Snow & Ice Melting System Solutions
Introduction

This presentation was developed for a 30-minute timeframe in an industry conference.

PPI has a more in-depth presentation Design and Installation of Hydronic Snow & Ice Melting Systems to Optimize Performance and Efficiency that contains more information about design, installation, controls, and operating costs.

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The Plastics Pipe Institute

PPI Represents All Sectors of the Plastic Pipe Industry
- PPI was formed in 1950 to research and develop test methods for plastic pressure pipes
- Today: Non-profit trade association serving North America, based in Irving, TX

PPI Mission: To advance the acceptance and use of plastic pipe systems through research, education, technical expertise, and advocacy

Members: Over 170 member firms involved with the plastic pipe industry

PPI Website: www.plasticpipe.org
The Plastics Pipe Institute

PPI Building & Construction Division (BCD)
- BCD is focused on plastic pressure pipe and tubing systems used within buildings and on building premises for applications such as plumbing, water service, fire protection, hydronic (radiant) heating & cooling, snow & ice melting, district heating & cooling, and ground source geothermal piping systems.

BCD Materials: CPVC, HDPE (Geothermal), PEX, PE-RT, PEX-AL-PEX, and PP (PP-R & PP-RCT)

BCD homepage: https://plasticpipe.org/building-construction/index.html
What Is A Hydronic SIM System?

- **Snow & Ice Melting (SIM) systems** are hydronic systems designed to remove snow and ice by circulating a heat transfer fluid* through tubing installed in an outdoor surface.
  *typically propylene glycol mixed with water at a ratio to prevent freezing

- SIM systems are used across North America in **all climates**

- The piping material for SIM distribution systems is typically:
  - **PEX**: Crosslinked Polyethylene, or
  - **PE-RT**: Polyethylene of Raised Temperature Resistance
What Is A Hydronic SIM System?

SIM systems are not new! They were pioneered in the 1930s, or earlier, using iron piping. Copper was the “new” material in the 1950s. Old industry manuals were excellent and thorough.

Revere no longer produces copper tubing

A.M. Byers closed in 1969
Outline

1. Benefits of SIM systems
2. Typical installation techniques
3. Common applications
4. Operating costs

Note: The PPI presentation *Design and Installation of Hydronic Snow & Ice Melting Systems to Optimize Performance and Efficiency* contains more information about design, installation, controls, and operating costs.
1. Benefits of Snow & Ice Melting Systems

This section will explain six benefits of SIM systems

1. Better safety
2. Reduced liability
3. Healthier convenience
4. Lowered maintenance costs
5. Minimized environmental impact
6. Long-term reliability
Benefits of Snow & Ice Melting Systems

1. Better Safety
   - Snow & ice melting systems provide better safety for pedestrians and drivers than mechanical snow removal
   - Eliminate build-up of snow and ice, keeping surfaces clear during snow events and evaporating water to prevent freezing
Benefits of Snow & Ice Melting Systems

2. Reduced Liability
- Snowbanks, ice, and trip hazards are practically eliminated
- Improve access and safety, while eliminating a source of liability risk in winter for homes and businesses
- Liability insurance premiums might even be reduced, potentially reducing ownership costs
Benefits of Snow & Ice Melting Systems

3. Healthier Convenience
- For the ultimate in snow removal convenience, SIM systems clear outdoor surfaces, leaving them dry - no snowbanks are left behind
- For residential customers, eliminate potential health risks of aching backs and heart attacks

BEFORE YOU PICK UP THAT SNOW SHOVEL:
1. DON'T eat a heavy meal.
2. DON'T drink alcohol.
3. DO use a small shovel.
   Lifting heavy snow can increase blood pressure.
4. DO consult a doctor if you have a medical condition.
5. DO learn the dangers of hypothermia. Dress in layers!
6. DO know the signs of a heart attack:
   chest discomfort; pain in the arm, neck or jaw; cold sweat; nausea; shortness of breath.

Published via social media by American Heart Association in Feb. 2021
Benefits of Snow & Ice Melting Systems

4. Lowered Maintenance Costs
- Traditional snow removal is very expensive and unpredictable
- Facility owners can pay thousands of dollars per year for labour, equipment, supplies
- Hydronic SIM systems are usually less expensive to operate than mechanical removal
- Indoor maintenance costs are reduced by avoiding sand and salt getting tracked inside

Snow removal equipment and supplies at airport parking garage

Salt at bank entrance
Benefits of Snow & Ice Melting Systems

5. Minimized Environmental Impact
- Hydronic SIM systems are typically powered by high-efficiency boilers, electricity, geothermal heat pumps, or waste heat
- Less fuel is used to power boilers than to power plows & trucks (= lower CO₂ emissions)
- SIM systems extend lives of surfaces by eliminating scraping, salting, and sanding operations
- Run-off of deicing chemicals (e.g., salt) onto lawns and drains is practically eliminated
- These factors can save energy and reduce environmental impacts

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Courtesy REHAU
Benefits of Snow & Ice Melting Systems

6. Long-term Reliability
- Boilers, heat pumps, circulators, piping components are highly reliable
- Plastic tubing does not corrode - inside or outside
- With proper design and installation, hydronic SIM systems provide decades of reliable operation with virtually no maintenance to piping systems
Benefits of Snow & Ice Melting Systems

6. Long-term Reliability
- Piping material for SIM systems is typically:
  - **PEX**: Crosslinked Polyethylene, or
  - **PE-RT**: Polyethylene of Raised Temperature Resistance

- PEX tubing is produced in accordance with standards ASTM F876/F3253 & CSA B137.5
- PE-RT tubing is produced in accordance with standards ASTM F2623 & CSA B137.18

- Tubing has long-term pressure ratings of 100 psi @ 180°F (690 kPa @ 82°C)
- These are tough and durable, yet flexible, products
Benefits of Snow & Ice Melting Systems

Summary: Benefits include…

1. Better safety
2. Reduced liability
3. Healthier convenience
4. Lowered maintenance costs
5. Minimized environmental impact
6. Long-term reliability
SIM Installation Techniques

Three typical installation types for outdoor surfaces

1. Poured concrete
2. Interlocking pavers
3. Asphalt

Hydronic snow & ice melting systems can be successfully installed in practically all types* of external surfaces

*Permeable concrete is the most difficult surface
SIM Installation Techniques

1. Tubing embedded within poured concrete

- In poured concrete, the tubing is simply embedded within the concrete.
- Very popular for stained concrete.
- Recommended to place the tubing 2 to 3 inches (5 to 8 cm) below the surface for faster response time (not always practical).
- Tubing is often stapled directly onto the insulation board, or tied to rebar or wire mesh within the poured concrete.
- Some insulation board has integrated “knobs” for holding the tubing.
- This is a simple and affordable technique for installing SIM piping.

Poured concrete with tubing embedded 2 to 3 inch from top surface.
SIM Installation Techniques

1. Tubing embedded within poured concrete

Poured concrete with tubing embedded 2 to 3 inch from top surface
SIM Installation Techniques

1. Tubing embedded within poured concrete

Poured concrete with tubing embedded 2 to 3 inch from top surface
SIM Installation Techniques

2. Tubing installed under interlocking pavers

- Plastic tubing is installed above insulation using plastic rails, staples or screw clips
- Tubing is encased within 1 1/2 inches (4 cm) of sand bed, compacted to 1 1/8 inches (3 cm) thick
- Pavers are placed above sand bed, and installed normally
- Technical specifications and drawings of SIM systems with pavers can be found at www.icpi.org

Media
- Compacted sand bed is recommended
- Stone dust loses strength when wet, and can heave when frozen

Pavers installed over sand bed with embedded heating tubing
SIM Installation Techniques

2. Tubing installed under interlocking pavers

Pavers installed over sand bed with embedded heating tubing
SIM Installation Techniques

2. Tubing installed under interlocking pavers

Pavers installed over sand bed with embedded heating tubing
SIM Installation Techniques

3. Tubing installed under asphalt

- Plastic tubing is installed above insulation using plastic rails, staples or screw clips
- Tubing is encased within 3 inches (7.5 cm) of stone dust or sand media, compacted
- Asphalt is placed above the media (dust or sand) and compacted normally
- Cold water is flushed through pipes during placement of asphalt and until it cools
- Water flow is regulated to be less than 150°F (65°C) at the manifold outlet to keep the tubing from overheating until the asphalt cools off

Media
- Compacted stone dust works best
- No pea stone or crushed gravel
SIM Installation Techniques

3. Tubing installed under asphalt

Tubing embedded within sand or stone dust below asphalt
SIM Installation Techniques – Piping Design

The piping designer has several options:

a. **Tube size** *(3/4 tubing is typical; 1/2 or 5/8 tubing is sometimes used (lower profile, shorter circuit))*

b. **Tube spacing** *(6 to 9 inch tube spacing is typical, based on heat load, width of area)*

c. **Tube circuit lengths** *(150 ft. to 300 ft. circuit length is typical, based on melting load, tubing size, heated area, and the selected circulator)*

Poured concrete with tubing embedded 2 to 3 inches from top surface is ideal for faster response time.
SIM Installation Techniques – Piping Design

Piping example:

a. Select ¾ Tube size

b. Install at 8 inch (20 cm) on-center Tube spacing (works well for 20 ft. width)

c. Design for 250 ft. (76 m) Circuit lengths (to keep head loss low)

Poured concrete with tubing embedded 2 to 3 inches from top surface is ideal for faster response time
SIM Installation Techniques - Insulation

Importance of Appropriate Insulation
- A significant amount of heat is conducted to the frozen earth below the SIM surface, if appropriate insulation is not installed
- Without insulation, downward losses can exceed **50%** of all the energy supplied to the area (especially at cold start)
- You’d better double the size of heat source and circulators!

= Tubing filled with warm glycol
SIM Installation Techniques - Insulation

Importance of Appropriate Insulation
- A significant amount of heat is conducted to the frozen earth below the SIM surface, if appropriate insulation is not installed
- With insulation, downward losses are significantly reduced, better response time
- Smaller heat source and circulators, better efficiency!

= Tubing filled with warm glycol

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SIM Installation Techniques - Insulation

Importance of Appropriate Insulation
- Most codes (e.g., CSA B214) require at least R-5 insulation below SIM areas, but many designers specify R-10, since insulation also improves response time.
- Typical insulation thickness is 1 in., 1 ½ in. or 2 in. (25 mm, 38 mm, 50 mm).
- Be sure the insulation is rated for outdoor use and meets expected compressive loading from vehicles, or settling can occur.
- E.g., Use high compressive-load insulation for vehicle roadways, loading docks, etc.
SIM Installation Techniques - Drainage

Importance of Drainage
- Melted snow (just like rain) must have a good drainage path
- Slope surfaces for natural drainage
- Drain to lowest points of the property
- Control run-off so as not to create hazards
- Plan locations of trench drain box/s
- Be sure that drains will not freeze; use pipes around or under a drain (see image)
- Connect drain to available storm sewer system, within code requirements
- Some systems drain to a nearby pond
SIM Installation Techniques

Summary: Three installation types for outdoor surfaces

1. Poured concrete
2. Interlocking concrete pavers
3. Asphalt

Note: See CSA B214:21 *Installation Code for Hydronic Heating Systems* for requirements on SIM installations
Latest 2021 edition released Jan. 15, 2021
Typical Applications of SIM systems

Common applications

1. Sidewalks
2. Steps
3. Driveways
4. Ramps
5. Pool decks

Snow & Ice Melting is popular at ski resorts, as is radiant floor heating inside the buildings.
Typical Applications of SIM systems

1. Sidewalks
   - Private homes
Typical Applications of SIM systems

1. Sidewalks
   - Municipal buildings, universities, commercial building entrances
Typical Applications of SIM systems

2. Steps
- Residential installations

[Images of residential installations]
Typical Applications of SIM systems

3. Driveways
- Under stained concrete
Typical Applications of SIM systems

3. Driveways
   - Under stained concrete or pavers

![Driveway image](image1)

![Driveway image](image2)

*Courtesy Klimatrol*

*Courtesy Ridgeway Home Services*
Typical Applications of SIM systems

3. Driveways
- Under stained concrete or pavers
Typical Applications of SIM systems

3. Driveways
   - Commercial applications

Courtesy Thornton Plumbing & Heating
Typical Applications of SIM systems

4. Ramps
- Pedestrian and vehicle ramps
Typical Applications of SIM systems

4. Ramps
- Pedestrian and vehicle ramps

Courtesy Uponor x 2
Typical Applications of SIM systems

4. Ramps
- Parking garage ramps

Courtesy REHAU
Typical Applications of SIM systems

5. Pool decks/Hot tubs
   - Facilitates winter access
Typical Applications of SIM systems

Summary: Common application types

1. Sidewalks
2. Steps
3. Driveways
4. Ramps
5. Pool decks

Courtesy Arndt & Son
Operating Costs

Following a careful design, it is possible to estimate operating costs, if you know or can reasonably predict:

1. Project location (for weather data)
2. Melting area (of the surface)
3. Annual hours of operation (melting)
4. Number of events (for pick-up loads)
5. Heat flux/load during operation (melting load)
6. Annual hours of idling (a control strategy)
7. Heat flux/load during idling (if selected)
8. Fuel type (e.g., gas, electric, propane)
9. Fuel cost (cost of energy)
10. Efficiency of heat source (%)
Operating Costs

Example (USA): 1,000 ft² hotel entrance in Albany, NY

1. Location: Albany, NY
2. Melting area: 1,000 ft²
3. Annual hours of operation: 156 hours (based on weather data)
4. Number of events: 10 times/year (estimating 15.6 hours/event)
5. Heat flux/load during operation: 150 Btu/hr-ft² (maximum)
6. N/A (no idling – Select On/off control)
7. N/A (no idling – Select On/off control)

A. Energy Usage Estimate:
   - Maximum energy usage: 150 Btu/hr-ft² x 1,000 ft² = 150,000 Btu/hr
   - Estimate annual energy usage: 32,500,000 Btu/year
Operating Costs

Example (USA): 1,000 ft² hotel entrance in Albany, NY

8. Fuel type: Natural gas
9. Fuel cost: Approximately $0.50/Therm
10. Efficiency of heat source: 95% AFUE boiler

B. Cost of Energy Estimate:
- Energy Content (gas): 100,000 Btu/Therm (this is a known factor)

- Cost per 1 million Btu = \( \frac{0.50/\text{Therm} \times 1,000,000}{100,000 \text{ Btu/Therm} \times 95\% \text{ efficiency}} \)

= $5.25 USD per million Btu produced
Operating Costs

Example (USA): 1,000 ft² hotel entrance in Albany, NY

C. Hourly Cost Estimate
- 150,000 Btu/hr x $5.25 per million Btu produced = $0.79/hour in fuel costs

D. Annual Cost Estimate
- 32.5 million Btu/year x $5.25 per million Btu produced = $170.00/year in fuel costs*
*includes starting up the system 10 times, plus melting for 15.6 hours per snow event

What would it cost for an annual snow removal contract?
Probably more than $1,000/year
Operating Costs

Example (Canada): 1,000 ft² (93 m²) ramp in Hamilton, Ontario

1. Location: Hamilton, ON
2. Melting area: 1,000 ft² (93 m²)
3. Annual hours of operation: 120 hours (based on weather data)
4. Number of events: 10 times/year (estimating 12 hours/event)
5. Heat flux/load during operation: 150 Btu/hr-ft² (maximum)
6. N/A (no idling – Select On/off control)
7. N/A (no idling – Select On/off control)

A. Energy Usage Estimate:
- Maximum energy usage: 150 Btu/hr-ft² x 1,000 ft² = 150,000 Btu/hr
- Estimate annual energy usage: 25,000,000 Btu/year
Operating Costs

Example (Canada): 1,000 ft\(^2\) (93 m\(^2\)) ramp in Hamilton, Ontario

8. Fuel type: **Natural gas**
9. Fuel cost: Approximately $0.25/m\(^3\)
10. Efficiency of heat source: 95% AFUE boiler

**B. Cost of Energy Estimate:**
- Energy Content (gas): 36,000 Btu/m\(^3\) (this is a known factor)

- Cost per 1 million Btu = \[
\frac{0.25/m^3 \times 1,000,000}{36,000 \text{ Btu/m}^3 \times 95\% \text{ efficiency}}
\]

= $7.30 CAD per million Btu produced
Operating Costs

Example (Canada): 1,000 ft² (93 m²) ramp in Hamilton, Ontario

C. Hourly Cost Estimate
- 150,000 Btu/hr x $7.30 per million Btu produced = $1.10/hour in fuel costs

D. Annual Cost Estimate
- 25 million Btu/year x $7.30 per million Btu produced = $182.50/year in fuel costs*
  *includes starting up the system 10 times, plus melting for 12 hours per snow event

What would it cost for an annual snow removal contract?
*Probably more than $1,000/year
Operating Costs

Result:
- SIM systems have the potential to reduce snow removal costs by 75% or more vs. mechanical removal.
- Eliminate frequent sanding and salting, and the inconvenience and cost of snowbanks left behind.
- Plus, the SIM system can be automatic (with the right controls) and is always on time!
- **Hydronic SIM systems deliver benefits and safety, plus cost savings for the owners.**

Courtesy Thornton Plumbing & Heating
Operating Costs

Disclaimers, Caveats, Notices, etc.

- All figures were based on stated assumptions and estimates

- Other control strategies can affect costs (e.g., Idling the ramp between snowfalls)

- Electrical costs for heat source, circulator, controls are not shown, but these are minor in comparison

- All SIM systems should be designed by qualified experts with knowledge of local and jobsite conditions and consultation with project owners and managers

Further Disclaimer:
Predicting the weather a week in advance is difficult, so predicting an entire season with accuracy is impossible. Therefore, every effort is made to explain assumptions based on known or assumed data, using historical averages.
Summary

1. Benefits of SIM systems

2. Typical installation techniques

3. Common applications

4. Operating costs

See article in Modern Hydronics, Fall 2017
https://plasticpipe.org/building-construction/bcd-magazine-articles.html
Thank you to the following for images:

- American Heart Association
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Snow & Ice Melting System Solutions

For more information, visit PPI webpage on SIM systems: https://plasticpipe.org/building-construction/bcd-sim.html