How To Properly Prepare Your Locomotives for Winter

Facts About Water Freezing

Water, when it freezes, changes from liquid to solid. As the temperature drops, the molecules become less energetic, moving more slowly until they reach a point at which the molecular structure changes, followed by the transformation into ice or solid water. Unlike most substances which shrink in volume as they freeze, water expands since ice's molecular structure takes up more space than water. Conversely, when you heat water, the molecules become more excited until they reach the point where the water vaporizes and becomes steam.

There is a misconception that if water can be kept moving, it won't freeze. Wrong! Water freezes at 32°F (0°C). Period. Since the expansion of water as it freezes is a fact of life, what should we know about this process to effectively deal with it in the rail industry? Frozen water in piping systems does more than simply clog the system and shut off the flow. Because ice takes up more room than liquid, when freezing occurs in a confined space like a steel pipe, the ice will build up extreme internal pressure, which is often enough to break the pipe and its associated valves and fittings.

Damage from a burst pipe or valve can escalate beyond just replacing the broken parts into labor costs for the repair and time/money lost from "down-time" in the affected area. Before effective measures can be taken to prevent such disasters, we need to learn about and understand what is happening.

The Physical Principles of Freezing

What underlying principles determine whether the water in a given device (pipe, valve, tank, etc.) will freeze? We already know that water freezes at 32°F. Heat must be removed (transferred) from the water to arrive at this temperature. (Remember - heat always travels from high to lower temperature areas). Heat transfer or the removal of heat from one place to another (i.e., from the 45°F water inside a pipe to the 25°F air outside a pipe) is one of the fundamental laws of nature. Heat is a form of energy. Others include chemical, electrical, mechanical, and nuclear, which are convertible from one state to another. In the USA, heat is usually measured in BTUs or British Thermal Units. One BTU is the amount of energy that, when added to one pound of water, will raise the temperature of that water by one Fahrenheit degree (from 65°F to 66°F).

This process is also totally reversible. Transferring one BTU of energy out of one pound of water will decrease the temperature by one Fahrenheit. If you transfer enough heat energy out of a given amount of water, the temperature will drop until it reaches 32°F, and the water freezes. The amount of water involved will affect the decrease in temperature. Based on the definition of BTU, it becomes evident that with two containers full of water, one of which contains twice as much water as the other, twice as much heat will need to be removed from the larger container to lower its temperature the same amount as the smaller container. One good example of this is a pond. Ponds tend to fill fairly shallow depressions in the earth and range from a few inches deep at their edges to several feet deep near their centers. Where the water is shallow, it freezes solid very quickly. Where the water is deeper, the freezing process occurs more slowly. The greater amount of water near the pond's center requires more heat to be removed, so it takes longer for the water temperature to reach the freezing point.

At its most basic, if freezing is to occur, it will be determined by both the amount of water present and the rate of heat loss from the water. Some of the most important factors that influence the rate of heat loss from a pipe are:

- The thermal resistance of the pipe wall
- The outside surface area of the pipe
- The wind velocity over/around the pipe
- The temperature difference between the water in the pipe and the outside air.

The "surface area" and "temperature difference" factors are directly proportional to the heat loss rate. If you double either of these factors, the rate of heat loss will double. By the way, adding heavy insulation to a non flowing pipe will significantly decrease the rate of heat loss (you are increasing the thermal resistance of the pipe). However, it will not stop it (no insulation is perfect), and the water in the pipe will still eventually freeze.

Thermal Actuator Technology Challenges Temperature

Regarding temperature, thermostatic technology takes the lead in finding the middle ground between hot and cold. Addressing the temperature control demands for applications exposed to inclement weather, like locomotives and passenger trains, ThermOmegaTech® designed a device to protect these systems from freezing during the chilly winter months.

ThermOmegaTech's thermostatic actuators contain a Thermoloid® paraffin wax blend that responds to temperature, liquefying when hot and solidifying when cold. Sealed within a diagram, the Thermoloid® material changes phase in response to a narrow range of temperature variations from 15°F to 300°F (-9.44°C to 149°C).

As temperature increases above the melting point of the Thermoloid® material, the wax begins to expand and pushes on the actuator's diaphragm, which in turn pushes on the piston. In its "hot position," the piston acts as a valve stem, opening or closing the valve. The wax compresses as the Thermoloid® material cools below its melting point, and a spring returns the piston and diaphragm to their "cold position." The piston movement produces a usable stroke that can control many components, including valve poppets, trip cams, release latches, etc.

Where Temperature & The Railroad Industry Clash

Although many consider it "the most wonderful time of the year," winter weather can be catastrophic to the rail industry. In most areas, especially up north, temperatures fall around September, dropping as low as below freezing from December until March. Aware of the damaging effects of freezing water on piping systems, operators must prepare their rolling stock early to prevent freeze-ups in their diesel locomotives' cooling systems.

Without a proper freeze protection solution, water tanks and pipelines that cool a locomotive's engine is at risk of freezing when the engine is off. Due to insufficient heat, the water in the cooling system will begin to solidify as temperatures drop below 32°F. As water turns to ice, it builds pressure, causing the pipes to crack and burst and potentially causing tens of thousands of dollars in damage. Understanding the physics of freezing, it is no question that when a locomotive fails to provide heat to its coolant system, the water in the system will, in time, freeze. To tackle locomotive operators' winter pain points, ThermOmegaTech® offers the GURU® Plug – a self-operating, thermostatic drain valve designed to monitor engine coolant water temperature and automatically drain a locomotive's coolant system before freezing can occur.

The GURU® Plug – A Locomotives Best Friend

Installed at the lowest point in the locomotive's coolant system, when the water temperature falls to the GURU®'s pre-defined set-point (offered in 35°F or 40°F), the stainless-steel GURU® cartridge snaps open, releasing itself from its body to rapidly drain the system before freeze damage can occur. Rather than being forced out by the tremendous pressure of expanding ice, which would typically crack and damage the system, this "snap-open" action allows for a ~ one-inch bore to release detrimental water temperatures, keeping the locomotive protected from ice buildup. When you are ready to return the locomotive to service, the GURU® cartridge can be warmed up and reinserted into the housing so the water tank can be refilled.

After system drainage, resetting and rearming the GURU® Plug is just as easy as installing the valve. Utilizing ThermOmegaTech®'s GURU® Flag & Clip or GURU® Flag & Key tool allows the operator to refill the locomotive's cooling system and have the locomotive back in service in no time.

Effects of Extreme Cold on the GURU®: Tested & Proven to Perform

While we know at what temperature it takes for water to freeze, ThermOmegaTech® pushes the boundaries at -60°F to prove the outstanding performance of the GURU® Plug. ThermOmegaTech® used a GURU® DL 2.1 Type-T valve and installed it in a Tenney Environmental Chamber® with exposure to 3MPH winds at -60°F (-51°C) to conduct this environmental exposure test. 55°F (12.7°C) water was directed to flow through the valve tee at 1GPM to simulate engine coolant and was monitored at the inlet and outlet of the chamber to ensure consistent temperatures throughout the test.

The temperature chamber door remained closed to maintain environmental conditions, and a leakSMART® sensor was installed to determine if a valve release occurred.

The results were remarkable! After two hours of constant exposure, the GURU® remained closed with no instances of nuisance dumping. The test proved that 55°F engine coolant flowing at 1GPM provides sufficient heat/energy for the GURU® to not snap open despite extreme outside winter conditions. The test also confirmed the benefits of sensing the coolant fluid's temperature compared to sensing the ambient air temperature.

Due to the GURU®'s fluid-sensing design, it can operate in environments where ambient-sensing products cannot. The 100% mechanical and self-operating GURU® Plug has proven exceptional performance and trust across all the North American Class 1's since 1983 and is considered the #1 freeze protection solution for locomotive winterization must-haves. With the GURU®, your railroad investments are in good hands!