Protecting our Water – Keep Chemicals in the Tank

Leaking or overfilled tanks can cause environmental problems, contaminate drinking water, and cost a company millions of dollars. Proper instrumentation, monitoring and control can prevent these problems

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Figure 1: Storage tanks containing dangerous chemicals require multiple levels of instrumentation, controllers and software that can monitor the contents of a vessel and provide an alarm in the event of a leak or overfill event.

Recent events in West Virginia have shown that our water supply is in jeopardy of contamination from leaks or overfills of storage and processing tanks (Figure 1) at chemical, petroleum, water/wastewater and similar facilities.

In Charleston, WV, a tank containing 4-methylcyclohexane methanol leaked, causing contamination of the Elk River. The Elk River provides over three hundred thousand people with drinking water. These people were without tap water for at least five days. The total effect of the spill may not be known for months or even years.

The company that owned the storage facility where the tank leaked—Freedom Industries—is now facing at least 31 lawsuits, along with state and federal investigations. As a result, Freedom Industries filed for bankruptcy.

In the wake of this incident, it's clear that additional scrutiny will be coming to chemical storage facilities, along with reviews of existing regulations. But with a few precautions and a relatively minor investment, this event could have been identified early on, and action could have been taken to mitigate the leak and its destructive aftereffects.

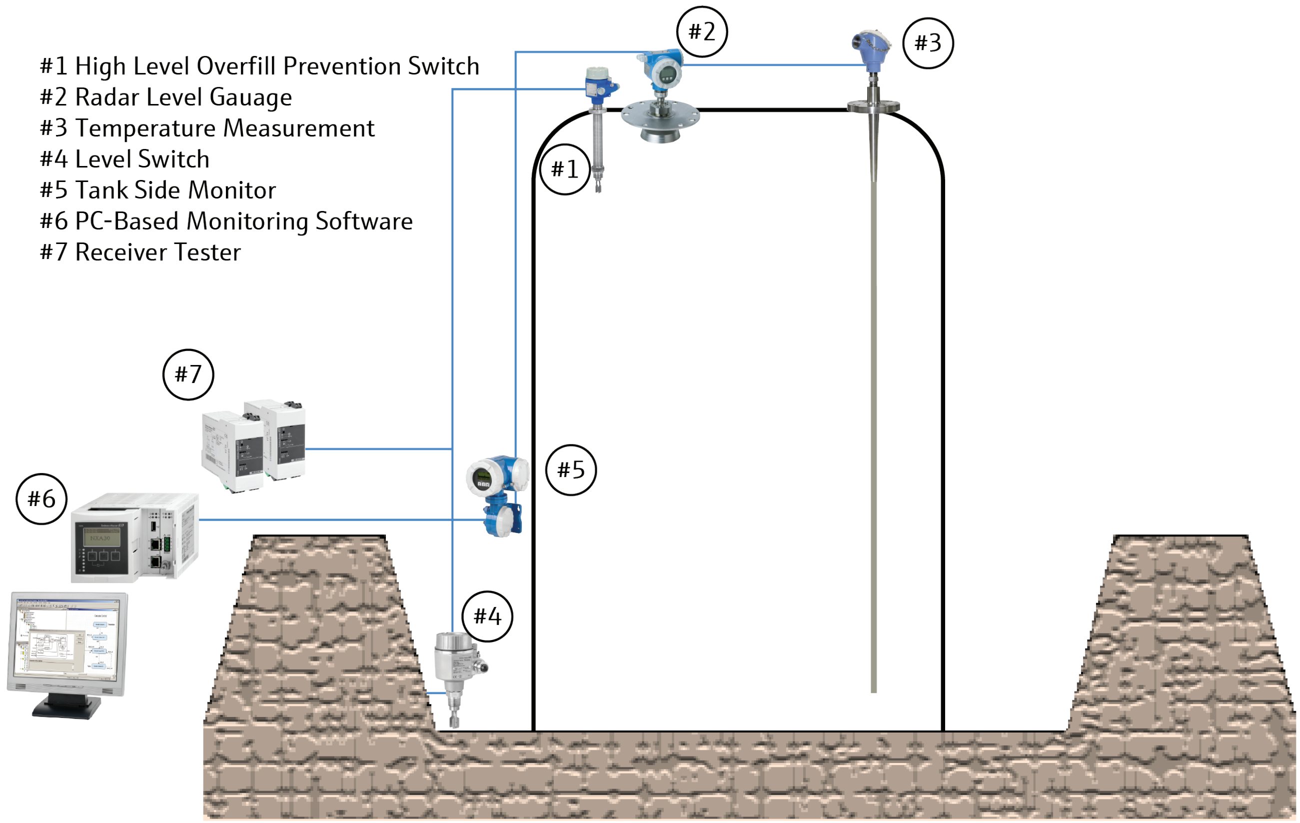

Figure 2: Properly specified, installed and maintained instrumentation will warn of possible spills and overfills, giving operators plenty of time to react.

Instrumentation exists that will monitor the contents of a vessel and provide an alarm in the event of a leak or overfill event. These products have been used for years and are well established and reliable. Figure 2 shows typical instrumentation for monitoring tank levels to prevent overfills and leaks.

Each instrument has a specific function for keeping the contents inside the tank.

Instrument 1 High Level overfill prevention switch. This switch is installed to indicate when the liquid in the tank reaches a dangerously high condition. It's often called a High-High level switch, as it is mounted above the high level switch used to indicate the normal stop fill point of the tank.

If the high level switch fails, the High-High level switch is there to prevent the tank from overfilling. High-High level switches typically include a way to function test the switch to ensure its integrity. Because High-High level switches are mounted above the normal maximum fill point, they can be in service for years without ever "seeing" liquid in the tank. Because of this, the ability to test the switch on a periodic basis to verify its function is critical.

In far too many tanks, a High-High switch is the only protection against spills. This is unacceptable. Additional spill and overfill detection methods are needed.

Instrument 2 Radar Level Gauge. A radar level gauge continuously monitors level in the tank. It is extremely important that the level gauge be very accurate to detect leaks, spillage or overfills. A high degree of accuracy is needed to provide an indication if the level decreases when the liquid in the tank is not actively being transferred or pumped out. If the level starts to decrease during inactivity, it would indicate a leak in the tank and the monitoring system would then provide an alarm. Because of these operating parameters, accuracy needs to be measured in fractions of millimeters. Radar level gauges can provide accuracy of 0.5 millimeters, sufficient for detecting even minor leaks.

The radar level gauge also acts as a backup to the High-High level switch.

Instrument 3 Temperature Sensor. It is important to measure temperature of the liquid in the tank. This is because the volume of most chemicals expands or contracts with changes in temperature. Without compensation, these changes in volume will look like changes in level when, in fact, the actual contents of the tank have not changed. Again, accuracy of the temperature measurement is very important, in this case to provide proper compensation. Temperature sensors with multiple measurement points and accuracy of 0.1 degree C are required for this application.

Instrument 4 External Level Switch. This level switch is mounted inside the retention dike to indicate if a liquid is accumulating. The level switch needs to be able to detect any liquid that is present. Even rainwater accumulating after a storm should be detected as it's necessary to remove this water to maintain the appropriate volume of the dike. Essentially, any accumulation of liquid within the dike, be it water or a chemical, requires a response. As such, switches that will reliably indicate the presence of any liquid, such as tuning forks, are best suited for this application.

Instrument 5 Tank Side Monitor. The tank side monitor performs corrected-volume calculations using the output from the temperature probe and the signal from the radar transmitter to determine the height of the material in the tank. It also provides intrinsically safe loop power to the level gauge and the temperature transmitter, reads data from all connected devices, and displays the values of each instrument.

Instrument 6 PC-based Monitoring Software (Figure 3). This is a typical PC-based HMI software package that displays the output of each tank in a tank farm as well as volume calculations. Such software packages are available from several suppliers. These software packages typically have web server capability built-in, so an operator or engineer can quickly and easily access tank information from any PC or handheld device via a browser.

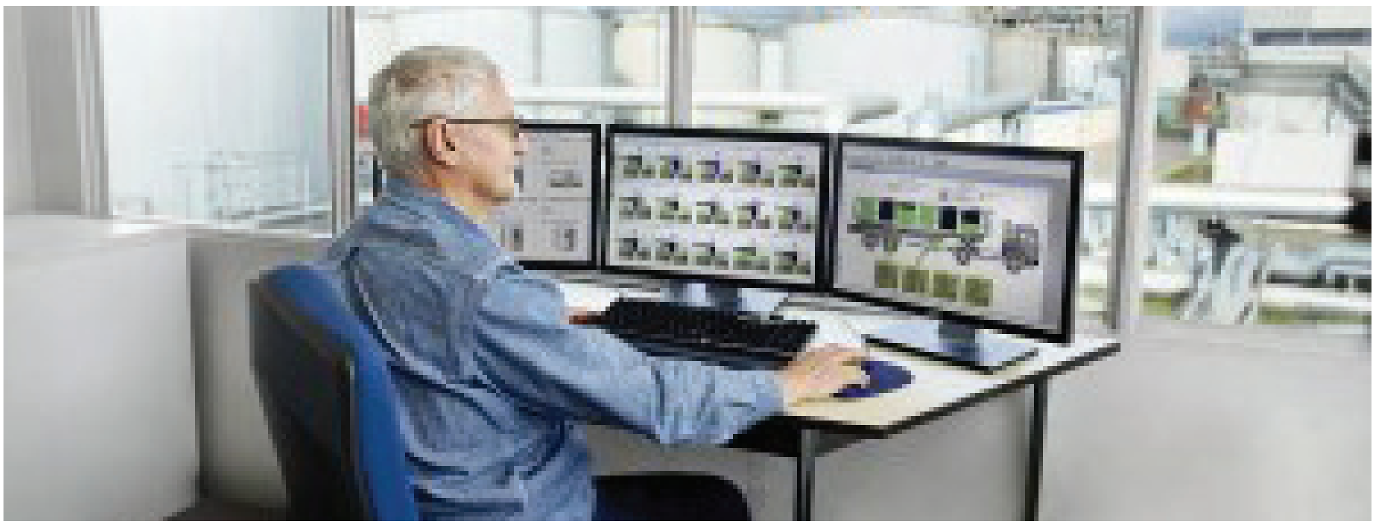

Figure 3: Tank monitoring HMI software, such as Endress+Hauser's Tank Vision, displays the output of each tank in a tank farm and checks for indications of leaks or overfilling.

The software also monitors tank level and can react to any level change. The software should have a feature that allows an inactive tank to be "Locked Down." If the level in a locked down tank drops, it would indicate a leak, and the software would produce an alarm.

As with all alarms and events, this information can be pushed out to users via an Ethernet link so that information registers on the appropriate device such as a PC, a tablet or a smartphone.

Instrument 7 Receiver Tester. As described in (1) above, it is critical to test High-High and external level switches to ensure they are functioning properly. Although many level switches have continuous self-checking to monitor their health, the receiver tester allows an operator to test the switch manually via a pushbutton.

The tester can detect a short circuit, an interruption in the signal line to the measuring sensor, vibrator corrosion in the sensor, or a defect in the input circuit. As a backup to the main automation system, the tester also includes relays to provide an output to an alarm and/or a control function such as a diversion valve to prevent overfilling.

Conclusion

With an instrumentation and monitoring system as described above, spills and leaks are detected at multiple levels—with tank monitors, HMI software and receiver testers providing redundancy.

The events in Charleston West Virginia make it clear that chemical storage tanks need to be secure, and that spills and leaks must be prevented where possible. This should extend to all industries that store chemicals which could contaminate water supplies. These industries include chemical, oil and gas, water and waste water, foundries and any other industry where toxic chemicals are stored.

In the petroleum industry, the American Petroleum Institute (API) has recommended practices for preventing and responding to spills (API2350 recommended practices for above ground storage tanks). In the chemical industry, most facilities that manufacture chemicals are required to have a SPCC (Spill Prevention Control and Countermeasure) plan in place.

Unfortunately, because the facility in West Virginia only stored chemicals and did not manufacture them, it wasn't required to have the site inspections and permits that a manufacturing facility would require. Lack of these requirements and the failure of the owners to provide proper level monitoring led to the incident, which was serious enough to bankrupt the company.

Proper instrumentation for monitoring storage vessels can prevent spills and identify leaks. Where these incidents cannot be prevented, it is critical that they are quickly identified, and that a response plan is in place to mitigate damage and environmental impact. Outfitting tanks with overfill prevention switches and tank monitoring instruments will provide the security that is needed to prevent catastrophes.

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