external vibration.

Finally, there are vibrating (tuning fork) and paddle level switches for high and low demand levels of bulk solids in bins silos and hoppers. The bulk density will dictate which type is best suited for the application. Due to size of the blade on the paddle switches, they are well-suited for very low bulk density media.

The requirements placed on level measurement in the chemical industry are extensive. It ranges from protection against overfilling to measuring in hazardous areas to complex processes, regardless of the type of tank. The media that needs to be measured may have extremely variable characteristics such as steam, dust, foam and high temperatures, not to mention pressures, turbulence, build-up,

and extreme product variances. With this in mind, it is easy to see that the “One level solution fits all” approach is not a feasible. But, doing business with an instrument provider that offers a complete portfolio has its advantages because when the time counts, you can call one place to address your instrumentation and technical needs and engineering support. When the future arrives, you can say thank goodness for automation.

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