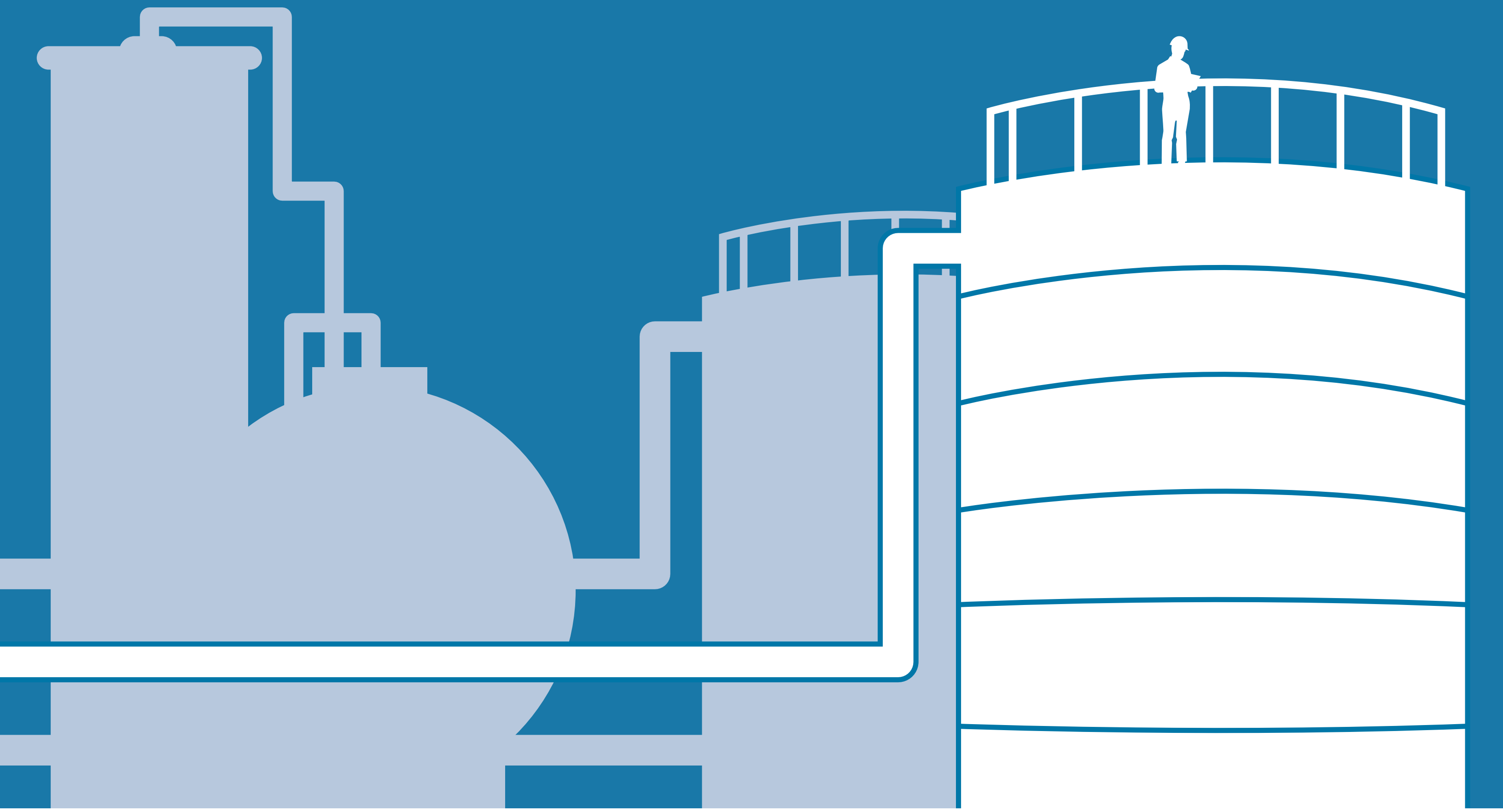
FOAM IN THE FIELD

How Proper Level Instrumentation Can Alleviate Foam Headaches



A Magnetrol® **Level Matters** Series White Paper

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INTRODUCTION

Many liquid tanks in the chemical, refining, food & beverage, life sciences and other process industries can, at times, have foam present. The dynamic nature of foam means there is no "one-size-fits-all" measurement solution. In addition to knowing what type of measurement is required, it is also critical to consider the characteristics of the foam itself.

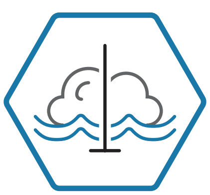
There are many reasons why foam can be present in a tank, including the introduction of air/gas into the product being measured or the operation of agitators/mixing blades. Regardless of the source, care must be taken when choosing a level measurement technology to prevent unnecessary errors or loss of measurement.

The objective of this paper is to review challenges presented by foam and how to realize operational improvements through proper level instrumentation.

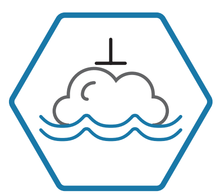
FOAM CHALLENGES

Foam's dynamic mixture of gas and liquid can present difficulties for traditional level technologies that are commonly employed for liquid level measurement.

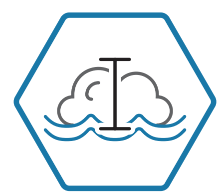
In general, there are three potential level measurements that would involve a liquid tank with foam:



Measuring the liquid level through the foam layer



Measuring or monitoring the top of the foam layer



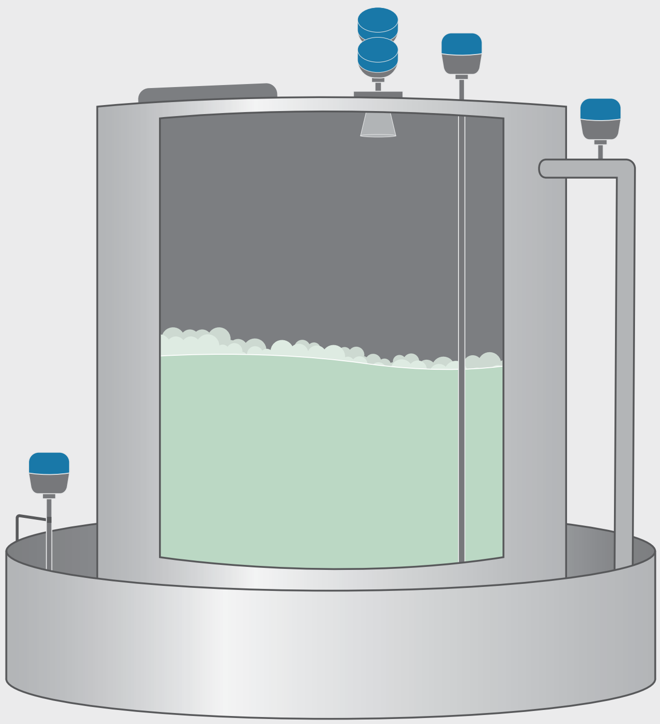
Measuring the foam thickness

Most of the time a continuous measurement of the liquid is desirable, as this is the valuable product being processed. Although a level switch may suffice when the goal is to simply monitor the presence or absence of the foam layer at a specific point, a transmitter can provide additional insight into vessel contents to improve the overall process. Many tanks have both a continuous level transmitter in operation along with a point level switch.

Determining a technology's suitability on a foaming application is dependent on the goal relative to the measurement: detect foam (point or continuous), ignore foam (liquid only measurement) or measure both foam and liquid. Additionally, the foam thickness and properties of the foam, such as density, bubble size and dielectric constant are key considerations that can impact the level measurement.

REALIZING OPERATIONAL IMPROVEMENTS

If there are existing issues in a process attributed to foam, consider reviewing the level technology (point or continuous) currently in use. The correct technology will reduce maintenance and environmental impact costs while enhancing process throughput.



Choosing the right technology or multi-technology solution can mitigate overfill conditions or mishaps and costly environmental impact.

When choosing a technology, it is important to consider what you are trying to measure: the liquid through the foam layer, the top of the foam or foam thickness.

By using the right solutions and applying best practices for measurement and detection, you can ensure optimal tank capacity utilization and boost process optimization and productivity.

OVERFILLS

Often when choosing a level measurement technology, the liquid surface takes precedence, with foam measurement only given secondary attention. This leads to foam-overs. Repeated foam-over conditions, if left unchecked, can obstruct the passage to overflow vessels and flood the containment basin/system. Expensive cleanup, environmental impact and lost product are the result of less than adequate level controls on foam.

The need for foam detection will vary by facility and individual tank. It is important to choose a level technology that is sensitive enough to detect the top of the foam layer and, possibly, provide a level of redundancy for foam detection. Some situations may only require a liquid level transmitter. However, if foam-over is a concern, a high-level switch or transmitter that can detect foam should be considered. In a plant that is continually receiving fines or encountering productivity issues due to foaming problems, a level switch will easily pay for itself.

Unfortunately, some of the most well-known liquid level switch technologies may not be suitable for detecting an upper layer of foam.

CASE STUDY: Overfills

A specialty chemical facility producing surfactants was frequently being fined for foam-overs by the U.S. EPA. The company reviewed the high-level switches in operation and found that they were very reliable with liquids, but incapable of detecting foam due to extreme variations in foam density. After testing several level switch technologies including tuning forks, ultrasonic gap switches, thermal dispersion switches and capacitance switches, the company determined that thermal dispersion and capacitance technologies were the best candidates for their particular foam scenario. This proved to be an economical solution to a costly problem.

MAINTENANCE

Aside from potential fines and clean-up due to a foam-over, monitoring foam levels may also reduce maintenance costs associated with starving pumps. Pumping foam instead of liquid can damage pumps, resulting in significant and avoidable production downtime and replacement parts costs. A liquid level transmitter will indicate low or high levels in the tank, but a switch could also be used to indicate liquid versus foam.

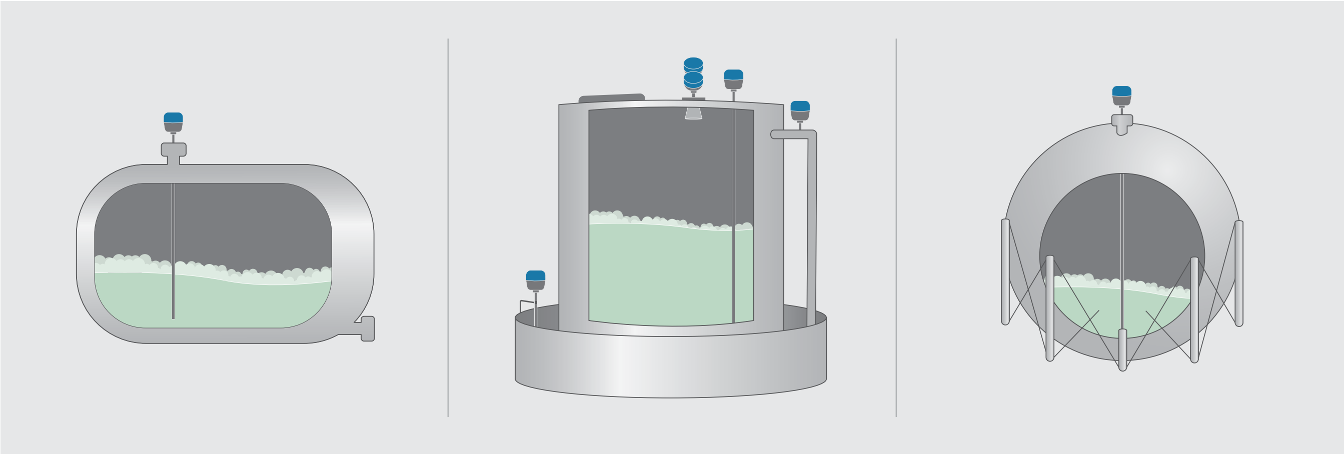
PRODUCTIVITY

Oftentimes facilities will sacrifice tank capacity by reducing the maximum allowable level to accommodate dynamic foam conditions. Deploying the right technology for proper detection and monitoring can allow additional headspace for dynamic foam conditions. Proper monitoring of the top foam layer provides access to and utilization of a tank's entire capacity. No longer do you have to add additional tank capacity as a buffer to optimize production throughput. With large tanks that are being severely underfilled, this can result in considerable productivity gains.

In addition to better utilization of tank capacity, reliable measurement of foam location, thickness and level can reduce the costs associated with anti-foaming agents and chemical additives. A redundant and diverse monitoring and detection solution can also be implemented on the most severe foaming applications.

USING RADAR-BASED TECHNOLOGIES ON FOAM

The scenarios previously described highlight the importance of choosing the appropriate level instrumentation. One of the fastest growing and most dependable technologies to both cut through foam and potentially measure the foam level is guided wave radar (GWR). Thanks to the strong signal down the waveguide (probe), GWR can be utilized across many applications and tank shapes.



The signal-to-noise ratio (SNR) is important for any technology, but in particular GWR. The higher SNR allows the instrument to detect lower dielectric liquids or foams and helps reduce the dead zone at the top of the probe. In the case of GWR, this means actual, direct level measurement, from the bottom of the probe up to the process connection, as opposed to inferred measurement via firmware techniques. This enables increased utilization of tank capacity and thus higher productivity.

CASE STUDY:
Advantages of GWR

GWR is continuing to replace older technologies and is becoming the standard in many industries. A German food processor required continuous level measurement of the yogurt running through a three-tank filling system. The product was prone to significant foaming, and the capacitance level transmitters being used were unreliable. In looking for a replacement, the company found that GWR not only performed reliably during normal foaming conditions, but also throughout the clean-in-place (CIP) cycle. All three capacitance transmitters were quickly replaced with GWR.

Although GWR technology has many advantages, as a contacting technology, the probe can be subject to buildup from viscous or sticky process fluids. However, a GWR transmitter with advanced diagnostics can detect and monitor buildup on the probe, allowing the user to schedule cleaning and maintenance before a problem occurs. Another option is to coat the probe with PFA (or similar) to reduce friction and material buildup or assist in corrosive environments (flushing ports can also be provided for in-situ cleaning). Depending on the application, non-contact measurement technology may be preferable for applications with coating, corrosion or installation concerns.

Whichever technology is chosen, it is important to evaluate which models or configurations within that technology are best for dealing with foam. This includes the probe type for contacting technologies or operating frequency for non-contact technologies, as well as other diagnostics and design features that will ensure peak performance.

CASE STUDY: Effective Measurement with Non-Contact Radar

Non-contact radar is another popular technology for applications with foaming and other process challenges. A specialty chemical facility encountered numerous level control when automating the operations of ten blending tanks. The dual-level mixing blades coupled with vortex breakers and sticky process fluids was a challenge for even the most robust technologies.

In this scenario the right technology was selected, but at the wrong frequency. Since frequency and wavelength have an inverse relationship, longer wavelengths (lower frequency) are better suited for applications where the signal must penetrate through foam and vapors. Understanding this relationship is key when deploying non-contact radar and can prevent process headaches. This facility switched to a lower frequency model and the issues were resolved.

MULTI-TECHNOLOGY APPROACH

As previously mentioned, for a technology to be successful, there are a few basic questions that need to be answered:

- Which levels must be measured (liquid, foam or both)?
- Do the levels need to be continuously monitored or would a level switch suffice (or does it require both)?
- What are the process conditions (temperature, pressure, corrosion, coating, foaming, dielectric)?
- What are the physical characteristics of the tank (material, shape, mounting location, agitators, vortex breakers, ladders, etc.)?

With answers to these questions, a reputable level instrumentation supplier will be able to better identify what technology or technologies will meet the needs of the application. Although one technology may be suitable for a variety of tanks, many times multiple technologies will be required to make the necessary measurements. While radar-based technologies show the fastest growth rates, Table 1 offers a comparison of the various level technologies that can be used when foam is present in a liquid tank.

MEASUREMENT TECHNOLOGIES FOR FOAM MEASUREMENT

Table 1: Technology comparison for liquid and foam measurement when foam resides on top of liquid

TECHNOLOGY	MEASUREMENT	LIQUID	FOAM	STRENGTHS	WEAKNESSES
Guided Wave Radar Transmitters	Typically measures the liquid level through the foam, but can often be configured with higher sensitivity to detect foam	🟢	🟡	Direct level measurement independent of density/SG Strong signal down probe No calibration required Buildup detection No moving parts	Thick or conductive foams may absorb signal Contacting technology
Radar (Non-Contact) Transmitters	Not intended for foam measurement but can often cut through foam to measure liquid	🟡	🔴	Non-contacting technology Varying frequencies available for potentially measuring through foam	Foam or vapors may reduce measurement distances or absorb/lose signal Increased commissioning time
Ultrasonic (Non-Contact) Transmitters	Foams or vapors may reduce measurement distances or absorb/lose signal	🔴	🔴	Economical transmitter Non-contacting technology	Heavy foam and vapors
Magnetostrictive & Displacer Transmitters	Buoyancy-based floats or displacers can be weighted to ignore the foam and measure liquid level	🟢	🔴	No calibration typically required	Moving parts Density dependent Contacting technology
Differential Pressure Transmitters	Not intended for foam measurement (ignores foam) but will measure liquid level as foam has negligible impact on density	🟢	🔴	Familiarity/installed base	Calibration required Density dependent Total cost of ownership
Capacitance Transmitters & Switches	Can potentially detect foam level or liquid with minor buildup	🟡	🟡	Economical transmitter No moving parts	Calibration required and is dependent on liquid or foam dielectric properties Contacting technology
Tuning Forks & Ultrasonic Gap Switches	Typically detects the liquid level and not the foam	🟢	🔴	No calibration required No moving parts Familiarity/installed base	False trips or relay chatter in dense foams Buildup
Thermal Dispersion Switches	Thermal conductivity differences allow for foam or liquid detection	🟢	🟡	Probe designs to reduce buildup effects No moving parts	Calibration required Excessive buildup

🟢 Recommended 🟡 Review Application Details 🔴 Not Recommended

CASE STUDY: Diverse and Redundant Solutions

There are critical applications where multiple technologies and redundancy are a necessity, but there is limited available space for mounting. In one instance, a specialty chemical manufacturer and toll processor only had one opening available on top of their tanks for level instrumentation. Using a special design, a GWR transmitter and an ultrasonic gap switch were installed through a single flange, providing both redundancy and improved high-level protection.

CONCLUSION

Every facility has unique requirements, but what many of them have in common is frustration with foam. It is vitally important to understand and leverage the strength of a technology while incorporating sound design principles to mitigate any shortfall. This is the key to reliability, reduced costs and increased productivity.

Magnetrol's leadership role in the level measurement industry has given us the depth of application and technology expertise necessary to mitigate foam issues, along with other application challenges faced in chemical processing and other process industries. We offer a full range of contact and non-contact level instrumentation, including the industry's most reliable and advanced GWR. You can find more of our application white papers, technical information and product profiles at **Magnetrol.com.**

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