

One of the fastest growing applications of hydronics technology is snowmelting. In some locations, it's a set of steps or a sidewalk that are kept free of snow and ice, in others it's an entire driveway or building entrance.

Snowmelting has many benefits including:

1. The ability to provide fully automated snow removal
2. Elimination of sanding and salting, the associated mess and environmental issues
3. The removal of snow without creating banks or piles that cause drifting
4. The removal of snow without damaging shrubs or other landscaping.
5. Improved safety and reduced liability
6. Reduced damage to pavements compared to other means of snow and ice removal

Achieving these benefits and ensuring the system has a long efficient life requires good design. Fluid temperature control, the proper protection of conventional boilers, and prevention of heat exchanger freeze-up are crucial issues that must be addressed in any properly-designed system.

GOOD FLOW IS FUNDAMENTAL

Snowmelting systems need to deliver substantially more energy per square foot in comparison to radiant floor heating systems. Depending on the expectations of the owners, systems must provide between 75 and 400 Btu/hr per square foot of pavement. The lower end of this range is typical of residential systems where some snow accumulation on the pavement prior to melting is generally acceptable. The upper end of the range is typical of areas such as hospital emergency room entrances or sloped pavement ramps that must be kept free of snow at all times.

The following equation can be used to calculate the heat output of an embedded tubing circuit when the fluid type, flow rate, and temperature drop of the system are known.

$$Q = 8.02 \times c \times d \times f \times \Delta T$$

Where:

- c = specific heat of the fluid (Btu/lb/°F)
- d = density of the fluid (lb/ft³)
- f = flow rate of the fluid (gpm)
- ΔT = temperature drop along the circuit (supply - return)

Since the properties of the fluid are essentially fixed, increasing the value of Q comes down to increasing flow rate and / or circuit temperature drop. A higher flow rate or higher the circuit temperature drop, increases the heat output of the circuit.

The designer has limited control of circuit temperature drop. Temperature drops in excess of 25°F in snowmelting can result in uneven melting patterns, especially over larger areas. Pavement surfaces over the beginning portion of the circuit will melt noticeably faster than those over the end of the circuit.

For this reason, **the high heat output requirement for snowmelting is usually achieved using higher flow rates.** In most cases these higher flow rates necessitate larger size tubing. For example, residential snowmelting systems often use 5/8-inch or 3/4-inch tubing, and commercial systems often use 3/4-inch or 1-inch embedded tubing.

Product & Application Documents:

PA02 - PC705 Variable Speed Injection Mixing Control

PA03 - Variable Speed Outdoor Reset "00" Circulator (00-VR)

PA04 - iSeries-R (Outdoor Reset) Mixing Valve

PA05 - Variable Speed (Setpoint) "00" Circulator (00-VS)

PA06 - iSeries-S (Setpoint) Mixing Valve

PA09 - Radiant Mixing Block

PA10 - X - Pump Block

Operating Mode Documents:

OM02 - Outdoor Mixing Reset: Variable Speed Injection Circulators

OM03 - Outdoor Mixing Reset: 2-way / 3-way / 4-way Mixing Valves

OM05 - Setpoint Temperature: Variable Speed Injection Circulators

OM06 - Setpoint Temperature: 2-way / 3-way / 4-way Mixing Valves

OM07 - Delta T (Temperature) & Setpoint with Delta T Max

WATER TEMPERATURE CONTROL

The relatively high flow rates associated with snowmelting affect the size and cost of the mixing hardware used to control fluid temperatures in the system. **If 3-way and 4-way motorized mixing valves are used, they must be sized to handle the full flow rate of the snowmelting distribution system.**

However, if injection mixing is used, the mixing control device only needs to handle the “hot” portion of the mixed flow. Hence, a relatively small 2-way iSeries Mixing Valve or variable speed injection pump can regulate a relatively high rate of heat transfer. **The greater the system flow rate, the greater the advantage of injection mixing relative to iSeries 3-way and 4-way mixing valves.**

Injection mixing using the Taco 2-way iSeries valve (see Figure 1) is sufficient for smaller snowmelt systems such as residential sidewalk areas, steps, and patios. However, for larger areas such as entire driveways, injection mixing using a variable speed pump provides greater rates of heat transfer and is generally more cost effective.

The piping for supplying snowmelting through a variable speed injection pump is shown in Figures 2a, 2b and 2c. Figure 2a shows a “dedicated” snowmelting system where the only load served by the boiler is snowmelting. The entire system is filled with a suitable antifreeze solution.

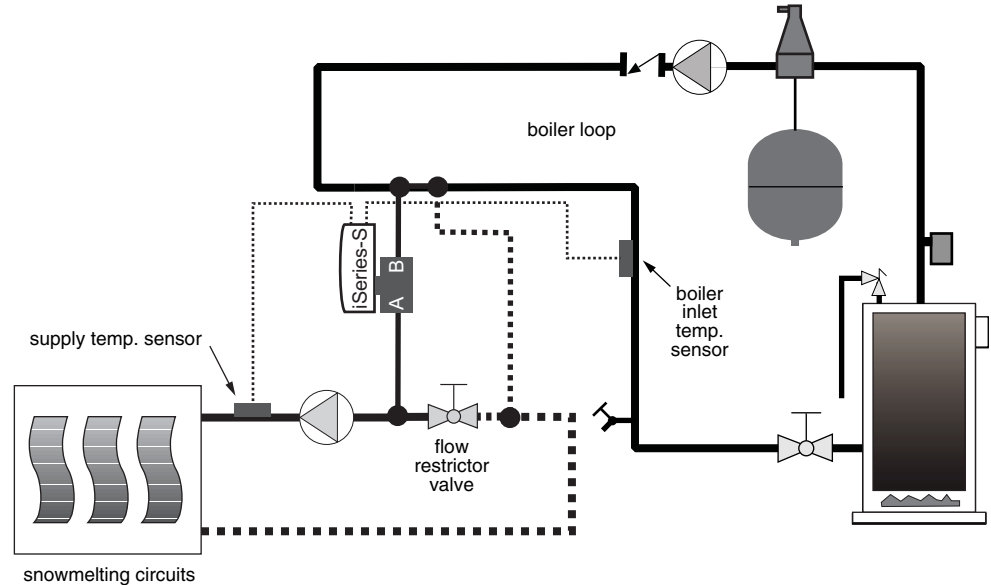


Figure 1 - Injection via 2-way iSeries Valves

Figure 2b shows the snowmelting load as one load on a multi-load system. In this case, a heat exchanger is used to separate water in the primary loop and other portions of the system from the antifreeze solution used in the snowmelting subsystem. Figure 2c shows an X - Pump Block which combines a variable speed mixing control, heat source circulator, system circulator and heat exchanger into a single unit. Notice that the snowmelting distribution system now contains an air separator, expansion tank, pressure relief valve, and fill/purging valves. These are necessary since the snowmelting distribution system is hydraulically isolated from the remainder of the system by the heat exchanger.

Upon a demand for snowmelting, a fixed speed circulator is turned on to supply hot water from the primary loop to the primary side of the heat exchanger. The variable speed injection controller is also activated. This controller begins monitoring the return temperature to the boiler. When that temperature is sufficiently high to prevent flue gas condensation the injection pump speed is increased to transfer heated antifreeze into the snowmelting distribution system. The controller now monitors the supply temperature sensor and regulates pump speed to maintain the programmed setpoint. If at any time the boiler temperature drops to a set minimum temperature the injection pump speed is reduced to prevent the boiler from operating with sustained flue gas condensation.

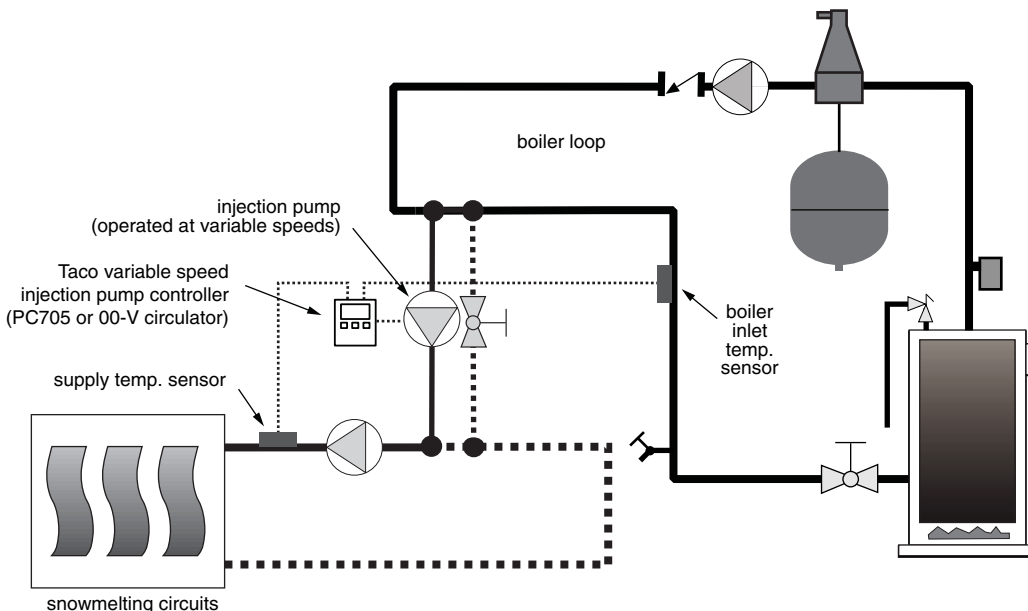


Figure 2a - Injection Mixing via Variable Speed Pump

Figure 2b - Injection Mixing
via Variable Speed Pump

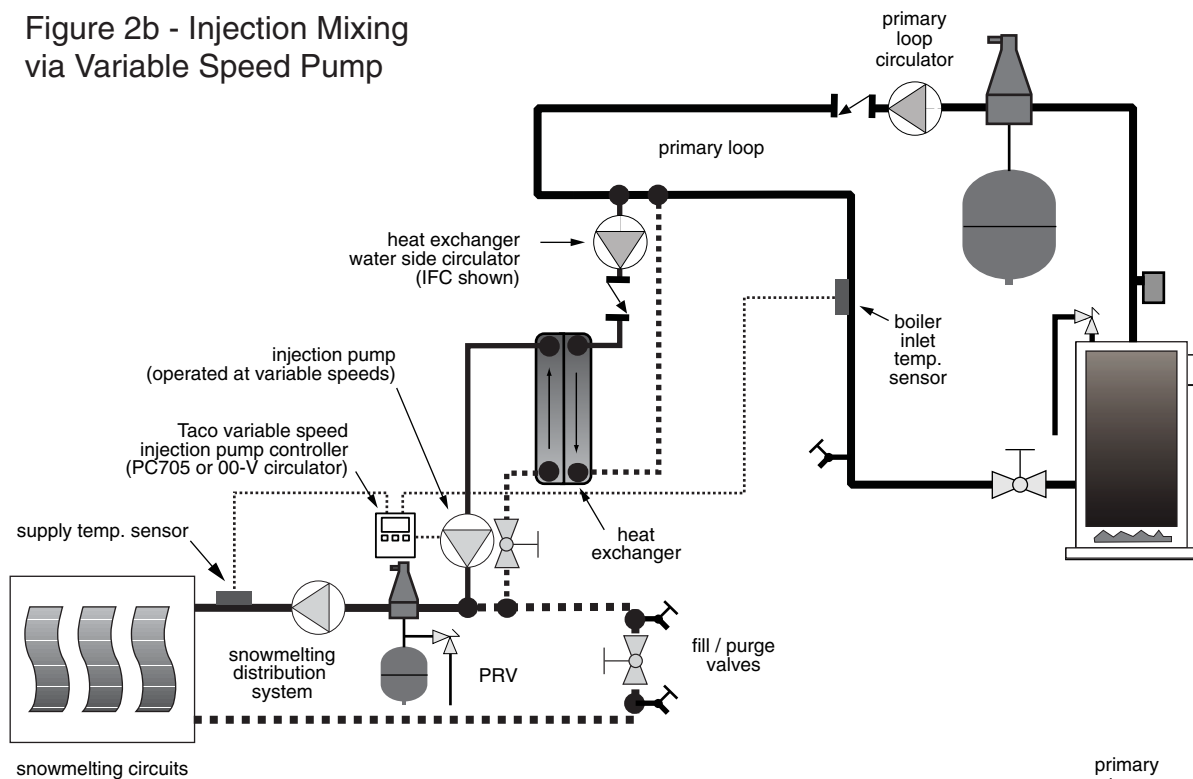
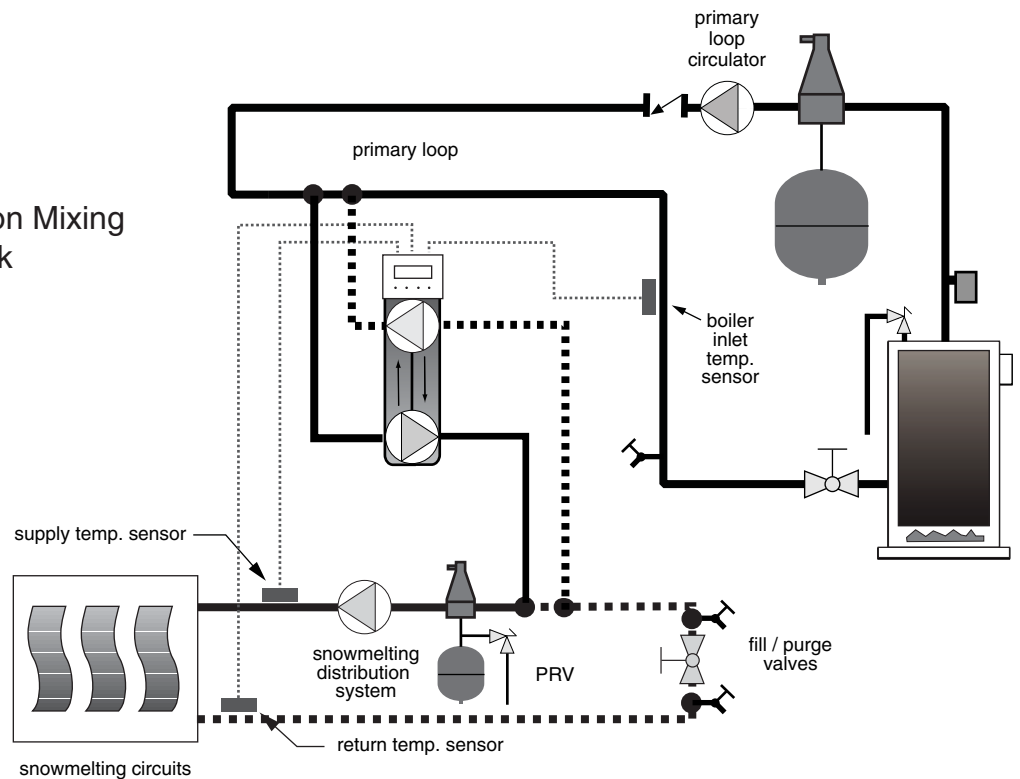


Figure 2c - Injection Mixing
via X - Pump Block



CONDENSATE CONSIDERATIONS

Taco 00-series circulators are now available with anti-condensate baffles. This feature prevents water droplets, which can form when the temperature of the fluid being circulated is lower than the dewpoint of the surrounding air, from condensing in areas that might damage the circulator's motor windings. Although originally developed for use in chilled water cooling systems, circulators with anti-condensate baffles are also ideal for circulating initially chilled anti-freeze solutions in snowmelting systems.

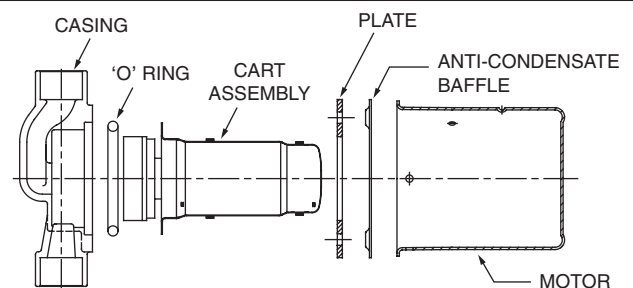


Figure 3 - "00" Series Circulator with Anti-Condensate Baffle

HEAT EXCHANGER PROTECTION

Another issue facing designers is the possibility of circulating very cold antifreeze solution through the secondary side of a heat exchanger that contains minimal amounts of water on its primary side. When the snowmelting system is first turned on, the temperature of the antifreeze solution returning from the outdoor pavement circuits can be well below 32°F. If this frigid solution circulates through the secondary side of the heat exchanger before heated water reaches the primary side, ice can quickly form on the latter. The result could be a frozen (and possibly ruptured) heat exchanger. This, in turn, would “dead-head” the water side circulator and create a service call to correct.

Such situations can be avoided by installing a temperature setpoint control to monitor the outlet temperature on the primary side of the heat exchanger, and only allow the antifreeze circulator to operate when a suitably high water temperature is detected at this location.

The Taco 00-VS circulator configured for the proper setpoint operation can provide this protection in a single unit when installed as shown in Figure 4.

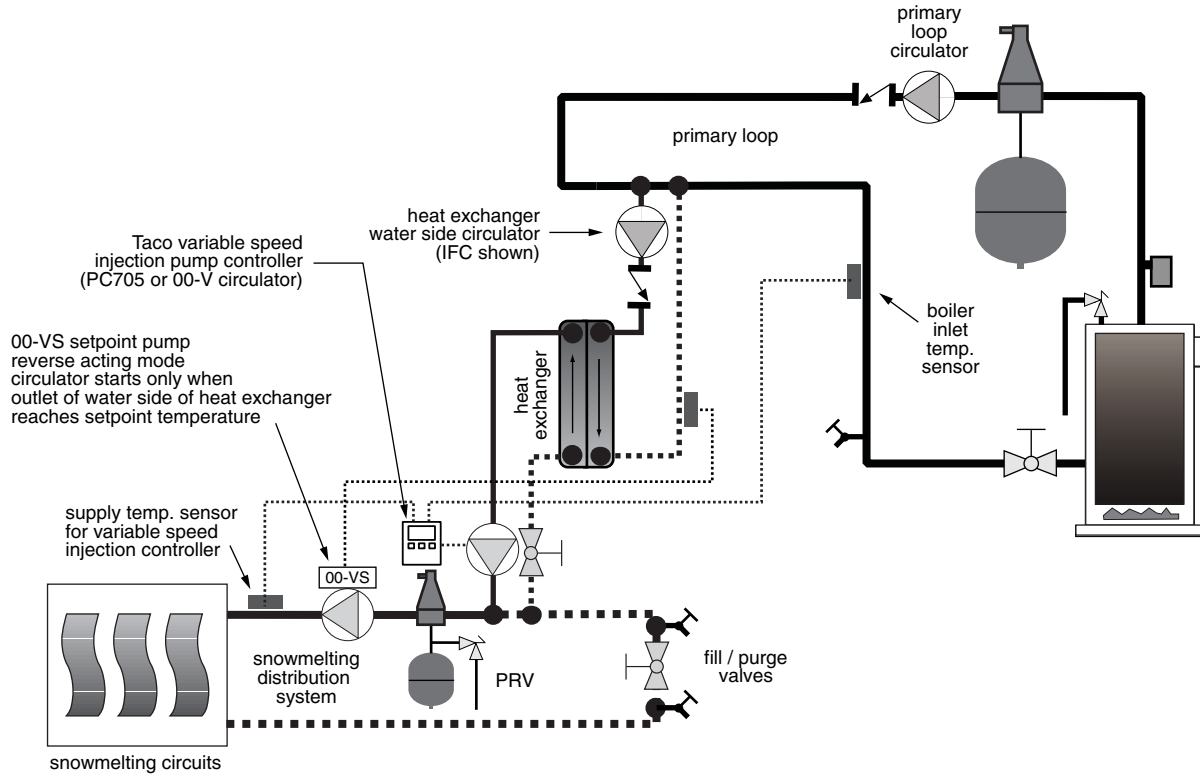


Figure 4 - Setpoint Pump Protection Mode

The 00-VS circulator would be set in “reverse acting” mode so its speed increases upon an increase in sensor temperature. The setpoint temperature would be set high enough to verify that heated water was circulating through the primary side of the heat exchanger – perhaps 120°F. At water temperatures below this setting, the snowmelting distribution circulator would remain off. When the water temperature at the outlet of the primary side of the heat exchanger reaches or exceeds this value the distribution circulator would quickly ramp up to full speed. This functionality also protects the heat exchanger from freezing should there be a failure in the system that prevents heated water from being delivered to the snowmelting heat exchanger.

As with radiant heating, the Taco 00-VS circulator, iSeries Mixing Valves, and X - Pump Block provide state-of-the-art functionality that allows designers to create efficient and reliable snowmelting systems.

Radiant Made Easy™

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