Post Flooding Recovery:

Safely and Quickly Restarting Insulated Piping and Equipment

TB1709

TECHNICAL BULLETIN

When an industrial facility gets flooded, low-lying thermal insulation is often one of the first elements to be affected. High winds, moving water, and falling debris can further damage insulated surfaces. To safely and quickly navigate the restart of insulated piping and equipment, consider the following four steps:

1. Inspection and triage
2. Pre-startup remediation
3. The startup process
4. Post-startup inspection and remediation

Inspection and Triage

For more than ten years, Pyrogel has been used in buried steam vaults that experience seasonal flooding. After hundreds of insulation inspections in these installations, one fact has become abundantly clear: Pyrogel survives whereas water-absorbent insulation materials are more likely to be damaged during a flooding event. The degree of insulation damage will depend on a number of factors, including the type and thickness of insulation material, the depth and duration of flooding, whether the water was flowing, and the presence of any debris and/or contaminants in the flood waters.

Damage mechanisms include:

- ***Physical displacement:*** *Submerged insulation can move, upwards, downwards, or both, depending on whether the insulation floats and/or saturates.*

- ***Slumping or crushing:*** *Since saturated insulation can be five- to ten-times heavier than dry insulation, the bottoms of vertical runs often crush and flare outwards, and the undersides of piping, exchangers, and drums can sag away from the substrate.*

- ***Missing bands and jacketing:*** *Wet insulation will often swell and sag, popping bands and dislodging the cladding.*

- ***Wash out:*** *When saturated with water, some insulation materials will crumble or simply dissolve, leaving behind empty jacketing.*

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Due to moisture wicking upward through water-absorbent insulation materials, wetness may be observed well above the flooded zone. On vertical piping and equipment, metal jacketing and rigid insulations are typically stacked and supported from the bottom up, so mechanical damage to the lowermost sections can compromise everything up to the next support ring.

Accordingly, the post-flooding restart process should begin with the inspection and triage of any insulated surfaces within 3 m (10 feet) of the high-water mark. These insulated surfaces will usually include low-lying pipes (e.g., drip legs, tank-farm steam and product lines, condensate returns and, in colder climates, utility and fire water lines), grade-level drums and exchangers, bottom elbows on vertical pipe runs, and the lower sections of storage tanks.

Inspectors should look beyond wetness, and instead focus on evidence of mechanical damage to the insulation or jacketing. Visual inspection is usually adequate, as distorted or dislodged sheet metal is the tell-tale evidence of underlying mechanical damage. Where jacketing is damaged, it should be replaced, and the insulation beneath it should be inspected and replaced if necessary. Some of these repairs can occur post-startup, depending on the degree of damage, the criticality of the process or unit, and the temperature sensitivity of the fluid.

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As shown in Figure 1, inspectors should group their findings into three categories, based on the level of damage and the type of service:

1. ***Repair before restart:*** Areas requiring immediate, pre-startup remediation will often include insulation used for freeze protection (if current ambient conditions warrant concern); steam lines at or near their saturation point; and temperature-sensitive materials such a molten sulfur, asphalt, benzene, and p-xylene. Electric heat trace (EHT) systems may also require at least partial removal of the insulation to facilitate inspection.

2. ***Repair after restart:*** For non-critical insulation systems (e.g., condensate return), or systems where the damage is minimal, repair can occur after restart, either on live piping or equipment, or during the next maintenance shutdown.

3. ***Leave in place:*** Proceed with restart: If still physically intact, flooded insulation is often recoverable, particularly if it is a water-repellent grade such as Pyrogel. For swift and reliable dryout, the system should be operating at least 50°C (90°F) above the ambient dew point.

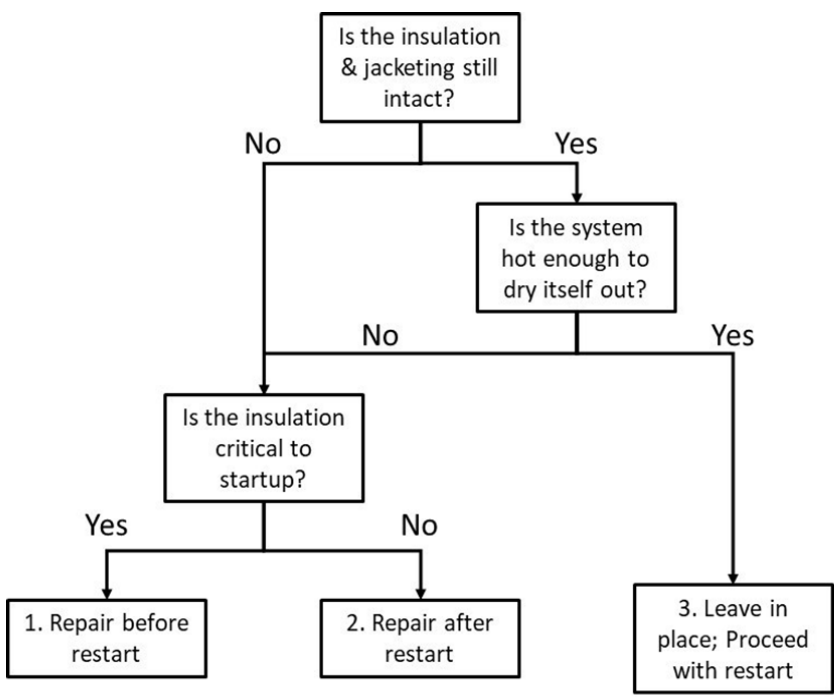

Figure 1: Insulation repair decision tree

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Pre-Startup Remediation

The slowest path to restored operations is the one that requires insulation to be stripped and replaced prior to startup. However, even if a complete strip-and-replace is required, a single layer of Pyrogel can often be a fast and effective stopgap measure. Depending on pipe size and process temperature, a single 10 mm (0.4 inch) layer will typically reduce heat loss by 80-90% compared to a bare surface. The Pyrogel can be temporarily secured with stainless steel wire or bands. Water repellent and impervious to UV exposure, Pyrogel can be left unjacketed for up to a few months. Following the successful unit startup, the jacketing and any subsequent layers of insulation (if necessary) can be safely applied while the system is in service.

The Startup Process

During startup, the rate of heat loss through water-saturated insulation can be orders-of-magnitude greater than under dry, steady-state conditions, and often exceeds that of bare pipe. Normal startup times can double, triple, or worse, as process energy is diverted into heating and vaporizing the absorbed water. On steam lines at or near their saturation temperature, continuous discharge from traps should be expected, and the risk of water hammer is much higher than during steady-state conditions. Depending on the ambient humidity, escaping steam may be visible in the area, as the evaporated water re-condenses in the atmosphere.

For areas of persistent wetness – often found near the bottom of vertical runs, at the furthest extents of long lines, and on low-energy (<100°C, or 212°F) systems – dryout can be accelerated by wrapping a single layer of Pyrogel around the existing insulation and jacketing. This will raise the average temperature of the underlying insulation, speeding the evaporation process. Due to Pyrogel's open-cell structure, the now-liberated water vapor will not become trapped, but instead will simply pass through the material and into the atmosphere. If the overwrapped material is to be left in place permanently, it should be jacketed. This can be either concurrent with the re-start effort, or within a few months thereafter.

Post-Startup Inspection and Remediation

Jacketing and insulation systems, already loosened by flood waters, may experience additional settling and dislocation during the startup process as the underlying metal undergoes thermal movement. Insulation materials that were flooded but left in place will recover their performance to varying degrees, depending on material type, process temperature, and other factors. It is therefore important to conduct a post-startup inspection once steady-state operations have been achieved. Additional remediation should be expected but, having now successfully restarted the facility, can proceed at a more orderly pace.

Final Thoughts

While corrosion under insulation (CUI) is always a concern whenever insulation gets wet, a one-time flooding event is far less dangerous than persistent wetness. Surface wet time is the best predictor for corrosion rates, so systemic wetness due to condensation or rainwater ingress is the real enemy. So long as the insulation gets the chance to permanently dry out after the flood waters recede, concerns over post-flooding CUI should be secondary to the safe and swift restart of the facility.

For additional guidance or on-site support from our Technical Services team, please contact Aspen Aerogels.

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