Snowmaking

“Snowmaking is an art.”

Three Types of Snowmaking Systems:
- Internal Mix
- External Mix
- Air/Water/Fan

Systems Advantages and Disadvantages

<table>
<thead>
<tr>
<th>Snowmaking System</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air/water/fan</td>
<td>Low energy system: 0.4 kW/gpm</td>
<td>Highly affected by wind forces; typically requires colder temperatures; either permanently mounted or difficult to move; little adjustment of snow consistency, thus increased losses from snow blowing off trail.</td>
</tr>
<tr>
<td>External mix</td>
<td>High energy system: 1.2 kW/gpm</td>
<td>Less affected by wind; allows high wet bulb temperature; light and portable unit; covers wide trails; ability to adjust snow consistency easy.</td>
</tr>
<tr>
<td>Internal mix</td>
<td>Low energy system: 0.5 kW/gpm</td>
<td>Inefficient due to its reliance on compressed air and noise generated by air compressors.</td>
</tr>
</tbody>
</table>

Reservoirs

Snowmaking requires large amounts of water

- Natural water supplies
- Negative impact of wildlife and habitat

Reservoirs can help:
- Protect natural water resources
- Protect aquatic habitat
- Reduce energy consumption

Reservoirs

Many resorts have installations or plans in place for reservoirs.

Case Study: Snowmass
- Snowmass Creek draw reduced by 1.5 million gallons
- Reservoir cost $110,000
- Savings of $14,000/yr in electricity

Dry Bulb/Wet Bulb Temperature

Practice takes advantage of lower temperature and dry air environmental conditions.

Case Study: Aspen Ski Co.

<table>
<thead>
<tr>
<th>Mountain</th>
<th>Annual Cost Savings</th>
<th>Implementation Cost</th>
<th>Simple Payback Period (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspen</td>
<td>$34,750</td>
<td>$0,000</td>
<td>2</td>
</tr>
<tr>
<td>Buttermilk</td>
<td>$33,300</td>
<td>$0,000</td>
<td>2</td>
</tr>
<tr>
<td>Snowmass</td>
<td>$35,000</td>
<td>$0,000</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>$103,000</td>
<td>$15,000</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Snowmakers must consider a longer time frame – in terms of the life-cycle of an ice particle, decisions on scheduling without air temperatures. Hal Hartman, ASC
Additives

Definition: Substances that act as nucleators to increase the nucleation temperature at which water droplets begin to form ice particles.

...similar to the formation of clouds

Water Cooling Systems

Systems cool the water supplied for snowmaking.

Cooler water minimizes losses and increases efficiency.

In a nutshell...
...the cooler the water, the less water is left unfrozen and the more snow is produced!

System Control Automation

Automated snowmaking systems adjust to weather conditions to optimize efficiency and minimize snowmaking variability.

Automated systems can...
...monitor (i.e., flow rates, temperatures, etc.)
...control (i.e., pressure, compressors, etc.)
...manage (i.e., snowmaking process, equipment, etc.)
...report (i.e., alarms in real-time)
...trend (i.e., historical data on operations)

Water Cooling Systems

Case Study: Snowmass

- Ski area uses cooling tower for snowmaking
- Water temperatures dropped from 42 to 34°F
- Cost and energy savings negligible, but equipment allows for earlier start to season

System Control Automation

Case Study: Snowmass

- Systems primary benefit: adjust water flow acc’ed to air temp
- 4.5-6.3 million gal. of water saved/year
- Water savings translates to $8,700 – $12,200/year
Air Compressors

Air compression is critical part of snowmaking – as well as most significant energy usage component.

System improvements can achieve energy savings of 20-50% (DOE/LBNL).

Key resource:  www.oit.doe.gov/bestpractices/compressed_air/

One key step to improve air system efficiency is to replace older rotary-screw compressors with newer centrifugal units.

Case Study: Breckenridge

- Four new centrifugal air compressors were installed to replace the existing rotary-screws
- The newer units eliminate oil use
- Including snow gun upgrades, energy savings of snowmaking system improvements yielded 1,416 kW/yr; 1,214,284 kWh/yr; and $36,192/yr.

Air Leak Inspections

Leaks are especially wasteful of energy.

Recommended practices:
- Regular inspections to identify any air leaks
- Repair air leaks in pipelines
- Shut all unused valves to prevent loss of air
- Repair all aboveground leaks at the hydrants
- Repair leaks in equipment, valves and fittings
- Target and replace corroded underground pipelines

Case Study: Aspen

- System includes 6 compressors rated at about 1,400 hp and operating 1,100/yr
- Estimated 275 hp lost to leaks
- Results:
  - Energy savings of 205,200 kWh/yr
  - Total demand savings 515 kW/yr
  - Total cost savings $8,230
  - Estimated 3 year payback on $25,000 implementation costs

Water Leak Inspections

Water leak causes:
- corroded underground pipes
- faulty piping and/or installation

Impact and costs considerations:
- severity of the leak
- pumping system
- slope(s) topography
- materials for repair
- excavation
- revegetation

What’s the big deal?
- wasted water
- lost pumping energy
- snow melting
Water Leak Inspections

Case Study: Aspen

- Using a closed-loop test, a large leak found between primary and booster pumphouses

Results:

<table>
<thead>
<tr>
<th>Item</th>
<th>Annual Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated water savings</td>
<td>6,600,000 gal</td>
</tr>
<tr>
<td>Estimated water cost savings</td>
<td>$12,740</td>
</tr>
<tr>
<td>Estimated electricity cost savings</td>
<td>$0.00</td>
</tr>
<tr>
<td>Total Annual Cost Savings</td>
<td>$13,740</td>
</tr>
<tr>
<td>Implementation Cost</td>
<td>$12,000</td>
</tr>
<tr>
<td>Simple Payback Period</td>
<td>0.9 year</td>
</tr>
</tbody>
</table>

- Annual Savings: $820
- Estimated electricity cost savings: $12,740
- Estimated water cost savings: $12,000
- Estimated water savings: 6,600,000 gal
- Implementation Cost: $12,000
- Simple Payback Period: 0.9 year

NSAA Winter Conference Session 1