Making Radar Level Measurement a Non-contact Sport

by John Kuldanek/RSM- Magnetrol International

Nirvana for every instrument person is to find a trouble-free, loop-powered level transmitter that can be mounted, wired and forgotten. As instrument shops' staffing have been whittled back to a minimum, it has become the goal of many manufacturers to meet that need for "Plug 'n' Play" devices. So how close have we gotten to applying two wires and walking away? First, a little background.

In the late 1990s/early 2000s, low-cost, loop-powered Radar burst on the scene. It was enthusiastically applied due to its ability to work even in the changing conditions that plagued the most popular technologies of the time. No longer would changing specific gravity ruin the accuracy of DP cells or displacers, changing dielectric spoil the performance of RF Capacitance devices or vapor space changes affect the propagation consistency of Ultrasonics. A new age was upon us.

Radar had already evolved into two variations: Non-contact/Through-air (antenna-based) and Contact/Guided Wave (probe-based). In a perfect world all transmitters would be non-contact as they would not have to contend with contacting the dirty, coating-prone, turbulent liquids that can wreak havoc with performance and mechanical integrity. However, since Guided Wave Radar (GWR) employed a metallic probe, an extremely efficient electrical path is provided to propagate the signal. This allowed extremely strong radar reflections off the liquid surface providing excellent performance in difficult conditions. We're closing in on Nirvana.

Its sister, Non-contact (NC) radar, slowly became the technology many people love to hate. Theoretically, non-contact can be so effective it should be everyone's first choice. It is small and easy to install, measurement in tall tanks did not create a long, expensive and unwieldy probe like GWR and it sat up high in the tank away from the tank contents. However, the vagary of launching an electromagnetic signal into space and waiting for its return is fraught with potential complications: false reflections from objects in the vessel, severe turbulence that can scatter the signal and foam that can absorb it are just some of the issues that exist to render NC Radar ineffective. Users reported challenges getting them ideally configured, too much babysitting.

Two of the keys to the effective use of NC Radar are correct installation and proper configuration. Installation includes avoiding sidewall and false target reflections. Configuration is getting the Gain (amplification) settings just right. This is the "Goldilocks dilemma"- it can't be too hot or too cold- too hot (excessive gain) and the echo saturates (distorts) deteriorating accuracy; too cold (insufficient gain) and the weak signal is lost. Optimal configuration is not an impossible task but one that has eluded many, good instrument personnel. How do we take that "spookiness" out of this endeavor?

Circular polarization helps

Electromagnetic energy can be launched using Linear or Circular polarization. Linear polarization has a constant E-field and needs adjusting to avoid sidewall reflections. To remove these launcher adjustments, Magnetrol's new R86 employs circular polarization which has a rotating E-field. In this way we get the user closer to the "plug & play" goal we all have.

Software assists configuration
These configuration issues can often be mitigated with modern software including that embedded in the transmitter firmware. Following are a few of the software approaches that have made life much easier for NC Radar users:

Pre-configuration
• This is the perfect place to start. Many manufacturers require an application sheet showing the most needed information. This gives experienced, factory personnel the opportunity to accept or reject an application. Add to this a Pre-configuration form complete with all necessary setup information and the transmitter will arrive ready to be installed and wired…can we walk away yet? No, there are two important caveats for NC Radar:

1. False target reflections (if any) in a vessel can only be addressed after the transmitter is installed. This is not difficult, nor always necessary, just something to consider.
2. The process information in a Pre-config form must correctly reflect the actual conditions. It is not uncommon for a factory person to hear from the user "I did not know there was that much foam in my application!". An even more common
mistake is that of a customer setting up for a 10m tall storage tank configuring for no turbulence- "It is a storage tank, there are no mixers, there is NO turbulence". This classic take on a common application forgets that the tank may be filled from
the top which can cause significant turbulence when the vessel is almost empty. Turbulence and Foam are two conditions that can significantly reduce the strength (therefore effectiveness) of a reflected signal. If configuration settings do not accurately reflect conditions in the vessel, problems can arise.

Echo Curve (automated capture)
• The capture and analysis of an Echo Curve is critical to the understanding NC Radar application issues. Strategic capture has always been the central issue. Can internal software monitoring capability eliminate babysitting? How many times have issues occurred at 2:00AM when there is no one around to react? This has been resolved in modern transmitters by automatically triggering echo captures based on known issues like complete loss of the echo or even just weak echo amplitude. Once captured, these are stored in the transmitter until downloaded for analysis by common programs like PACTware.
Key points to make for the Echo Curve (above) are:
1. Level target is at ~79 inches (Distance)
2. Small false target at 42 inches (Distance) is fooling transmitter into reporting an invalid measurement. Note blue cursor confirming the transmitter mistakenly believes this is the correct echo.
3. Simply running an Echo Rejection routine would effectively eliminate the false target creating a very clean radar scene.
4. How would you know what to do at 8:00A if this happened momentarily at 2:00A? This automated Echo Capture (internal monitoring) offers the solution.

Tank Profiling
• One of the more interesting and effective of the new analysis tools is one called Tank Profiling. Similar to common Trend/Data log approaches that capture information like Level, Echo Strength and Loop Current data based on a time scale, this approach differs in some key areas:
1. Only Echo Strength and Echo Margin data are captured. This data is the most crucial is providing insight into configuring Gain adjustments like Turbulence and Foam.
Echo Strength, essentially amplitude, is the most common bit of information used by all radar personnel to assess the health of an application.

Echo Margin is a form of Signal-to-Noise ratio customized for use in level measurement. It not only calculates the difference of the key level reflection to noise (false targets), it also calculates their relative strength in relation to the current Threshold. In this way Echo Margin alerts users when a false target is getting close to breaking above the threshold thereby becoming a “valid” target that could be reported as an invalid Level value.

2. Maximum and Minimum values are captured and displayed for each interval in the cycle. If the Tank Profiling process finds no new data that exceed Max on the top or Min on the bottom, no changes are made to the stored information. However, if data in subsequent cycles exceed these values a new Max/Min point is placed on the graph. By taking these Max/Min values into account adjustments made to Echo Strength can avoid the pitfalls of too little Gain causing Echo Loss and/or too much Gain which could saturate/distort the reflection.

3. The capturing of information is based not on Time, but on Level measurement intervals (e.g. 1 inch) and Tank Cycles (full/empty) regardless the amount of time it takes. It is well known by radar personnel that optimizing configuration settings based on a single point in the vessel is far from optimal. It is far more effective to know WORST case conditions (regardless their position in the vessel) and configure appropriately. This approach can run for several cycles gathering information throughout many changes to the liquid surface conditions.

There are always a few key important takeaways in any Tank Profile information:

• Look for areas of poor Minimum Echo Strength values. In this example, ~118” of Level it is 10 which is dangerously close to a Loss of Echo. At that same point the Maximum Echo Strength is only 48 which allows plenty of head room for increasing the amplitude of the Echo by increasing a Gain parameter.
• Another key factor to look for (not shown in this example) is when the Echo Margin value decreases while Echo Strength remains high. Where the Echo Margin reaches its lowest value is a position at which to look for a false target. Running Echo Rejection (while liquid Level is above this point) will cancel the false target allowing Echo Margin to remain strong through this area.

On-board HELP text
• How many times have you heard “Does anyone know where we put the Instruction Manual?” Often a few bits of simple information is all that is needed to yield needed insight into a configuration or troubleshooting issue. Now context sensitive HELP text can be found on the transmitter by holding down the ENTER key or in the DTM by a simple cursor “flyover”…burn the manual.

Non-contact Radar is one ofthe most effective level measurement technologies on the market today. There are tens of thousands of transmitters installed globally operating in an extremely wide range of applications. Magnetrol’s new R86 Radar transmitters employ all of the advanced features mentioned in the article. When configured properly it can be everyone’s go-to transmitter. Having said that, no transmitter ever made is totally trouble-free. But when problems occur, we should have the ability to diagnose them quickly and bring the device back on line as fast as possible. That day is here.

www.magnetrol.com
04-24-17