B&B Landscaping Snow Melt Heat Exchanger

THE UNIVERSITY OF UTAH
Department of Mechanical Engineering

Team: Nathan Bartlett, Tim Goneau, Nate Jones, Jon McMurry, Sebastian Serbinowski, Jim Thorpe
Advisor: Dr. Samira Shiri

Abstract:

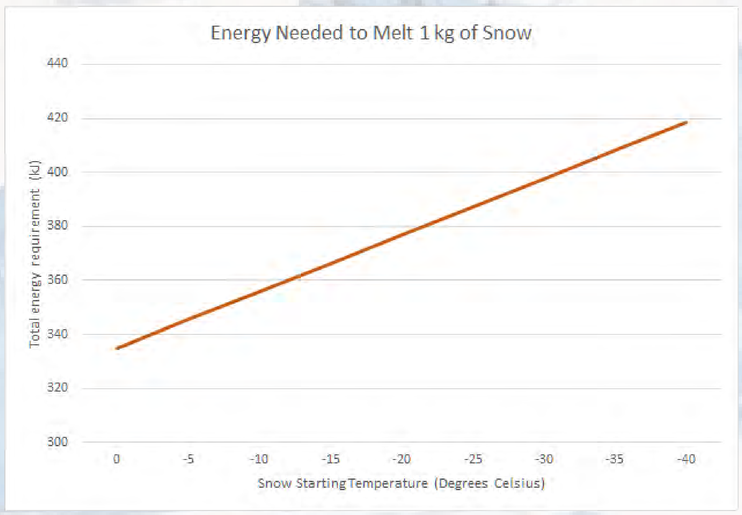
Mountain towns and ski resorts use haul trucks to remove snow to off-site locations. This is very expensive and not environmentally friendly. B & B Landscaping requested a device to melt snow on-site that uses scaled parameters of a landscaping trailer that emphasizes portability and efficiency in its design, all while being robust enough to withstand cold temperatures and frequent loads of snow.

Design Considerations:

Pump & Sprayer: The pump and sprayer system was hydraulically designed to provide a flow of 1 GPM through each nozzle for a total of 6 GPM.

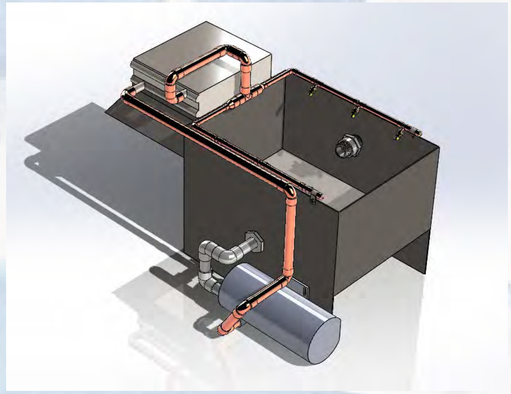
Heat Exchanger: We utilized a prefabricated tube-fin heat exchanger with sine wave fins to maximize heat transfer from the burner exhaust gasses to the water.

Burner Rating: Our testing was done in two stages; first with a burner estimated to work at 1:20th scale producing 35000 BTU/hr. Further analysis showed it was underpowered when working with low snow temperatures, so a second test was required with a larger burner. The second burner is 200000 BTU/hr, roughly 1/4th of what our anticipated full-scale energy consumption would be.



Sensible Heating: Snow has to be warmed to 0°C before it can start to melt, requiring more energy with a lower starting temperature.

Design:



Test Methods:

1. Prefill water reservoir
2. Turn on burner
3. Turn on pump to move water through heat exchanger and out spray nozzles
4. Input a measured amount of snow (weight, kgs)
5. Record time taken until snow is fully melted
6. Repeat 4 & 5 as needed
7. Empty water reservoir

35000 BTU Results:

Test	Mass of Snow (Kg)	Time to melt (min:sec)	Snow melt rate (kg/hr)	Snow melt rate (at full scale: kg/hr)
1	10	4:46	126	2520
2	10	5:53	102	2040
3	10	7:07	84	1680
Goals	10	6:40	90	1800

200000 BTU Results:

Test	Mass of Snow (Kg)	Time to melt (min:sec)	Snow melt rate (kg/hr)	Snow melt rate (at full scale: kg/hr)
1	9.2	0:59	561.4	2245.6
2	9.7	1:30	388	1552
3	11.3	1:36	423.8	1695
4	11.3	2:05	325.4	1301.6
5	9.3	1:50	304.4	1217.6
Goals	10	1:12	450	1800

Discussion:

Our 35000 BTU testing hit our target rates until we had a sprayer malfunction on the third trial reducing the flow rate. The 200000 BTU tests initially seemed to be on target, but fell off quickly. We believe that we exceeded the capacity of our heat exchanger with the new burner. A full-scale model would use a dedicated boiler and would have less heat lost to the environment. Our original 35000 BTU burner had a steady state temperature of 34 degrees Fahrenheit, as opposed to 200000 BTU burner which held steady at 64 degrees Fahrenheit while the system was loaded with snow.

Conclusion:

Our design proved to be successful. If brought to full-scale with minor adjustments, our device could compete with existing products on the market. The latent heat of fusion of water being very high necessitates a large heat input to melt snow. We believe that our design could be improved by utilizing a heat exchanger capable of transferring more heat.