# Hydronic snowmelting essentials

## *Part 1*

*Here Phc News begins a two-part article about the basics of snowmelt system design and installation, with a focus on the need for careful consideration about and the use of inhibited propylene glycol solutions. Part one introduces the snowmelt system and its various forms and uses.*

Photo courtesy of Watts Radiant

*Hydronic snowmelting systems find a host of applications such as this popular means of clearing snow and ice from entryways at private homes. Radiant snowmelting systems clear snow completely, leaving a clean, dry and safe walking surface.*

We all know that during winter, sleet, snow and freezing rain lay down the challenge for safe movement outside. As professionals in the business of designing or installing hydronic snowmelt systems, one of your key challenges is overcoming building owner reluctance to install a system.

Granted, it's not inexpensive. But there are benefits that help to sway the decision. These include convenience, environmental enhancements (no salts, cinder and chemical de-icers), and the greatly reduced labor and hardware costs that are otherwise needed to remove snow and ice. Ice-melt chemicals can kill nearby plants, increase building cleanup as they're tracked inside and, over time, seriously degrade floor surfaces, concrete and asphalt. In essence, using radiant heat is a "greener" approach to melting snow and ice.

Snowmelting is the radiant heating of outdoor surfaces. The most common method is the use of tubing embedded inside concrete or asphalt surfaces to distribute warm fluids. The end result: pathways, driveways and other areas remain dry and clear. For commercial applications, especially those deemed critical areas — hospital and senior housing entry areas, helicopter pads, delivery and handicap access ramps, etc. — radiant heat can prevent injuries and saves lives.

Another advantage is the proactive prevention of liability claims and added safety overall. Given today's litigious society, snowmelt systems don't cost money; they save it. The cost of the system is more than returned with one avoided lawsuit. And, some insurers recognize the value of these systems, rewarding building owners with reduced insurance rates.

### Examples of snowmelt systems

The most common pipe material used to distribute warmed fluid solutions are cross-linked polyethylene (PEX) or synthetic (EPDM) rubber. Because the fluids are exposed to freezing temperatures in the mass that surrounds them, it's widely known that to prevent freezing, inhibited (corrosion-protected) glycol solutions are used.

Common snowmelt applications include:

- **Helipads**. Hospital helipads are excellent examples of places needing to be safe and snow-free. With space becoming more and more precious, many hospitals are forced to install helipads on the building roofs. These rooftop helipads can become extremely dangerous when coated with ice and snow.
- **Sidewalks**. By making walkways convenient and more inviting to the passerby, sidewalk snowmelt systems can increase business and decrease liability. Customers are more likely to shop stores with clear sidewalks.
- **Stairs.** Pedestrians can travel in relative comfort and safety. The spacing of tubes for stairs varies according to application, but they are usually installed with two lengths of tubing in the tread and one length in the riser.
- **Car washes**. Water is always present in car washes, but property owners can keep car washes open and ice-free. Tubing for car washes is always installed in a concrete slab. The control strategy for car washes is simple. Either air temperature or slab temperature can be monitored. If the temperature of the slab or the air drops below 35°F, the system is turned on. When the temperature rises above 35°F, the system is turned off.
- **Hospital entrances**. Tube spacing for hospital entrance ramps usually are set closely at 6" on center. Further, these systems are idled, or operated at a reduced output, to decrease system lag time (the time required for the system to reach operating temperature and start melting snow). When the sensors detect freezing precipitation, the system then operates at full output.
- **Parking garage ramps**. Snowmelting systems ensure cars driving in from the street can safely negotiate up and down parking garage ramps.
- **Loading docks**. Snowmelting systems ensure that the goods can be easily moved in and out of a facility.
- **Large area "hot pads."** Instead of heating the entire area exposed to winter elements, it may be more cost effective to operate a snowmelt system on a smaller area where shoveled snow can be piled on. This technique is most commonly used for airport runways and large parking lots. Typically, tubing for hot pad slabs is spaced at 4" to 6" on center to accommodate a large amount of snow. Hot pads are usually operated manually, activated whenever the need arises.

### Know your system

If you find yourself at work on a snowmelt system without inhibited glycol in it, there are key steps to take to ensure that you aren't introducing good fluid into a bad system. Factors that cause excessive fluid degradation include: operating temperature; the amount of air or dissolved oxygen the fluid is exposed to; system age; the materials of construction; and the quality of the heat transfer solution, including proper dilution and maintenance, to name a few.

The use of a poor quality glycol fluid can lead to serious corrosion problems. Any glycol can provide freeze protection, but only a properly formulated glycol, at the right concentration level and with industrial strength corrosion inhibitors can keep corrosion in check. All glycols can introduce the potential to thermally degrade or oxidize even when left alone in their original sealed container. Degradation proceeds even more rapidly when glycols are used within an operating system.

Many system owners learn the hard way that not all glycols can provide long-term protection of system components from corrosion. The old adage, "Do it right the first time," holds true since it always costs more to correct a serious corrosion problem than it is to prevent one from happening.

The industrial inhibitor packages used in products like Dow Chemicals DOWFROST propylene glycol based fluids and DOWTHERM SR-1 ethylene glycol base fluids are specially formulated to help prevent corrosion in two ways. First, the corrosion inhibitors "passivate" the surfaces of the metal, so they are less susceptible to corrosion. Second, the inhibitors buffer the organic acids formed as a result of glycol oxidation to keep the fluid from becoming acidic. ■

*End of part 1. Part 2 to continue in the March issue of Phc News. Part 2 of this article looks in greater detail at the need for inhibited glycol solutions when installing snowmelt systems. It also examines the type of heat losses that will occur, how to anticipate the influence of heat loss, basic types of operation and control, and cost of system operation.*

Photo courtesy of Watts Radiant

*Stairs are another excellent application for radiant snowmelting, providing an extra measure of safety.*

## A boiler's worst nightmare

*By Keith Whitworth*

A snowmelt system typically requires a boiler with high output. A key advantage, however, is that when the thermal mass of a floor or heated surface has reached temperature, shorter and less frequent boiler cycle-times are required.

A key challenge for boilers coupled with a snowmelt is the combination of high demand and high mass with extremely cold water/glycol temperatures. Thermal shock, like the final thrust of a Nor'easter to push a storm into its "perfect" state, happens when freezing return-water temperatures come crashing into the heat exchanger at startup. New condensing boilers take this brutal jab in stride.

Or, to prevent thermal shock with even the sturdiest of non-condensing boilers, boiler bypass piping — the mixing primary and secondary returns — is often used. This helps to avoid the key risk of condensing the boiler flue-gas, which can deliver a lethal blow.

*Keith Whitworth is a system design engineer and Midwest regional sales manager for Watts Radiant.*

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## Part 2

*Part one, which appeared in the last issue of* Phc News, *introduced the snowmelt system and its various forms and uses.*

*Part two of this article looks in greater detail at the need for inhibited glycol solutions when installing snowmelt systems. It also examines the type of heat losses that will occur, how to anticipate the influence of heat loss, basic types of operation and control, and cost of system operation.*

### Avoid uninhibited glycols

Plain glycol solutions, because they lack corrosion inhibitors, can increase the threat of corrosion in a hydronic snowmelt system. Moreover, putting them into your system cold will eventually cost you far more than the initial fluid price. Uninhibited glycols are less expensive, but become an ongoing threat to your system components.

Heat, oxygen, chlorides, sulfates, metallic impurities and other contaminants can increase the rate of corrosion in the system. Combined, these are likely to create unscheduled system shutdowns, maintenance issues and reduced system life. Glycols produce organic acids as they degrade, especially when heated. If left in solution, these acids lower the fluids' pH.

With no corrosion inhibitors to buffer these acids and protect the metals in the system, the corrosion rate of a solution of plain ethylene or propylene glycol can be greater than that in plain water, highly corrosive in its own right.

### Snowmelt Commandment #1

*By Keith Whitworth*

Tubing in the floor or embedded in outdoor concrete surfaces requires some special precaution. If heavy machinery is to be mounted to the floor, or if guard rails are to be placed in snowmelted garages or truck ramp spaces, the setting of anchor points must be located long before people begin popping holes in the concrete.

If there are trench-drains, garage slab or loading ramp drains or — in the case of rooftop helicopter landing zones with drains to accommodate runoff there — tubing must go around those.

Basically, anything that goes through the floor, is bolted to the floor, or protrudes from the floor… radiant tubing should go around, or special provisions must be made.

*Keith Whitworth is a system design engineer and Midwest regional sales manager for Watts Radiant.*

*Photo courtesy of Watts Radiant*

*Conveniences of snowmelt include reduced labor costs for snow and ice removal.*

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### Melting snow with hydronic snowmelt system

It takes a lot of energy to melt snow, about five to six times the load required to heat a building of similar size. For example, it may only take 30-40 Btu/hr per square foot to radiantly heat a structure. But it can take up to 150 Btu/hr-square foot or more to melt snow and ice from a surface.

Many variables interact to affect system effectiveness:

**Sensible heat:** The first load factor is the sensible heat required to increase the temperature of snow or ice from ambient temperatures to 32°F. The lower the temperature when precipitation is detected, the higher the sensible load will be.

**Heat of fusion:** Once the mass of snow or ice has reached 32°F, additional energy is required to change its state from solid to liquid. This stage of snow/ice melting generally requires the most energy.

**Snow-free area ratio:** The insulating effect caused by the presence of a layer of snow or ice has a huge effect on heat transfer and evaporation occurring at the snow melt surface.

**Heat of evaporation:** As the mass temperature increases, natural evaporation will begin to take place.

**Heat loss to the atmosphere:** Atmospheric losses are the fourth phase of the snowmelt process. Once we start melting snow off our system, we will begin to have voids in the snow cover — areas that may not have initially contained as much snow as other areas due to drifting or may be exposed to solar gain effects. These areas clear faster causing clear patches to form, allowing for greater losses to the atmosphere.

**Back and edge losses:** Back and edge losses refer to losses not directly associated to the melting snow. These include the ground below the mass as well as to the side. Energy in a snowmelt system behaves like any other radiant system: heat moves from a hot source (the tubing) to a cold source (the mass). When a snowmelt system first starts, energy moves in all directions equally since the surrounding mass is of equal temperature. This condition changes the longer the system runs.

### System basics

Normally, PEX tubing can handle up to 180° to 200°F, but there are variations. The maximum temperature rating can also be affected by the concentration and type of glycol used in the snowmelt system.

Tubing comes in a variety of sizes with $^1/_2$" ID (inside diameter) to 1" ID being typical for a snowmelt system. Supply and return manifolds are often made of steel, copper or stainless steel. The layout is usually easiest if these manifold pairs are located together next to the "zone," or area to be melted. Manifolds can be located away from the zone, but then more tubing will be required to get to and from the manifold pair.

The tubing is normally spaced from six to 12 inches on center and circulates heat transfer fluid that has been heated to 110° to 140°F. Tube spacing can be varied according to the performance of the snow melting required. Higher snowfall requires closer spacing of tubes. Higher slab thickness or tubing, which is buried further below the slab surface, increases resistance to heat transfer which may require higher supply water temperatures.

Inhibited glycol-based heat transfer fluids are more viscous than water and this means higher system pressure drop and higher pumping cost. This will be most noticeable during system start-up when the fluid temperature is coldest. The viscosity of ethylene glycol based fluids becomes excessively high below fluid temperatures of -20°F, whereas propylene glycol fluids reach excessively high viscosity below a temperature of 0°F.

### System costs

Cost to operate depends on location and system specs like energy source — access waste heat or steam, natural gas or oil versus electricity and also equipment design, required performance, need for redundancy, slab geometry, materials of construction, etc.

The concentration of glycol used for a system must have a freezing point which is 5°F below the lowest anticipated winter temperature to ensure adequate protection. Failure to use sufficient freeze protection can lead to bursting or rupturing of system piping caused by formation of ice crystals. Fluid heaters must be capable of providing required heat loads which typically range between 100-300 Btu/hr-ft2. Add the cost of supply and return piping required to get the energy from the boiler to the slab. With all these factors, including a larger heat source, a snowmelt system can typically cost between $6-$12 per square foot.

- On-off. The cheapest system to operate is with an on-off mode. These systems are only used five or 10 times each year.
- Idled systems. Idled systems, because they operate any time the temperature is below 38°F, cost more to operate. These systems typically consume up to 100 Btus per hour, per square foot whenever they are idling and up to 300 Btus per hour per square foot whenever they are operating. Hospitals may have waste heat from steam or condensate that may be readily available, greatly reducing or eliminating energy needs.

So, whether you're seeing an occasional need to eliminate snow, or warming an emergency room entrance, a snowmelt system, properly installed and protected, will readily answer the call. ■