Radiometric measurement solutions for extreme process conditions

Henning Springer, MD of MECOSA, the specialist supplier of niche instrumentation solutions, talks about radiometric measurement technology from Berthold for advanced, non-contact density and level measurement applications.

“MECOSA was started in 1982 by my father, Erich K Springer, who was very involved in instrumentation and control at that time, having been a founder of Krohne South Africa in the mid-1970s,” begins Henning K Springer, the company's current MD.

“We started with a single agency, Heinrichs Messtechnik GmbH, which is still one of our trusted instrument brands today. Over the years, we have grown to represent more than 20 instrumentation OEMs, mainly European companies, all chosen to meet the needs of increasingly complex local applications,” Springer tells *MCA*.

“We strive to provide high-quality measurement signals where conventional solutions fail: slurries in minerals processing circuits, molten steel on continuous casting lines, or any application where a conventional industrial instrument would get destroyed in the processing environment,” he explains.

Radiometric measurement, he continues, is an ideal example. Based on the use of a radiation source and a sensor mounted on the outside of a pipe or tank, accurate measurements of density and/or level can be achieved without physical contact with the process material, avoiding exposure of the instrument to harsh processing conditions.

Density and the Berthold radiometric detectors

Berthold Technologies offers a range of radiometric detectors for directly measuring the density of a process material, tracking density changes in a tank, or determining when maximum or minimum allowable levels have been reached.

“For the mining industry, we have been offering solutions based on the Berthold LB414 for several years now. These are ideal for density measurements on underflow pipes of large volume thickening tanks that are used in the mining industry to concentrate ore or minerals,” he says.

Thickening involves coalescing solid content from a slurry mix so that it will settle under gravity. This enables solid-liquid minerals separation. The concentrated solids are removed via an underflow outlet at the bottom of the tank, while the clear liquid is tapped off from the top. “Care must be taken to monitor the slurry density of the underflow, because too high a solids content can clog or damage pumps and pipes,” he explains.

A SmartSeries Berthold LB414 radiometric detector continuously monitors the underflow density of a thickener.

The SmartSeries Berthold LB414 radiometric detector has been designed for use in harsh environments, such as mill circuits and minerals processing facilities. These detectors offer cost-effective and reliable measurement with excellent accuracy and reproducibility, ensuring dependable performance for many years. “Some Berthold radiometric devices use, amongst others, the HART protocol, which not only makes calibration easy – it can be carried out via a push button on the detector, any HART communicator, a PC with service modem, or an infrared remote control – once calibrated, the 4-20 mA HART output can be used to continuously display the measured value, or sent to a process controller, PLC or the plant's DCS,” he explains.

“These instruments ensure smooth process flow free from clogging, they optimise flocculant use through feeding rate control and determine and deliver exact mass flows in combination with a flow meter, all of which help to minimise operating costs and optimise recoveries. In addition, the non-contact nature prevents wear or damage to the measuring components. Additionally, the radiometric process is maintenance-free without the need for recalibrations for up to the full recommended life of the source – typically 10 to 15 years,” Springer tells *MCA*.

Radiometric measurements principles

When measuring density using a radiation source to penetrate a material, fewer counts per second will be detected for more dense materials, and vice versa. “Like an X-ray, high-density bone is white because fewer rays come through to expose the plate; space is black; and lower-density areas are shades of grey. Typically, the output from our Berthold instruments is an electrical signal of between 4.0 mA and 20 mA, with 4.0 mA corresponding to the lower density value of the calibrated scale,” Springer explains.

The LB430 is an advanced, compact, low-energy radiometric measurement solution that combines the signal and the power supply connections into one, eliminating the need for separate power supply and signal wiring.

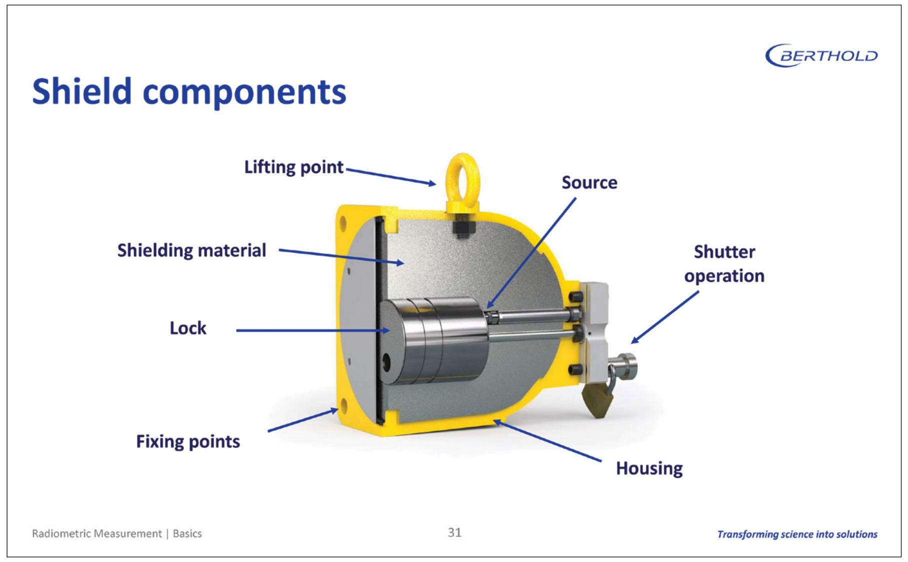
A typical radiometric measurement arrangement consists of a radiation source that emits gamma rays; a reaction vessel or pipe that contains a process fluid, material or slurry, for which the density and/or the level needs to be measured and controlled; and a gamma radiation detection instrument for capturing the levels of gamma radiation penetrating through the vessel or pipe walls and the material being processed in the tank.

The amount of radiation absorbed by a material depends on the density of the material the rays pass through and the distance they travel through each different material. “This makes radiometric density measurement a reliable solution where other technologies fail. The actual density can be determined regardless of temperature, pressure and any known obstacles in the tank,” he adds.

In terms of sources, Berthold instruments use high-energy gamma sources such as Co-60 or Cs-137, for which all atoms except hydrogen have a constant absorption coefficient.

The radioactive material of the source – Cs-137 or Co-60 nuclides – is encapsulated in a Secure Source Capsule (SSC) with at least two layers of stainless steel to provide maximum safety. For increased corrosion resistance, titanium versions are also available. “Our SSCs offer maximum security, exceeding the best possible classification in ISO 66646. They have double encapsulation, at a minimum, are temperature tested up to 1 200°C for 60 minutes, and drop tested with 20 kg from 1.0 m height,” Springer assures.

In addition, to offer better encapsulation and beam alignment, Berthold source capsules are housed in a source shield that is filled with lead. A shutter in this source shield enables the source to be completely shut off and opened to direct the radiation beam accurately.



A shutter in the Berthold source shield enables the source to be completely shut off and opened to direct the radiation beam accurately.

The new Berthold LB430

Launched earlier this year, the LB430 is an advanced, compact, low-energy radiometric measurement solution. This new system combines the signal and the power supply connections into one, eliminating the need for separate power supply and signal wiring. “The LB430 is powered from the low-current 24 V signal available from the controller, PLC or DCS. As well as powering the instrument, the 4.0-20 mA output signal from the instrument is carried through this same four-wire signal cable,” says Springer.

Explaining how this has been made possible, he says much more voltage was needed to power traditional photo-multiplier tubes (PMTs), required to translate the gamma radiation count penetrating the process fluid, first into photons through photoemission, and then, through electron multiplication, into an increasingly stronger stream of electrons needed for the instrument's density signal.

“The new LB430 detector uses a silicon photo-multiplier (SiPM) that works similarly to a digital camera. It uses an array of silicon photodiodes, known as microcells. When each microcell in the array absorbs a photon, it triggers an avalanche multiplication of electrons, allowing an SiPM array to deliver a directly measurable signal in the 4.0 to 20 mA range, without requiring much external power.

Complexities and customised solutions

Every installation of a radiometric detection system, continues Springer, involves a significant amount of customisation. Citing the use of a Berthold system for level control in a continuous casting application, he says that molten steel flows through a nozzle into a mould at a high flow rate. “When approaching the 100% level, the system needs to react very quickly to prevent molten steel from overflowing, which could be a dangerous fire hazard and destructive to equipment.

“Instead of dampening the signal to obtain a smooth, averaged reading, as is typically done when measuring density values or detecting the level in a large tank with slow-moving level changes, we set up continuous casting level measurement systems with very short time constants, allowing them to react rapidly to control the molten metal flow,” he explains.

Complications also need to be overcome when dealing with very high-pressure systems, where the density of the gas or air in the tank can get relatively high. This happens in polypropylene production, for instance, because liquid polypropylene is a low-density material and the high-pressure gas tends to distort the density measurement.

“Particularly in the chemical industry, where vessels tend to have high densities, pressures and high temperatures, it is difficult to predict what is happening inside that vessel. Densities might be changing from high to low, and agitators may be creating vortexes, so a more complex set of instruments may be needed to achieve the optimised process control required to make sure that the product being produced is of a consistently high quality,” Springer tells *MCA*.

“The most important thing for us at MECOSA is the interaction with our customers to make sure that we fully understand the process and we can design and deliver the right equipment for the application,” he says.

“We take care of all the drawings, get all the measurements, and the thicknesses and densities of the walls and any outside lagging or lining material inside a pipe or tank. We always make sure that the measurement equipment we supply is well matched to the application and the on-site process equipment being used,” concludes Henning Springer.

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