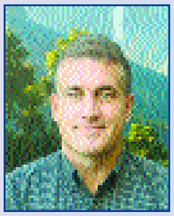
QUICK TAKES

Radar Level Gauges



Bob Botwinski is the guided-wave radar product manager for Magnetrol International (www.magnetrol.com). He has 20 years of experience in the industry, 17 of them as an electronic design engineer for RF capacitance, contact ultrasound, air sonar, and guided-wave radar technologies. Currently, Mr. Botwinski is responsible for Magnetrol's Eclipse and Horizon guided-wave radar product lines.

Q: *What are the key advantages a radar-based level transmitter offers over traditional level measurement technologies (i.e. differential pressure, RF capacitance, magnetostrictive, etc.)?*

A: Guided-wave radar overcomes a number of weaknesses in many of the older technologies. Being immune to changes in specific gravity, GWR outperforms DP cells and displacer transmitters. In addition, the fact that GWR has no moving parts, it eliminates the issue of mechanical parts needing maintenance or losing their tolerance.

The biggest concerns with RF capacitance applications are: 1) the need to move levels to calibrate the device; and 2) changing dielectric constants. GWR does not require level movement and no field calibration is necessary. Secondly, since GWR is only looking for an impedance change between the air and liquid level, changing dielectric constants do not affect GWR. As long as the dielectric constant of the medium is high enough to be detected as a level, a change in dielectric does not affect performance. In other words, the position, in time, of the reflection does not change with changing dielectric constant — only the amplitude of the signal changes. Another weakness of RF capacitance is that significant measurement error can occur if a conductive medium coats and builds up on the probe. A single-rod GWR probe can operate effectively even with coating and build up, although some error will develop based on the extent of the coating.

One major advantage GWR offers over Magnetostrictive technology is that it has no moving parts. This lends itself to applications in the food/beverage and biotech industries that require a sanitary finish.

Q: *What type of applications is guided-wave radar typically best suited to handle?*

A: There are very few applications that GWR cannot handle. It comes down to the type of probe required. Coaxial probes are the most efficient configuration, capable of handling very light hydrocarbons, such as butane propane, which are down in the 1.4 to 1.6 dielectric range. Twin-rod and single-rod probes are designed for more viscous applications.

Q: *What type of applications is guided-wave radar typically not a good fit for?*

A: Being a contact-based measuring device, applications needing very long probes could make [guided-wave radar] cumbersome. Although flexible probes are available for these applications, very large tanks are probably better suited for through-air radar.

However, if the dielectric constant of the medium in a very large vessel is low, then the signal reflected may not be optimal for a through-air radar device and GWR may be preferred.

Q: *How is guided-wave radar different from through-air radar?*

A: The basic principal of operation is the same for both technologies. High-frequency electromagnetic energy is transmitted into a vessel. A reflection occurs at the point where there is an impedance change between the vapor space and liquid level. This impedance change is caused by the two media having different dielectric constants. The higher the dielectric constant of the product, the larger the amplitude of the reflected signal.

The difference between the two technologies lies in the fact that through-air radar sends its energy out into the open air. In this way it can be attenuated by the vapor space in which it is traveling, and reflections from objects other than the level signal (false targets) can cause performance issues. GWR transmits energy down a probe (i.e. waveguide) where it is focused. Very little energy is lost down the probe, therefore very low dielectric media can be measured. Using a probe, GWR virtually eliminates the variables that can influence through-air radar.

Q: *What type of applications is through-air radar typically best suited to handle?*

A: In many cases, through-air will be considered first as most people prefer a noncontact solution. Quality of the signal reflection is always the main consideration: mid-to-high dielectric media, little or no turbulence or foam, few false targets in the vessel, liquids that have a high propensity to coat, corrosive applications that demand noncontact. Larger vessels (>15-20 feet) or where headroom above the vessel is small are more easily outfitted with through-air.

Q: *What probe options are available for guided-wave radar today, and in what scenarios should users consider using them?*

A: Coaxial probes are the most efficient of the probe types and should be considered first in all applications. Analogous to the efficiency of modern coaxial cable, coaxial probes allow almost unimpeded transmission of high-frequency energy. The electromagnetic field that develops between the inner rod and outer tube is completely contained. The efficiency and sensitivity of a coaxial configuration yields robust signal strength, even in extremely low dielectric applications. The sensitivity of this "closed" design also makes it more susceptible to measurement error in applications of material coating and buildup.

The relationship of the twin-rod probe to the coaxial is similar to that of older twin-lead antennae to modern coaxial cable. Three hundred ohm twin-lead cable simply does not have the efficiency of 75 ohm coaxial cable. The parallel conductor design is less sensitive than the concentric coaxial, which translates to twin-rod GWR probes measuring media with dielectric constants down to only around 2.0.

Single-element GWR probes act quite differently than coaxial and twin-rod element designs. The pulses of energy develop between the rod and the mounting nut or flange; the pulse propagates down the rod as it references its ground at the top of the tank. The efficiency of the signal is directly related to how much metallic surface exists around it at the top of the vessel.

This single element design is the least efficient of the three. Because the design is open, it exhibits two strong tendencies: First, it is the most forgiving of coating and buildup. Secondly, it is most affected by proximity issues. It is important to note that a parallel metal wall close to the probe increases its performance while a single, metal object protruding near the probe may be improperly detected as a liquid level. FC