ONTARIO RECREATION FACILITIES ASSOCIATION INC.

Understanding Artificial Ice Operating Temperatures

The ORFA is often contacted to provide guidance on “best” ice operational temperatures. There are some general temperature levels that have existed for many years with most still being considered reasonable targets to be met. However, it is important that today’s ice maker understand the science and variables that exist in each facility that can render the following recommendations not applicable? Understanding the following variables will allow you to better comprehend the challenges you may be facing in your building. The following information from ORFA’s Certified Ice Technician (CIT) professional designation training courses are shared as a quick overview to the subject and will allow the reader to better understand the variables that can impact many of the temperatures we are to discuss.

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 will lack today’s equipment capabilities and will often 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 (RH) - 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 the amount of moisture (relative humidity) of air, so by comparing wet bulb temperature with a dry bulb temperature, relative humidity may 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
We have started to expose the different temperatures found in a typical arena. Outside weather temperature, indoor air temperature, humidity levels, secondary refrigerant temperatures and the actual ice temperature (slab base temperature, ice temperature and slab surface temperature) can all be targeted.

Outdoor weather conditions – can challenge ice conditions and the ice maker 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 – 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 previously described outdoor and indoor temperatures are the root causes to indoor humidity levels.

Secondary refrigerant temperatures – the setting and controlling of the secondary refrigerant temperatures dictates the ice temperature. Some systems do not have adequate or have poorly operating refrigeration systems that just do not shut off, thus never meeting the set temperature level. This temperature is recorded in the refrigeration room as “supply and return” temperatures.

Ice temperatures – readings measure how cold the ice is. These readings can be taken in the concrete slab, in the ice 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 give you the same ice conditions. A temperature taken in the concrete slab or in the ice sheet may be recorded colder when compared to a surface reading, but the ice maker must understand the insulation factor of the concrete and ice and how it affects 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 in turn reduces the load placed on the refrigeration system. It can also help balance internal air temperatures with the added bonus of increased lighting levels.

Common operational mistakes – include a facility setting temperatures at the beginning of the season and never adjusting them throughout the year and then wondering why ice conditions change as the season progresses and different events occur. Many of the settings we are about to share are set as start targets, when 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 as the event goes on.

Simple operational attitudes such as door openings can significantly impact indoor air temperatures. Too many operators leave large entrance doors open for no reason or use the wrong size door for simple operational tasks as they believe opening the ice resurfacer doors to accept deliveries is easier then a general facility entrance/exit door.

Most arenas require 6-8 hours of refrigeration run time to change a temperature by 1-3 degrees. Again, this can be impacted by all the variables we have discussed this far.

CIT staff have received sound knowledge on variables that affect ice making. They understand from their training that outside temperatures, inside temperatures, type of ice activity, amount of spectators, spectator heating, all play a factor in maintaining optimum artificial ice conditions! However, they must be committed to applying these skills in the workplace. Having a strong theoretical understanding but failing to apply the knowledge gives no return on training investment.

So What are the Best Temperatures?
The sliding coefficient between a skate blade and the ice surface are at its best at exactly 28°F. When there are warmer ice temperatures the skate blade cuts deeper, while at colder temperatures friction is also increased due to frost formation on the surface.

The constantly changing internal external heat loads on the ice surface cause the temperature on the ice to vary from ideal levels. An ice technician’s true skill is the synergy between the "art" of "making ice" with the ice-resurfacer and the science of understanding and controlling ice temperatures! Too many rely on pre-set controls and then wonder why they have poor ice conditions at some events.

A community arena strives to be between 50-60 degrees F dry-bulb and 40-50% relative humidity, or a dew point of 32-38 degrees F.

- **Hockey** ice surface temperature (22-24F)
- **Public Skating** ice surface temperature (24-26F)
- **Other Ice Sports** ice surface temperatures (24-26F)
- **Figure Skating** ice surface temperature (24-26F)
- **Speed Skating** (short track) ice surface temperature (19-21F)
- **Ice Maintenance** ice surface temperature (26-28F)

Professional curling ice surface temperature - look for an air/ice interface temperature of 24-26 degrees F using demineralized water with a facility temperature of 40 degrees 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 – this is not the best approach to maintaining good quality ice conditions.

Ice makers must also understand that 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 supply temperature is – 17-19F

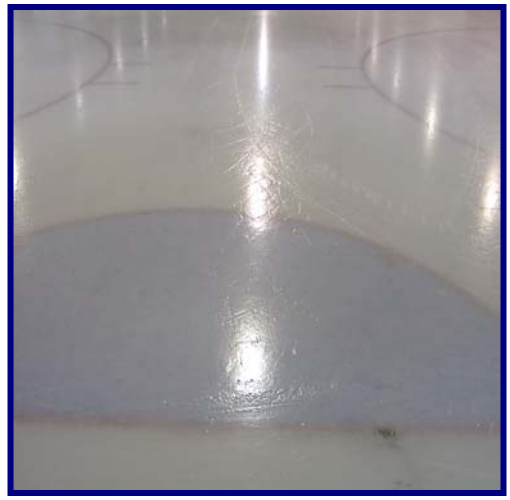
Typical brine secondary refrigerant return temperature is – 19 -21F

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 CIT training courses may assist you in better understanding this information while helping you 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 per cent. The drop is because 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.
Source: Energy 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 saves energy and also "tempers" the ice making it more durable resulting in less ruts and chips which requires less maintenance.

Additional Information and Resources to this Document

EnergyIce provides 1. http://www.customicerinks.com/energyice/press4.htm 2. http://www.customicerinks.com/energyice/press3.htm

Icekube Systems Thermal Energy Storage
http://www.icekubesystems.com/htmlfiles/thermal-energy.asp

Cimco Refrigeration
http://www.cimcorefrigeration.com/pdf/CIMCO%20Ice%20Rink%20Controllers.pdf 2. http://www.cimcorefrigeration.com/ice_articles_04.asp

Energy Management manual for Curling and Ice Rinks (SaskPower)
http://www.saskpower.com/pubs/energy_management.shtml

CETC Varennes (NRC) Factsheet on Controlling Ice Temperature (utilizing energy conservation methods)
http://cetc-varennes.nrcan.gc.ca/fichier.php/codectec/En/2003-066-6/2003-066-6f.pdf

To purchase ASHRAE Refrigeration Handbook [Chapter 35: Ice Rinks]
http://resourcecenter.ashrae.org/store/ashrae/newstore.cgi?itemid=28125&view=item&page=1&loginid=27100463&priority=none&words=ice%20rinks%2034&method=and

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