Arresters

A practical guide to arresters, covering the reader intent, the relationship to arresters, key evaluation criteria, common risks, and the information the intended project audience should confirm before taking the next step.

Main topic: Main Page
https://www.level-meters.com/

In the realm of industrial automation and level measurement, the term "arresters" encompasses a critical range of safety and protection devices designed to safeguard sensitive electronics and volatile environments. Whether protecting a radar level transmitter from a lightning-induced surge or preventing a flame front from entering a chemical storage tank, arresters are indispensable components of a robust engineering design.

For engineers and plant managers, understanding the distinction between surge arresters and flame arresters—and their specific applications in level measurement—is vital for ensuring both operational uptime and site safety. This guide explores the principles, selection criteria, and installation best practices for arresters used alongside industrial level sensors.

Measurement and Protection Principles

Before selecting an arrester, it is essential to understand the physical phenomena they are designed to mitigate. In level measurement applications, we primarily deal with two types of "threats" that require arresters: electrical transients and thermal combustion fronts.

Surge Arresters (Surge Protective Devices)

Surge arresters, or Surge Protective Devices (SPDs), are designed to protect electronic components from transient overvoltages. In level measurement, these transients typically originate from lightning strikes (direct or indirect) or switching operations within the industrial power grid.

The principle of a surge arrester is based on voltage-dependent resistance. Under normal operating voltages, the arrester maintains high impedance, allowing the measurement signal (such as a 4-20mA loop) to pass through unaffected. When a high-voltage spike occurs, the arrester’s internal components—typically Metal Oxide Varistors (MOVs) or Gas Discharge Tubes (GDTs)—rapidly switch to a low-impedance state. This diverts the excess energy to the ground, clamping the voltage to a level that the level meter’s internal circuitry can withstand.

Flame Arresters

Flame arresters are mechanical devices installed on tank vents or sensor mounting ports. Their primary function is to allow the flow of gases or vapors while preventing the transmission of a flame. This is critical in "Level 1" hazardous areas where flammable vapors are present.

The principle of a flame arrester relies on the "quenching distance." By passing the flame through a matrix of narrow channels (usually a wound stainless steel ribbon), the device absorbs the heat of the flame faster than the combustion can sustain itself. This cools the gas below its auto-ignition temperature, effectively stopping the fire from propagating into the tank or through the piping.

Surge Protection for Level Measurement Systems

Level measurement instruments, such as radar level meters and ultrasonic sensors, are frequently installed at the highest points of a facility (on top of silos or tanks) or in remote locations (deep wells or open channels). This positioning makes them particularly vulnerable to atmospheric discharges.

Protecting Radar and Ultrasonic Sensors

Modern radar level meters utilize high-frequency microwave signals and sensitive processing electronics. A surge entering through the power supply or the 4-20mA / HART communication line can instantly destroy the microwave oscillator or the microprocessor.

For these applications, arresters should be installed at both ends of the signal cable: one near the sensor on the tank top and one at the control cabinet (PLC/DCS end). This "dual-zone" protection ensures that induced currents along the cable length are neutralized before reaching sensitive hardware.

Hydrostatic Pressure Transmitters

Hydrostatic level sensors, often used in deep well pumping or wastewater lift stations, face a unique risk. The long vented cable used to compensate for atmospheric pressure acts as a massive antenna for electromagnetic interference. In these cases, specialized arresters with low capacitance are required to ensure that the surge protection does not interfere with the high-accuracy analog signal.

Selection Criteria for Industrial Arresters

Selecting the correct arrester requires a technical evaluation of the electrical environment and the process media. For comprehensive technical data on level instruments and their compatible protection modules, engineers can consult the Main Page for detailed specifications.

Surge Arrester Selection Table

Parameter	Signal Line (4-20mA/HART)	Power Line (AC)	Power Line (DC)
Nominal Voltage (Un)	24V DC	110V / 230V AC	24V - 48V DC
Max. Operating Voltage (Uc)	33V DC	275V - 320V AC	38V DC
Nominal Discharge Current (In)	5 kA - 10 kA	20 kA - 40 kA	10 kA - 20 kA
Response Time (tA)	< 1 nanosecond	< 25 nanoseconds	< 10 nanoseconds
Mounting Type	DIN Rail or In-line	DIN Rail	DIN Rail

Flame Arrester Selection Factors

When choosing a flame arrester for a level measurement port, consider the following:

1. Gas Group: Is the medium Group D (Methane/Propane), Group C (Ethylene), or Group B (Hydrogen)? The quenching gap must be smaller for more volatile gases.

2. Maximum Experimental Safe Gap (MESG): The arrester must be rated for the MESG of the specific chemical vapor.

3. Deflagration vs. Detonation: Will the flame be a slow-moving deflagration or a high-speed supersonic detonation? Most tank-top level sensor ports require end-of-line deflagration arresters.

Installation Considerations and Best Practices

An incorrectly installed arrester is often as ineffective as having no protection at all. To ensure the reliability of Welk level measurement solutions, follow these engineering guidelines:

1. Grounding and Equipotential Bonding

The efficacy of a surge arrester depends entirely on the quality of the ground connection. The grounding lead should be as short and straight as possible (ideally less than 0.5 meters or 20 inches). Use a large cross-section conductor (minimum 4mm² for signal lines, 16mm² for power lines) to minimize impedance. High-frequency surge currents follow the path of least inductance, not just least resistance.

2. Proximity to the Protected Device

Surge arresters should be installed as close to the level transmitter as possible. If the distance between the arrester and the sensor exceeds 10 meters (33 feet), the voltage clamping effect is diminished due to the inductive reactance of the intervening cable.

3. Hazardous Area Compliance

In environments with explosive atmospheres, arresters must be certified (ATEX, IECEx, or UL HazLoc). For surge arresters, this often means they must be "Intrinsically Safe" (Ex i) or housed in a "Flameproof" (Ex d) enclosure. Flame arresters must be tested and approved according to ISO 16852 or equivalent regional standards.

4. Pressure Drop and Venting

When installing a flame arrester on a level sensor port, ensure that the device does not cause an excessive pressure drop that could interfere with the sensor's reading or the tank's vacuum relief system. Regular cleaning of the flame cell element is required to prevent clogging from dust or polymerizing vapors.

Limitations and Maintenance

While arresters are highly effective, they are not "set and forget" devices. They have specific limitations that engineers must account for in their maintenance schedules.

Sacrificial Nature: Surge arresters, particularly those using MOVs, degrade slightly with every surge they divert. After a major lightning event, the arrester may reach its end-of-life. Many modern arresters include a visual status indicator (green for OK, red for Replace).

Voltage Clamping Limits: No arrester can reduce a 50kV strike to 0V. There will always be a residual "let-through voltage." It is critical to ensure that this let-through voltage is lower than the impulse withstand voltage of the level meter's electronics.

Flame Arrester Clogging: In many chemical applications, vapors can condense or crystallize on the flame arrester element. This can lead to tank over-pressurization. Differential pressure monitoring across the arrester is recommended in critical applications.

Frequently Asked Questions (FAQs)

Q: Does my radar level meter need an external surge arrester if it already has internal protection?

A: Most high-quality industrial radar meters have basic internal surge protection (typically up to 1kV or 2kV). However, for outdoor installations or sites with high lightning activity, an external Type 2 or Type 3 arrester is strongly recommended to handle higher energy discharges (up to 10kA or 20kA).

Q: Can I use a surge arrester for both the power supply and the signal line?

A: You must use specific arresters for each. Power line arresters are designed for high current and higher voltages, while signal line arresters are designed for low voltage and must not introduce resistance that would interfere with the 4-20mA loop accuracy.

Q: How often should flame arresters on level sensor ports be inspected?

A: In standard applications, an annual inspection is recommended. However, in "dirty" processes or those involving sticky vapors (like crude oil or bitumen), quarterly inspections may be necessary to ensure the quenching element is not obstructed.

Q: What is the difference between a lightning arrester and a surge arrester?

A: In common industrial parlance, a lightning arrester is a heavy-duty device installed at the point of entry of power lines into a facility (Type 1). A surge arrester (Type 2 or 3) is a finer protection device installed closer to the end equipment, such as a level transmitter, to clamp residual voltages.

Conclusion

Arresters serve as the primary line of defense for industrial level measurement systems. By correctly implementing surge protection, engineers can prevent costly downtime and equipment replacement. Simultaneously, the application of flame arresters ensures that level measurement activities do not compromise the fire safety of storage facilities.

For further guidance on selecting the right level measurement technology and integrated protection accessories, professionals are encouraged to review the technical resources available on the Main Page. Choosing the right combination of sensor and arrester is a fundamental step in achieving reliable, long-term performance in any industrial automation project.