Warming Up To Snowmelt Technology

From sidewalks to hospital entrances and helipads, these systems are becoming a more common part of a project's mechanical infrastructure. Examine differences between ASHRAE's old and updated classifications, then review design considerations such as heat of evaporation, heat loss to the atmosphere, and back and edge losses. Tubing, spacing strategies, and controls round out the primer.

BY KOLYN MARSHALL

The design process for a new health-care facility, with its rushed schedules and tight budgets, can be a demanding challenge, but it all has to come together with the highest of quality — patients' lives may be on the line. In the rush to make the perfect health care design, have you ever taken the time to step back and look to see if your efforts met your client's long-term expectations?

It's that time of year again, when Old Man Winter's got us in his cold, icy grasp. Sleet, snow, ice, and freezing rain will challenge safe movement outside. As plumbing engineers, most of us readily see the value of snowmelt systems. Many building and facility owners, however, have yet to embrace it.

Frequently, a key obstacle to winning their interest is the upfront cost for snowmelt system installation. Certainly, it's not inexpensive. But there are benefits to consider on the other side of the equation. 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 do the job. Icemelt chemicals can kill nearby plants, increase building cleanup as they're tracked inside and, over time, seriously degrade concrete and asphalt.

This key obstacle may be minimized if a facility has waste heat that can be exchanged. If excess heat is available, or if all that's needed is an additional geothermal or water-sourced heat pump during the design phase, green lights for the upgrade may be just around the corner.

In essence, snowmelting is radiant heat thrown out the door. This method of snow and ice removal employs tubing buried outside in a mass to gently melt off winter precipitation to keep pathways, driveways, and other areas 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 performs a valuable, perhaps life-saving function.

Other advantages include the proactive strike against potential liability claims and added safety overall. The cost of the system may be more than returned with one avoided lawsuit. Additionally, some insurers recognize the value of these systems, rewarding building owners with reduced insurance rates.

SNOWMELT CLASSIFICATIONS

For the sake of easy reference, snowmelt's uses are grouped into classifications. These allow us to quantify the level of snowmelting a system is designed to perform. There are two essential systems of classification, the old ASHRAE and new ASHRAE.

The old ASHRAE classifications split snowmelting systems into three groups: Class I, Class II, and Class III. These classes split systems into the amount of snow actually melted at design conditions:

- Class I – systems designed not to melt snow while it is falling, but afterwards
- Class II – half the snow is melted during snowfall, the rest afterwards
- Class III – all snow and ice is melted while falling

The key to these classifications is the design conditions. If a system were designed as a Class I (no snow melted) for 36 in. of snow per day, it could act as a Class III system with a minor snowfall of 8 in. Conversely, a Class III system designed for around 6 in. of snow per day would act as a Class I system with 36 in. of snowfall. So, to guide your decisions, know your snowfall.

The new ASHRAE standards still keep Class I, II, and III, but ASHRAE now calls it 0, 0.5, and 1 for ratio of snow melted. However, they also add a new twist — a percentage to quantify how often the maximum amount of snow occurs. Many professionals (especially we engineers) tend to "overdesign" a system to handle the worst-case scenario. The snowmelt percentages, as divided by AHRAE, are essentially classified into 75%, 90% 95%, 98%, 99%, and 100%, with 100% being the maximum snowfall foreseeable for an area.

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 to 40 Btuh/sq ft to radiantly heat a structure. But it can take up to 150 Btuh/sq ft or more to melt snow and ice from a surface. Why is so much energy required? Namely, the components that make up the load. There are five basic parts to a snow/icemelt system.

- **Sensible Heat: Qs.** The first load factor is the sensible heat required to raise the snow or ice from ambient temperatures to 32°F. The colder the ambient conditions during precipitation, the higher the sensible load.
- **Heat of Fusion: Qm**. Once the mass has reached 32°, the second phase of the snowmelt process can begin. This phase is called the heat of fusion, which is the amount of energy required to change states from a solid to a liquid. This phase of the snow/icemelt system generally requires the most energy.
- **Heat of Evaporation: Qe.** As the mass temperature increases natural evaporation will begin to take place directly from the snow to the atmosphere. This phase is generally a small part of the overall process, but one that must be considered.
- **Heat Loss to the Atmosphere: Qh.** 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 had as much snow cover as other areas due to drifting or may be exposed to solar gain. These areas clear faster, and clear patches form, allowing for greater losses to the atmosphere — the air surrounding the snowmelt. The cold atmosphere will literally "suck" the heat from the slab. We must continually provide energy to the slab to replace energy lost to the atmosphere.

FIGURE 1. An installation crew attaches snow-melt PEX tubing to reinforcement wire at J. B. Hunt's headquarters building.

- **Back and Edge Losses: Qb.** 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 will travel from a hot source (the tubing) to a cold source (the mass).

When a snowmelt first starts, energy moves in all directions equally since the surrounding mass is of equal temperature. This condition changes the longer the system runs. Since the ground is not an exposed surface it will begin to retain energy, thus causing its temperature to rise. Conversely, the exposed surface of the mass continuously loses energy (to the snow and atmosphere). Back and edge losses, however, are really negligible when compared to the other snowmelting factors. Heat loss to the ground is generally only 3% to 5% of the total system load.

EXAMPLES OF SNOWMELTS

Typical snowmelts employ tubing buried in a concrete slab. The most popular tubing used is either synthetic rubber (EPDM) or cross-linked polyethylene (PEX). EPDM is derived from synthetic rubber and is crosslinked, much the same way PEX is, in the presence of a catalyst and heat (low-pressure steam). Both types of tubing have a long history of performance and longevity in high temperature applications.

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FIGURE 2. Snowmelt systems are ideally suited to building rooftop helicopter landing pads.

Tubing comes in a variety of sizes, typically 1/2 in. inside diameter (ID) to 3/4 in. ID will be seen in a snowmelt system. The tubing ties into the supply and return piping via manifolds that have barbs that transition the flexible tubing to copper, stainless steel, or brass pipe. These manifolds come in pairs, a supply manifold, where the tubing starts, and a return manifold, where the tubing stops. The layout is usually easiest if these manifold pairs are located together next to the "zone," or area to be snowmelted. Manifolds can be located away from the zone, but then more tubing will be required to get to and from the manifold pair. Tubing lengths vary according to manifold placement.

The tubing is spaced from 6 to 12 in. on center and circulates water that has been heated to 110° to 140°. Tube spacing varies according to the degree of snowmelting required. More snowfall that needs to be melted at a faster rate will require closer spacing of tubes. More material over the top of the tubing increases resistance to heat transfer requiring a higher supply water temperature.

Common snowmelt applications include:

Helipads. Hospital helipads are excellent examples of snowmelts. With space becoming more and more precious, many hospitals are forced to install helipads on the building roofs. Snowmelt systems keep these helipads snow and ice free.

Sidewalks. Convenient and more inviting to passers by, sidewalk snowmelts can increase business and decrease liability. Customers are more likely to shop stores with clear sidewalks and that are free from ice, snow, and chemicals.

Stairs. Stairs are always viewed as slippery and dangerous. By snowmelting 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 perhaps one length in the riser.

Car washes. Water is always present in car washes. Using snowmelt, 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°, the system is turned on. When the temperature rises above 35°, the system is turned off.

Hospital entrances. Because they are usually considered Class III systems, tube spacing for hospital entrance ramps are usually set closely at 6 in. outside clearance (OC). 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 precipitation, the system is then operated at full output.

Parking garage ramps. Snowmelting systems ensure cars driving in off the street can safely negotiate up and down parking garage ramps. One note of caution: be sure to place sensors for these controls where they can detect snowfall, or precipitation and temperature. The sensors are usually placed away from the ramp.

Loading docks. Moving the goods is the motto of many a shipping company. Trucks can easily get into and out of loading docks, which are often depressed and slippery. Snowmelting systems ensure that the goods can be moved in and out of your facility.

FIGURE 3. At Mammoth Mountain ski resort in California, snowmelt systems are installed for patrons.

Large area "hot pads." Instead of melting the entire area, sometimes too large and cost prohibitive, smaller areas are melted where

FIGURE 4. Snowmelt systems greatly reduce the risk of injuries, even at ski resorts.

the snow can be shoveled off and piled on. Used with airport runways and large parking lots. Large snow piles take up valuable parking spaces and create dangerous runoff. Typically, tubing for hot pad slabs is spaced at 4 to 6 in. OC to accommodate a large amount of snow. Remember, 6 in. of snow from a runway or parking lot will be collected and deposited on the pad. It's not uncommon to have a hot pad of perhaps 30 by 30 ft, with snow piled 4- to 6-ft high.

Hot pads are usually operated manually and area-ctivated when the need arises. Twist timers can be used in place of on-off switches so the operator doesn't have to remember to switch the system off. No doubt, facility owners wouldn't appreciate seeing the gas bill for a hot pad (or pads) left on inadvertently for several weeks.

PRINCIPLES OF OPERATION

On-off operation. Some snowmelts are operated only when there is ice or snow. These systems are operated in the presence of precipitation when the ambient temperature is below 35°. While less costly to operate, these system take longer to start melting ice and snow because they have to raise the temperature of the slab first.

Controls. Simple temperature and precipitation sensors sense precipitation when the temperature is below 35° to 38°. Because these controls are relatively simple, their cost is also relatively low when compared to other snowmelting controls.

After precipitation and temperature conditions are met, the system will operate until the precipitation stops. Most controls will continue to operate the snowmelt for a period of 4 to 6 hrs after precipitation has stopped, ensuring the surface is free of ice and snow.

Twist timers can also be used in parallel with the snowmelting control allowing some manual control over the system. If it is known that a winter storm is approaching, the system can be manually started several hours before with the manual twist timer to reduce system lag time. Or, conversely if snow happens to drift onto the snowmelting surface, but does not engage the precipitation sensor, the system can be manually started with the twist timer.

Idled systems. In order to help systems respond faster, some systems are idled or operated at a reduced output until precipitation is sensed with a temperature below 35° to 38°, when the system is operated at full output. These systems allow for a faster system response. No snow or ice builds up on these systems. These systems are crucial when the surface must be kept free and clear of ice and snow at all times.

Controls. Sophisticated controls that sense slab temperatures, outdoor temperatures, and precipitation are used. These controls are generally more costly than on-off controls due to their complex nature, but allow for much greater system control. Controls usually have settings for warm-weather shutdown, slab idle temperature, and cold-weather shutdown. Cold weather shutdown is necessary because snowmelt systems cease to be effective below about 0°. We simply can't provide enough energy below 0° to effectively provide snowmelting. Yet, this is rarely troublesome because snow below 0° contains very little water.

Operating cost. Snowmelts themselves are not that expensive to operate, since they usually only operate a few times a year. The biggest cost incurred with a snowmelt system is the upfront cost. Glycol antifreeze is required for all systems, since the system fluid is either dormant or could go dormant for a period of time. Relatively large pumps could be required to move the slushy water-glycol mixture on initial system start-up. Larger boilers are required to deliver the 100 to 300 Btuh/sq ft. Supply and return piping is required to get the energy from the boiler to the manifolds for the tubing buried in the slab. With all these factors, including larger heat source, a snowmelt system can typically cost between $6 to $12/sq ft, depending.

On-off. The cheapest system to operate is an on-off snowmelt.

FIGURE 5. Snowmelting systems employ tubing buried in a concrete slab and can increase business and decrease liability when used in sidewalks.

These systems are only used five or 10 times per year. As an example, a Class II system in Buffalo, NY, may only cost about $0.21/sq ft/yr. The same system in Chicago, may only cost $0.12/sq ft/yr. Minneapolis or St. Paul may only cost $0.25/sq ft/yr.

Idled systems. Idled systems, because they operate any time the temperature is below 38°, cost more to operate. These systems typically consume up to 100 Btuh/sq ft whenever they are idling and up to 300 Btuh/sq ft 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 in Newark, NJ, or warming an emergency room entrance in Nome, AK, a snowmelt system, properly installed, can readily answer the call. **ES**

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