On the level

In this second of our series on instrumentation and control engineering, Brian Tinham looks at issues and technologies around level measurement equipment for plant

Last year, we began a series of features on instrumentation and control, aimed at helping plant engineers to skill-up. In the first feature we covered pressure and flow equipment. In this second piece, we move on to level instruments – choices, sizing and what works best and why.

Although there are clear similarities – level being another physical parameter sensed using comparable equipment and with similar issues, in terms of the need for caution around process materials and conditions – there are also significant differences. For liquids, the plant infrastructure itself (tank girders, stirrers, agitators and materials of construction) and any potential for foaming, multiple level interfaces, vapours and dust, density and pressure changes, all need to be considered. Then, in the case of solids, sticking characteristics, granule size and the existence of in-flight material entering tanks and silos are salient factors.

Below: Emerson TankRadar
Bottom: Kent Pohl, level solutions manager, Emerson

It's also important to note that, following the Buncefield disaster, plant operators tend to be more sensitive about getting level right. That's certainly the case where high-level alarm switching and spillage prevention are the requirements (and especially with petrochemicals, oil and gas, for which new guidelines are available via HSE); but it's also heightened awareness of getting level detection properly working and maintained elsewhere – to ensure plant safety and to improve process uptime.

Which, with the very wide variety of level monitoring requirements and technologies, isn't always as easy as it might seem.

So what are the choices? Well, they include mechanical (displacers, floats, bubblers etc) and electronic (differential and hydrostatic pressure etc) point and continuous level devices, ultrasonic, guided wave radar, free radiating radar, capacitance, vibrating fork, nuclear and RF admittance instruments – as well as specialist equipment for boiler controls. Each has pros and cons, and most engineers have their favourites, based on their own experience, but it's worth being aware of the range.

Kent Pohl, level solutions manager with Emerson Process Management, says: "If you're looking at general process level measurement, the big three are pressure-based, radar and ultrasonic, with vibrating fork and float switches for level detection. Then, for solids, the most common choices are capacitance, paddle and vibrating fork switches and radar-based technologies."

Whichever you choose, selection and subsequent sizing aren't too difficult today, given the advent of free online configuration software. "In our case, you start by entering process data and answering questions about the application and mechanical considerations, and the software tells you which technologies will work best from our product range. It also covers material selection and generates data sheets for you," says Pohl.

That's great, but Chris Brennan, product specialist for Endress + Hauser, suggests that engineers do need to remember that instrument vendors don't all cover all the available choices. He also makes the point that background knowledge of the relevant science is still key to getting instruments working at their best – and that level instrumentation technologies are constantly being developed. "For example, our old Liquiphant tuning fork level switches are now capable of monitoring their own status, which makes them more suitable for SIL [safety integrity levels] applications. And these instruments can also use frequency to derive density and concentration, for process control."

Capacitance and radar

Similar improvements have been made with capacitance level sensing, for switching and continuous level measurement, he says. "We use a range of techniques to deal with problems such as product build-up on the probes. With capacitance, you still have to consider the conductivity and dielectric constant of your fluid, but we now offer a range of constructions and wetted materials, and one of the benefits of these instruments is you do get very fast response level measurement."

Even radar level devices have moved on, and that applies to both free space and guided wave types. Brennan explains that free space devices emit radar through an antenna into a vessel and measure time of flight of the reflected signal. Higher frequencies are now used and upsides include good signal processing, efficient automated tank mapping software (to eliminate unwanted reflections) and an ability to handle a wide range of applications, now

including solids. Guided wave radar instruments, on the other hand, require less energy, can measure level even on low dielectric constant products, can deal better with product foaming, but may suffer from product contact with the radar waveguide.

"Using free space radar technology to get non-contact level measurement with powders, granules and pellets is the real new winner here," says Brennan. "It's superior to ultrasonic measurement not only because it's unaffected by product in flight coming into a vessel, but also dust in the atmosphere. What's more, the frequencies are fixed and device setup is all done fairly automatically by PC software, usually at the remote end of a cable using the HART [digital plant communications] signal – although it can also be done using local programming in the instrument head."

Just a couple of caveats. Pohl advises engineers to consider aspects such as the installation and

lifecycle support offered by different instrument vendors. "Use the selection and configuration tools, but be aware that there are features and benefits with, for example, commissioning, SILs and health verification, that some vendors offer and others do not," he warns. And Brennan adds that engineers need to understand that older level technologies might not be safest. "With modern self-diagnostic equipment, engineers can be advised of a fault long before it becomes a dangerous situation."

And, if you're still concerned, there are safety nets. Neil Ritchie, manager of ABB's Drives and Instrumentation Service business unit, says his company recognises that plant engineers in all sorts of industries are being stretched, so it has established a specific instrumentation phone support service. "It covers everything from basic stuff, such as 'which terminals should I use?' to detailed troubleshooting and advice on obsolescence, instrument spares and training.

"We come across all sorts of problems, often due to the wrong instruments being used in the wrong environment, or engineers assuming that, because they're using newer instrumentation, it's virtually maintenance free – so failing to implement proper maintenance and support programmes.

"People think of instruments as commodities, but they still need at least periodic calibration to make sure they're monitoring or controlling the process properly or meeting regulatory requirements. Our view is that engineers need to establish a maintenance infrastructure that supports the lifecycle of the plant – not just the instrument." PE

Premiere Products cleans up with 'outside looking in' radar

When Cheltenham-based commercial cleaning and maintenance chemicals manufacturer Premiere Products took delivery of a new 40,000 litre polypropylene tank for processing and storing detergents, it soon ran up against problems. Plant engineers found that the ultrasonic level measuring system, included with the tank, was struggling to cope with foam, particularly when products were being recirculated – resulting in spurious and inaccurate readings.

So they called in Hycontrol, which came up with a novel way of using its TDR (time domain reflectometry) radar level measuring system. Instead of installing the stainless steel waveguide cable inside the tank, Hycontrol advocated installing it in a plastic tube on the outside.

Why? Well, because polypropylene has a low dielectric, the instrument's microwaves can pass right through the tank wall, so the system operates as if the tank doesn't exist – yet it's no longer exposed to the foam. Says Hycontrol area sales manager Dave Wadsworth: "Initially, Premiere engineers were sceptical about our 'outside looking in' solution, but they soon realised that this offered a highly effective answer and the system works extremely well.

"We supply the VF7 TDR units pre-calibrated, making installation very easy, and, in this application, there was no disruption to the process. Also, unlike a number of alternative technologies, TDR has the advantage of not being affected by process factors, such as dust, vapour, agitated and boiling surfaces, and pressure, temperature and density variations."