

Level measurement using radar technology



The severe operating conditions commonly encountered in pulp mills can prove difficult for level measurement instrumentation. Ingemar Serneby* explains how the latest non-contact radar transmitters meet these challenges

The various stages of the pulp production process involve a broad range of applications in which accurate and reliable level measurements are essential. These measurements play a crucial role in reducing chemical use, product variability and energy costs; optimising production and storage efficiency; and increasing plant and worker safety.

However, the severe operating conditions in pulp mills present challenges for most level measurement technologies. These include turbulence, foaming surfaces, corrosive

chemicals, condensation, viscous materials, density and pressure variability, high temperatures, dust generation, and media with a low dielectric constant.

It is therefore essential to select

Conditions in pulp mills can be challenging for measurement systems

instrumentation that can best overcome these challenges to provide the high degree of level measurement certainty they require.

Measurement technologies

Various technologies can be employed to monitor and

measure the level of fluids and solids. The most basic method is the manual process of viewing the medium through a sight glass. Other traditional techniques include electro-mechanical devices such as floats and displacer switches, capacitance point level switches, ultrasonic technology, differential pressure sensors, laser-based devices and load cells.

In pulp mills, however, these methods are increasingly being replaced by modern electronic technologies such as vibrating fork level switches, guided wave radar (GWR) transmitters, non-contacting radar transmitters and acoustic scanners. These advanced devices provide enhanced functionality and increased diagnostics capability, leading to improved measurement accuracy and repeatability, reduced maintenance requirements and lifecycle costs, and greater reliability.

Non-contacting radar

Non-contacting radar technology provides a top-down, direct measurement of the distance to the surface, which is highly accurate and reliable and can be used with liquids, sludges, slurries and some solids. With built-in diagnostics, a lack of moving parts, and straightforward installation and commissioning, non-contact radar transmitters provide both ease-of-use and low maintenance requirements.

To perform continuous level measurements, non-contacting radar transmitters use one of two main modulation techniques – either pulse or frequency modulated continuous wave (FMCW). In pulse systems, thousands of short radar pulses



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are emitted from an antenna positioned at the tank top directly towards the material below. These pulses are reflected back to the transmitter from the material's surface. The transmitter measures the time delay between the transmitted and received echo signal, and an onboard microprocessor calculates the distance to the material's surface, and consequently the level measurement.

Transmitters using FMCW technology transmit a radar signal with increasing frequency over time to create a signal sweep. The signal echo reflected from the surface is picked up by the antenna.

Because the frequency of the transmitted signal constantly varies, the echo frequency always differs slightly from the transmitted signal at any given moment. The difference between these frequencies is directly proportional to the distance from the transmitter to

the surface, thereby enabling the level to be measured.

FMCW radar transmitters have more than 30 times higher sensitivity than pulsed devices, which maximises their signal strength and enables them to deliver greater measurement accuracy and reliability. However, FMCW technology uses more electrical energy than pulse.

Although level measurement technology selection is very much application-dependent, non-contacting radar transmitters provide a broad range of important benefits that enable them to meet many of the toughest challenges presented during pulp production.

Turbulence and foaming

Heavy turbulence or a large amount of foam can affect the signal strength of non-contacting radar transmitters. But recent advances include dedicated software algorithms that counteract the effects of turbulence and surface foaming. Alternatively, devices can operate in bypass chambers or stilling wells to negate these problems.

Corrosive media and condensation

Devices must be designed to cope with aggressive media and condensation. The latest non-contacting radar devices overcome this with all-PTFE process seal antenna, engineered to maximise resistance to corrosive chemicals.

Coating, viscosity and dirty antennas

Non-contacting radar transmitters are unaffected by coating and viscosity but a device's antenna can become



dirty and this can affect its performance. The latest radar transmitters can detect a dirty antenna using signal quality metric diagnostics, enabling preventative maintenance to be scheduled.

Density, temperature and pressure

Liquid density can change as part of a reaction, along with

Despite the dusty conditions the 5408 has required less maintenance and downtime, leading to improved productivity

radar transmitters based on FMCW technology maximise their signal strength, enabling them to accurately and reliably measure low dielectric media.

Case study: the Södra Cell mill

Typical examples of how advanced non-contact radar technology is helping pulp producers to meet their toughest level measurement challenges can be seen at the Södra Cell mill at Värö in Sweden. The mill is one of the world's most modern pulp production facilities, producing around 700,000 tons of high-quality, chlorine-free softwood pulp and 1.6 TWh of energy annually. The company was facing two demanding level measurement challenges, which it solved by installing advanced non-contacting radar transmitters from Emerson.

The first challenging application required the level measurement of very fine lime powder stored in 27 metre high silos. As the powder piles up inside, the material tends to form in towers beneath the inlet. In addition, the powder covers everything with a fine layer that is prone to build-up, making it difficult to measure the level with any degree of accuracy. Other challenging factors include the long distance to be measured and the powder's low dielectric constant.

Södra had tried using mechanical devices, ultrasonic technology and radars, but their performance was affected by clogging. With the majority of non-contacting radar devices, ►



temperature and pressure. Non-contacting radar transmitters are suitable in these applications as they do not need to compensate for density, high temperatures or pressure changes.

Solids measurement

Measuring the level of solids and powders – in lime silos, for instance – have an uneven material surface that creates false

signal reflections. By using a signal processing algorithm that merges surface peaks, the latest radar transmitters based on FMCW technology are able to overcome this challenge and provide a high degree of accuracy.

Dust generation

Non-contacting radar transmitters usually handle dust well, but a heavy layer can clog

the antenna and block the signal. The latest devices overcome this with an integrated air purging system that cleans the antenna.

Dielectric constant

A low dielectric constant – such as in the lime powder used in pulp production – means that much of the energy from pulse radar transmitters is absorbed, so less is reflected. Non-contact



the signals are very low, which makes them unreliable. However, Södra solved this by installing Rosemount 5408 Non-Contacting Radar Level Transmitters with parabolic antennas.

The 5408 uses FMCW technology, and its increased sensitivity allows it to successfully measure lime powder, despite its low dielectric constant. The parabolic antenna's built-in air purging adapter prevents the lime powder from building up. To ensure accurate measurement, the 5408 uses special software algorithms specifically designed to handle the characteristics of solids.

Since being installed, the 5408

has proved to be extremely reliable. Despite the dusty conditions the 5408 has required less maintenance and downtime, leading to improved productivity.

Södra also needed to find a better way of measuring the level in mixing tanks containing a mixture of lye and soap. The media is aggressive and contaminating, with a dense, thick layer of foam forming on its surface. A number of different technologies had been tried to accurately and reliably measure the level in the 18-metre tanks. Mechanical devices experienced problems caused by build-up, while the nozzle of GWR transmitters proved to be too

narrow, causing measurement errors whenever the probe came close.

The build-up problem required Södra to find a system that was resistant to the media, so installed Rosemount 5408 level transmitters with PTFE process seal antennas.

The superior sensitivity and advanced software functions of the Rosemount 5408 enable it to accurately measure through foam, even when the surface is turbulent. The transmitter's signal quality measurement functionality is able to detect abnormal process conditions such as antenna coating, while its PTFE process seal prevents the media from

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building up on the transmitter, thereby maintaining an accurate and reliable measurement.

Since integrating the Rosemount 5408 into the distributed control system at the mill, Södra has been delighted with the positive results. These include significantly reduced maintenance and downtime, and an increase in productivity.

More information from www.Emerson.com/rosemount5408

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