White paper

Next Generation Level Devices Help to Improve Plant and Worker Safety

EMERSON

Next Generation Level Monitoring Devices Help to Improve Process Plant and Worker Safety

Abstract

This paper details the need to understand the root causes of accidents in process industries, reveals the extent to which human error affects plant safety, and explains how the latest level monitoring devices help to reduce such errors. These non-contacting radars and vibrating fork level detectors offer greater device reliability and enable easier installation, commissioning, operation and maintenance, leading to improved process plant and worker safety. The importance of periodic proof-testing in detecting dangerous failures in safety-related systems is examined. The paper also explains how using the latest smart devices enables operators to remotely perform in-process partial proof-testing of safety instrumented systems (SIS) in liquid level measurement applications, therefore providing significant safety benefits.

Introduction

Implementing effective safety procedures that robustly protect personnel, assets and the surrounding community and environment is the number one priority for process plant owners and operators. If the number of accidents is to be reduced, it is important their root causes are understood. In the process industry, accidents can result from various failures to address hazards effectively. These failures can include:

- poor management decisions
- single-point equipment failures or malfunctions
- knowledge deficiencies
- management system inadequacies such as failure to perform hazard analysis or failure to recognize and manage change
- human errors

There are startling statistics that reveal just how much human errors affect plant safety. An ARC Advisory Group study conducted in 2015 revealed that 40 percent of accidents at chemical plants are the result of human errors. Compounding this, the ARC has also reported that operator error results in 42 percent of unscheduled plant shutdowns in the process industry – and it is widely accepted that more than 50 percent of process safety incidents occur during transient states such as shutdowns, start-ups and unplanned operations. Focusing on reducing human errors and their effects can therefore directly and significantly impact plant safety.

Automated systems

Liquid level measurement applications have traditionally involved mechanical equipment and manual monitoring techniques. However, moving parts within mechanical devices can be prone to failure, leading to operational problems and increased maintenance requirements. Also, manual measurement methods are vulnerable to human error and require workers to make trips into potentially dangerous environments, where they are more at risk of a safety incident.

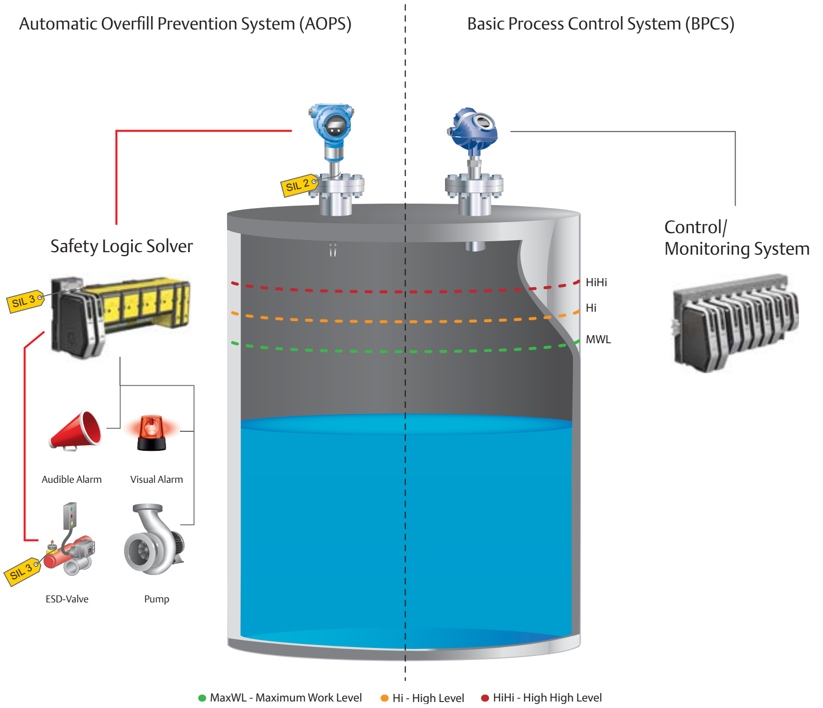
Where possible, plant operators are looking to replace manual and mechanical methods with modern automated systems which are designed to be as straightforward as possible to install and use.

Automated systems use a range of technologies, including vibrating fork level detectors and non-contact or guided wave radars, to provide very accurate and reliable results. The latest generation of devices almost eliminate maintenance requirements caused by wear and tear, increase reliability and reduce the risk of false readings that may lead to a tank overfill. Radars have the added benefit of being virtually unaffected by any process conditions, such as temperature, pressure, density and turbulence, meaning that their accuracy and reliability is further enhanced.

Increased plant automation has helped reduce human error by taking away many decisions and activities, but plant workers still need to interact with technology during installation, commissioning, day to day operation and maintenance. A crucial strand of a plant's overarching safety strategy should therefore be to improve the ease-of-use of its control systems, automation equipment and instrumentation. The easier a system or device is to use, the less likely it is that human operational errors will occur. Similarly, reliability has an important role to play in ensuring safety, as the more reliable a system or device is, the less likely it is to fail and potentially cause an incident that could put workers and assets at risk.

A common safety function addressed by instrumentation is to prevent the risk of overfill. For these instruments to be an effective risk-reducing solution, it is critical that they are easy to use, perform reliably, and are designed with a clear focus on process safety.

Figure 1-1. Automation Overfill Prevention System



The latest generation of non-contacting radars and vibrating fork level detectors deliver a big step forward in all the areas of ease-of-use and reliability. They achieve this through enhanced technology and Human Centered Design principles - meaning that they have been designed around how people use the technology - and they offer a range of functions that help increase plant and worker safety.

Making devices easier to use

With an estimated 30 percent of the existing process industry workforce expected to retire over the next five years, taking a great deal of operating and commissioning knowledge and experience with them, it is becoming ever more challenging for the remaining, less-experienced workforce to install and maintain constantly evolving technology.

It is essential for devices involved in critical measurements to be correctly installed and commissioned, as incorrectly commissioned devices can give inaccurate or unreliable readings. This could then contribute to a potential safety incident, such as an overfill or spill. Even if an error is identified before an incident takes place, the device would still need to be reinstalled, which would involve placing workers in a hazardous environment again. The most advanced next generation, SIL 3-capable non-contacting radar level transmitters and vibrating fork level detectors have both been designed to simplify installation and operator tasks. This means even less-experienced workers will be able to perform these tasks easily, thus minimizing the potential for human error to occur.

With close end-user collaboration, the next generation non-contacting radar level transmitters have been systematically designed to provide an easy user experience at every step, from product specification to installation, commissioning, proof-testing, operation and maintenance. Pictorial product documentation is available where and when it's needed, and the highly graphical software interface makes configuration straightforward and the instrument easy to understand.

Ease-of-use throughout installation, commissioning and operation is also integral to the design of next generation vibrating fork level detectors. The fact that these devices don't contain any moving parts makes them easy to install and maintain. By minimizing the amount of time that maintenance teams might need to spend working on them in potentially dangerous areas, the devices also increase safety. Easy integration into HART® 5 and HART 7 systems allows them to take advantage of the latest HART communications functionality. Devices can be configured with a local operator interface of push buttons and LCD display, or remotely by sending HART commands from the control room.

Figure 1-2. View of Control Room

Increasing equipment reliability

Another challenge facing plant owners and operators is to increase plant equipment reliability, including the installed control and instrumentation technology. Ensuring reliability is vital. Every time a device fails and requires unscheduled maintenance, it not only adversely affects process efficiency, it also affects plant safety and places maintenance workers in potentially dangerous environments – something which all plant managers strive to avoid.

To support enhanced reliability, next generation non-contacting radar level transmitters use Frequency Modulated Continuous Wave (FMCW) technology. That means it continuously transmits and receives echo information from the measured surface, as opposed to traditional technology that only transmits and receives radar signals in pulses. FMCW technology is not new, but is rather a well-established technology for the most reliable and accurate level measurements. However, recent developments with unique energy-efficient radar chips have enabled the latest FMCW radars to better fit the infrastructure of process industries by being 2-wire loop-powered instruments with very low power voltage requirements.

Another way new generation devices are helping to provide improvements in reliability is through advanced diagnostics. Smart diagnostics within next generation vibrating fork level detectors enables operators to continuously monitor the device's electronic and mechanical health and provide greater insight into the condition of the switch. This supports predictive maintenance practices by identifying potential problems before they become serious. Emerging build-up, or corrosion can be detected, giving an indication that maintenance may be required and allowing this to be scheduled during periods of plant downtime. This not only improves the reliability of the device, therefore increasing safety, but also enhances plant efficiency.

Next generation vibrating fork level detectors also provide functionality to monitor voltage and current drawn over the device's lifetime, and a trend change in loop power may indicate emerging issues that could affect reliability, such as corrosion. Further functions help to configure appropriate density settings to calculate and maintain optimum and consistent switching points in fluids of unknown properties, so that the device always switches with the highest degree of repeatability.

Similarly, next generation vibrating fork level detectors not only have diagnostics to continuously monitor the device's health but also enhanced abilities to provide early alerts if the following conditions exist:

- supplied power starts to drop
- antenna build-up becomes severe
- excessive foaming

Every alert comes with recommended actions, and supporting preventative maintenance in this way streamlines the troubleshooting process, increases reliability and further reduces safety risks.

SIS proof-testing

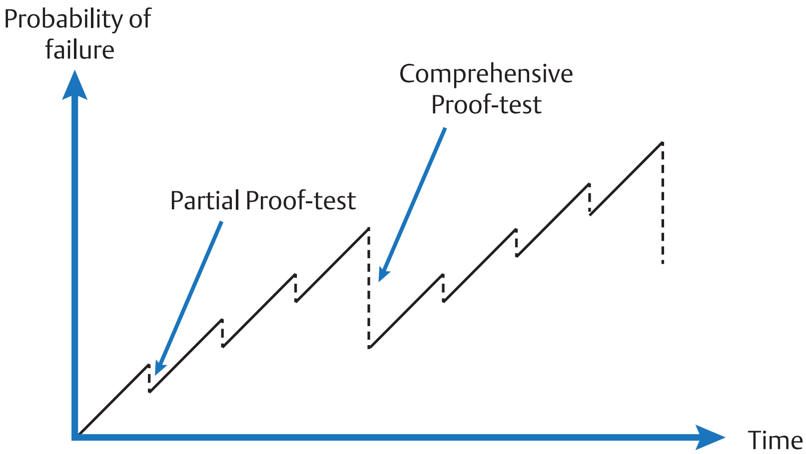
One area technological advances are having a positive effect is supporting the proof-testing of a SIS in liquid level measurement applications. Devices within a SIS must undergo regular proof-testing to make sure they are operating to the required safety integrity level (SIL). There are two types of proof-tests for instruments.

1. A full proof-test returns the probability of failure on demand (PFD) average back to or close to the instrument's original targeted level.

2. A partial proof-test brings the PFD average back to a percentage of the original level.

Traditionally, performing a full proof-test not only takes a great deal of time and effort, but also presents certain safety risks. If the test is carried out with the device still in the tank, it could involve having to raise the process liquid level to the activation point of the instrument being tested, to prove it still works. However, if the instrument is a critical-high or high-high level sensor and it fails to activate during the test, this is likely to result in a spill, which would constitute a safety risk. A full proof-test can also be performed by removing the instrument from the vessel and testing it in a simulated vessel, using material from the process. However, this could involve the process being taken offline, which may interrupt the overall production process and therefore prove costly. This method of testing also has its dangers, as workers could potentially be exposed to vapor releases from the tanks when removing a device.

Figure 1-3. Failure Rate Comparison of Proof-Tests



Given the safety risks involved, as well as the costs and the potential loss of plant productivity, it can be beneficial for plant operators to find a means of extending the period between full proof-tests, while remaining within regulatory requirements. This can be achieved by performing a partial proof-test. As partial proof-testing does not fully return the PFD to the instrument's original state, a full proof-test must eventually be performed. However, performing a partial proof-test can justify an extension of the length of time between full proof-tests.

Technological advances in the latest level monitoring devices are now enabling partial proof-testing to be performed remotely and in-process. This eliminates the need for workers to climb tanks and/or be exposed to tank contents during testing, and therefore provides significant safety benefits.

Next generation vibrating fork level detectors can be remotely proof-tested by issuing a HART command from the host. Upon receiving the command, the device enters test mode. This cycles the output through wet, dry and fault states, then returns into normal operation. If the partial proof-test detects an issue, it is reported on completion of the test. Since the test can be performed in-process it can take less than one minute to complete, although the duration is user-programmable in case a longer test is required.

Next generation non-contacting radar level transmitters can be remotely proof-tested using dedicated software. This enables an operator to perform the proof-test simply by inputting a straightforward sequence of settings and commands from their interface. As with next generation vibrating fork level detectors, this remote method of proof-testing brings considerable benefits in terms of reducing risk and errors, saving time, and increasing safety and efficiency.

Summary

Ensuring the safety of a process plant and its personnel should be at the top of every owner and operator’s agenda. And with human error a major cause of safety incidents at process plants, it is vital they find ways of reducing the potential for such errors to take place. Working environments within the process industry can be highly dangerous and accidents can have serious and tragic consequences, so anything that can improve safety is hugely important. With their focus on ease-of-use, reliability and, above all, safety, the latest generation of level measurement devices are using advanced technology to minimize the potential for human error and can therefore help to provide greater protection for process workers and plant assets.

For more information on the latest generation of Rosemount level monitoring devices, see Emerson.com/Rosemount-Level.

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