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Ice Temperature Control For Artificial Ice Rinks

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The following information is intended to provide a quick overview and provide guidance for best practices when setting and controlling operational temperatures. It is essential that arena operators fully understand the variables that can impact the different temperatures existing in a typical artificial ice rink.

There are some general guidelines for setting temperature levels that have existed for many years most of which are reasonable targets to be met. However, it is important that today's ice maker understand the science and the many variable existing in each facility may render the following recommendations ineffective. Understanding these variables will allow you to better comprehend the challenges you may be facing within your building.

Geographical location – an arena in the far north will naturally have better ice due to outside conditions when compared to a rink in the south. Outside air temperature will extremely impact indoor ice conditions. In the same context, winter ice and summer ice in both locations will have the same challenges.

Age, design and maintenance of the facility – older buildings often lack the infrastructure needs and capabilities to operate effectively. Refrigeration systems and control struggle due to wear and deterioration of the refrigeration and mechanical systems. The design of the building may also challenge indoor temperatures. Poorly placed structural beams or mechanical ducts can reduce air flow and contribute to poor ice conditions. A lack of ongoing maintenance to pipes, pumps, air/fluid filters and refrigerants can cause the system to work harder and longer thus not allowing the ice to freeze quickly during the resurfacing process.

Dew Point – temperature at which air reaches 100% relative humidity (saturation) and the vapor begins to condense to a liquid.

Relative Humidity – ratio of water vapor in air to the maximum amount or water vapor that the air could hold at a given temperature and pressure.

Wet Bulb Thermometer – thermometer with a wet wick around its bulb. Cooling effect of evaporation depends on amount of moisture (relative humidity) of air, so by comparing wet bulb temperature with a dry bulb temperature, relative humidity can be determined.

Humidity – moisture, dampness in the air.

Sublimation – changing directly from solid to gas without becoming a liquid, as with Dry Ice. In ice arenas sublimation can take place when the relative humidity falls below 40% RH. This leaves a rough and granular surface on the ice rink.

Air/ice interface - when the air above the ice sheet has a dew point temperature higher than the ice surface temperature, moisture from the air will condense on the ice surface (making it frosty).

Temperatures
There are various temperatures that affect a typical artificial ice arena. Outside weather temperature, indoor air temperature, humidity levels, secondary refrigerant temperatures and the actual ice temperatures (slab base temperature, ice temperature and slab surface temperature) All of these temperature can be targeted.

Outdoor weather conditions – outdoor conditions can pose a challenge for the operator and the quality of the ice in several ways. A building that has all the best equipment can be put to the test when 500 patrons come in to the building during a rain down pour in the parking lot and their clothes are soaked.

This moisture will be released along with the energy they exert based on the excitement of the event.

Further, fresh air must be circulated throughout the building. The air being drawn into the building if left untreated through a quality dehumidification HVAC system will cause the ice maker grief. Warm and cold outside air will contribute to different ice conditions.

Indoor temperatures – These conditions will vary based on building design and use. A building that sits empty with no use can easily be controlled. Turning on the lights, allowing patrons and users in while adding resurfacing water will all contribute to rising indoor air temperature.

Humidity levels – the outdoor and indoor temperatures previously described are the root causes to problems associated with indoor humidity levels.

Secondary refrigerant temperatures – the setting and controlling of the secondary refrigerant temperatures will dictate the ice temperature. Inadequate or poorly operating refrigeration systems that do not shut off will never meet the set temperature level. This temperature is recorded in the refrigeration room as "supply and return" temperatures.

Ice temperature – readings measure the temperature of the ice – how cold is it? These readings can be taken in 3 areas; the concrete slab; the ice surface through a probe that is frozen into the ice sheet; or on top of the ice though an infra-red system. Each will vary in temperature but may well give you the same ice conditions. A temperature taken in the concrete slab or in the ice sheet could be recorded colder when compared to a surface reading. However, the ice maker must understand how the insulation factor of the concrete and ice and how it will affect the interpretation of the reading.

Low E Ceiling - this ceiling material traps heat between the fabric and the roof not allowing heat rays to radiate back onto the ice which reduces the load placed on the refrigeration system. It also can help balance internal air temperatures with the benefit of increased lighting levels.

Common operational mistakes – include a facility setting temperatures at the beginning of the season and failing to adjust them throughout the year; ice conditions change as the season progresses when different events take place which can result in fluctuating ice conditions. Many of the settings we are about to share are start targets but in fact an ice maker needs to be setting all the equipment to meet these targets at the end of the event – not the beginning as ice conditions will deteriorate throughout the event.

Simple operational attitudes such as door opening can significantly impact indoor air temperatures. Too many operators leave large entrance doors open for no reason or use inappropriate doors/access points for simple operational tasks. For example opening the large ice resurfacer doors to accept deliveries rather than general facility entrance/exit door. Most arenas require 6-8 hours of refrigeration run time to adjust a temperature by 1-3 degrees. Again, this may be impacted by any of the variables we have discussed thus far.

Well trained arena operators will have a sound knowledge on the variables that affect ice making. They understand from their training that outside temperatures, inside temperatures, different types of ice activities, number of spectators, bleacher heating, all have a role in achieving optimal artificial ice conditions. Unfortunately few are actually applying this skill in the workplace. Having a strong theoretical understanding of ice making but failing to apply the knowledge gives no return on your training investment. It is essential to put valuable training skills into practice.

Optimal Temperature Settings

The sliding coefficient between a skate blade and the ice surface are best at exactly 28°F. With warmer ice temperatures the skate blade cuts deeper, while at colder temperatures friction there is also an increase in friction due to frost formation on the ice surface.

Internal and external heat loads on the ice surface are constantly changing and can cause the ice surface temperature to fluctuate away from ideal levels. An ice technician's true skill is recognizing the synergy between the "art" of "making ice" with the ice resurfacer and the science of controlling the ice temperatures. Too many operators rely on pre-set controls and then wonder why they have poor ice conditions at some events.

A community arena should strive to achieve 50-60°F dry-bulb temperature and 40-50% relative humidity, or a dew point of 32-38°F.

Ice Surface Temperatures

- **Hockey** - 22-24°F
- **Public Skating -** 24-26°F
- **Other Ice Sports -** 24-26°F
- **Figure Skating -** 24-26°F
- **Speed Skating** - 19-21°F
- **Ice Maintenance -** 26-28°F
- **Professional curling -** look for an air/ice interface temperature of 24-26°F using demineralized water with a facility temperature of 40°F five feet above the sheet with a relative humidity of 65%.

Professional Ice Arenas - are looking for the air conditions in the facility to be maintained between 62°F-64°F with 40-44%RH and a surface temperature of 22-24F at games end.

Secondary Refrigerant Temperatures - some ice makers believe that they can control ice temperature by setting the secondary refrigerant temperatures; however this is not the best approach to maintaining optimal ice conditions.
Secondary refrigerants will vary in temperature depending on the type used. For example, a glycol system will operate at warmer temperatures than a brine system which generally runs 2 to 3 degrees colder than the glycol system

Typical Brine Secondary Refrigerant Temperatures

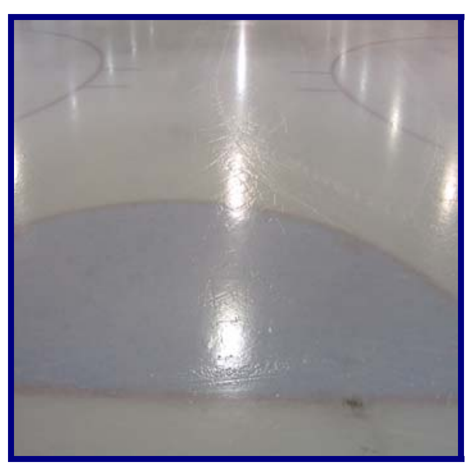
- supply temperature is 17-19°F
- return temperature is 19-21°F

Other Points to Consider
Some facility managers have discovered that how skates are sharpened can impact ice quality. Trying to determine why ice damage is occurring should include skate sharpening "hollows" as part of an ice technician's investigation. A 5/8 hollow will have less of an impact when compared to a 3/8 hollow.

The introduction of harder stainless steel blades has also contributed to an ice maker's challenges.

Conclusion
A "caution" is given to all the information you have just reviewed. Undertaking any adjustments must first have the ice technician understand exactly what they are about to adjust. Never consider new adjustments prior to or during significant facility events. Record in detail all adjustments and the result of the adjustments for future references or corrective action.

ORFA Certified Ice Technician training courses can provide you with a better understanding of this information while helping you to create and maintain an exceptional sheet of ice.



Temperature Adjusting Energy Notes
Each Degree Fahrenheit that you raise the ice temperature reduces the load on the ice plant by up to 2%. This drop is a result of the combined effects of conductive, convective and radiant heat loads on the ice surface. The higher the ice temperature, the lower the potential for heat transfer.
Energy Management Manual for Arena and Curling Rinks. SaskPower 2006

Increasing the ice temperature during times that there is to be no use (8+hours) has several benefits. Ice temperatures in some facilities are increased to as much as 28 F. This increase in temperature actually saves energy and will “temper” the ice therefore making it more durable; the resulting ice will have fewer ruts and chips and less maintenance will be required.

SOURCES:

- EnergyIce http://www.customicerinks.com/energyice
- Icekube Systems Thermal Energy Storage http://www.icekubesystems.com
- Cimco Refrigeration http://www.cimcorefrigeration.com
- Energy Management Manual for Curling and Ice Rinks (SaskPower) http://www.saskpower.com
- CETC Varennes (NRC) Factsheet on Controlling Ice Temperature (utilizing energy conservation methods) http://www.cetc-varennes.nrcan.gc.ca
- To purchase ASHRAE Refrigeration Handbook [Chapter 35: Ice Rinks] http://www.ashrae.org
- Dave Loverock – Jet Ice Ltd. http:///www.jetice.com
- ORFA Arena Technical Advisory Committee (2008) http://www.orfa.com
- Hans Wuthrich – Curling Ice Professional

T. 416-426-7062 F.416-426-7385
www.orfa.com info@orfa.com