Winter is Coming–Wrap Up Warm

By Phil Luppke

Severe winter weather with extremes of cold, wind, rain, and sleet, quickly can find the weak spots in outdoor instrumentation installations. Reliability audits of heat tracing around outdoor equipment is regularly performed, but similar checks on the instrumentation in field enclosures and cabinets are rare. It's easy to assume that because there is some protection already, things will be OK.

The weather has become more unpredictable. An instrument failure can cause significant issues for a plant, from costly downtime of a process, all the way to a plant shutdown or even dangerous situations. For example, my company recently met engineers from a process plant in a central state that had to quickly fabricate ad-hoc shelters to protect outdoor instrumentation that was tripping the control system during the cold wave of 2017-18 (when record low temperatures were experienced in Central and Eastern U.S. regions). While it can be challenging to detail all of the winter-related problems that could affect outdoor enclosures, this article will address some of the more common issues.

Frozen Lines

Frozen impulse lines to process transmitters are probably the most common failure. In relation to instruments already mounted inside enclosures, such problems often stem from insufficient heating. The heater sizing calculation has to be done carefully, and it is heavily influenced by the details of the installation: the enclosure materials and components employed, and the care taken during installation. The enclosure's thermal performance will have been known at purchase time, but allowances for subsequent process connections, and poor installation may not have been made.

Outdoor process instrumentation enclosures are almost


These photos show a process plant with outdoor field instrumentation ready for winter.

invariably modified by adding access holes for cable and tubing and this can change heat loss characteristics substantially. Holes act as "thermal shortcuts" and can account for a large percentage of an enclosure's heat losses. Another aspect of these access points can be either an absence of insulation, or ad-hoc arrangements. If insulation is used, it's sometimes rudimentary—such as wrapping mineral wool around a tube or cable or using DIY silicone sealant around the hole. As extra holes are often added late in the enclosure design phase to accommodate last-minute improvements to process connections, or during the enclosure's life, their effect on the overall thermal performance can, and does, get overlooked. Such unforeseen heat losses—combined with extremes of winter temperature—can be enough to tip the balance and cause a failure.

Poor Engineering

Designing an outdoor enclosure system with temperature regulation is not a trivial task. Yet, I regularly come across enclosure designs where little care has been taken.
For example, fitting soft covers on an outdoor instrument

With convection heating, thermal energy flows from the heater, through the space to be heated, and onto the external environment through the enclosure fabric and access points. Specifying enclosure construction materials and carefully insulating connections has a highly beneficial effect on reliability.

destined for Alberta and expecting it to survive in a region where winters can mean cold snaps down to -40°C. Even if a soft cover works adequately at the start of an installation's life, these styles of enclosure can sometimes degrade over time due to water ingress or poor refitting after maintenance.

Another factor in design-related failures is the general reduction in availability of engineering skills as older engineers retire and fewer youngsters enter the profession. If the plant's instrumentation network is large and an EPC was involved, the design is usually well thought out. However, even this isn't guaranteed. But, for ongoing MRO activities, failures are often caused by sloppy work practices. Modifications to the instrumentation network often are undertaken by outside contractors: many are good, but some opt for cheap and convenient solutions, choosing enclosure components that are readily available and/or not taking the time and care needed to engineer a reliable solution.

Problems may surface following modifications to existing enclosures. Little thought might be given to the extra heating load that installing additional equipment might involve for example. Or, there might not be adequate room to mount or position a larger or extra heater inside an existing enclosure. We've seen convection heaters mounted above instruments, for instance, rather than at the bottom of the enclosure with space to foster efficient convection.

Materials Matter

Good insulation is critical to most outdoor enclosures. And the choice of enclosure material can be especially important for applications in harsh environments. Few off-the-shelf metal enclosures are available with the appropriate degree of insulation to minimize the temperature regulation problem. In any event, just adding insulation is not always adequate because of limitations posed by the nature of the metal construction. Any metal connection between outer and inner shell provides a thermal shortcut. With metal construction, it is almost impossible to avoid metal parts in some design elements (such as the door frame, door leaf, window, and wall penetrations for cables and tubing) because the stability of this type of housing is based on bent sheet metal, and insulation materials are typically soft. Heat losses are exacerbated by the good heat-conducting properties of a metal enclosure, and often by the typical kind of metal bulkhead fittings used to mount such enclosures as well—which can act as a kind of rudimentary fin.

If the enclosure is destined for a very harsh climate like Alaska, it might be exposed to temperatures so extreme that material properties can change; for example, thermoplastic enclosures can become brittle.

Enclosures made from glass fiber reinforced polyester (GRP) have a thermal resistance that is over a thousand times superior to metal, and remain stable even down to -100°C. Enclosures destined for use in harsh environments also can be fabricated from composite GRP sheets incorporating embedded insulation. This production technique eliminates gaps and thermal short-cuts between interior and exterior. Add specialized accessories to ensure that the necessary process connections do not degrade overall thermal performance, This holistic approach to enclosure design has major benefits in avoiding the 'cold-spots' that lead to many field problems. It delivers ultra-stable operating environments for the instrumentation—ensuring the performance of vital process control applications such as process analyzers—and plays a crucial role in minimizing long term cost of ownership. IMPO

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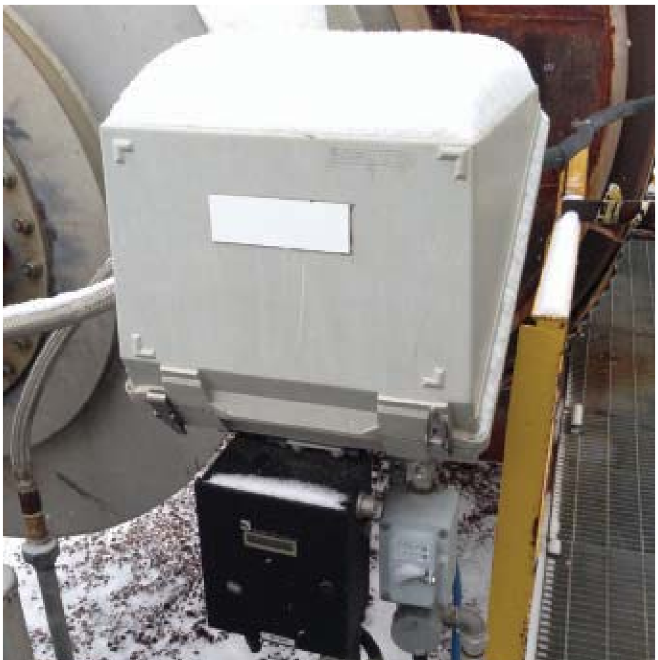

Fit-for-purpose field environmental protection is a good investment for process plants, as total cost of ownership dwarfs initial purchase costs.