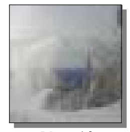
Snowmaking

Snowmaking Systems

"Snowmaking is an art."

Three Types of Snowmaking Systems:



Waterstick system

- **Internal Mix**
- **External Mix**
- **Air/Water/Fan**

Air/water/fan snow gun

Systems Advantages and Disadvantages

Snowmaking System	Advantage and Disadvantages	Capital Cost (per gun)[a]	Efficiency[b] at 20 °C Wet Bulb Temperature (kW/gpm)
Internal mix	***Advantages:*** Less affected by wind; allows high wet bulb temperature; light and portable unit; covers wide trails; ability to adjust snow consistency ***Disadvantages:*** Inefficient due to its reliance on compressed air and noise generated by air compressors	$750 to $900 (other cost considerations: compressed air, pumping, and piping systems)	High energy system: 1.2 kW/gpm Low energy system: 0.5 kW/gpm
External mix	***Advantages:*** More energy efficient than internal mix because less compressed air required (lower air to water ratio); waterstick eliminates use of compressed air; quiet and easy to operate ***Disadvantages:*** 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.	$1,200 to $3,500 (towers can range from $2,500 to $3,500 for purchase and installation)	Low energy system: 0.4 kW/gpm
Air/water/fan	***Advantages:*** Uses minimal compressed air, thus is the most energy efficient per unit volume of water (except for watersticks, which are not widely used); quiet; can adjust snow consistency ***Disadvantages:*** Difficult to adjust position (requires machinery) because equipment is often bulky and large (increased labor requirement)	$15,000 to $40,000	About 25 kW is required to operate small compressor and fan, at any temperature

Reservoirs

Snowmaking requires **large** amounts of water

Large water demand causes concerns of:

- 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.

Snow reservoir

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.

Mountain	Annual Cost Savings	Implementation Cost	Simple Payback Period (months)
Aspen	$34,700	$5,000	2
Buttermilk	$33,300	$5,000	2
Snowmass	$55,000	$5,000	1
Total	**$123,000**	**$15,000**	**1.5**

"Snowmakers must consider a longer time frame – in terms of the life-cycle of an ice particle – and base operation decisions on subfreezing ambient 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

Additives

The decision to use additives depends on the purity of the water and the presence or lack of naturally occurring nucleators.

If there is a sufficient number of naturally occurring impurities, additives can be excluded from the snowmaking process.

Water Cooling Systems

Systems cool the water supplied for snowmaking.

Cooler water minimizes losses and increases efficiency.

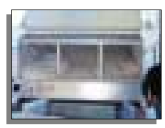
In a nutshell…

…the cooler the water, the less water is left unfrozen and the more snow is produced!

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



Water cooler

System Control Automation

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

Automated systems can…

…montior (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)

System Control Automation

Case Study: Snowmass

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

Example: Mountain operation screen for snowmaking guns

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.

Centrifugal air compressors

Air Compressors

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

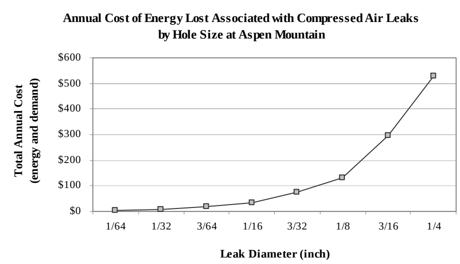
Leaks are especially wasteful of energy.

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

Air Leak Inspections

Case Study: Aspen



Air Leak Inspections

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:

Item	Annual Savings
Estimated water savings	6,600,000 gal
Estimated water cost savings	$12,740
Estimated electricity cost savings	$820
Total Annual Cost Savings	**$13,560**
Implementation Cost	$12,000
Simple Payback Period	0.9 year