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ONTARIO RECREATION FACILITIES ASSOCIATION INC.

Understanding the Impact of Humidity in an Ice Rink

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Introduction

Like humans, a building's health is directly related to air quality. Failing to control moisture trapped in the air will dramatically reduce the life-cycle of the materials used during construction. Further, moisture will impact ice quality and patron satisfaction. An ice technician must understand how the air and moisture found in an ice rink can influence the sport played and the amount of maintenance and upkeep that will be required to maintain a healthy facility.

Understanding Ice Rink Comfort Level vs. Proper Operational Conditions

When a patron arrives at their local rink on a warm spring day, their first impression is the rink is cool (10-14C db / 50-55°F). If that ice rink has a well-controlled humidity level that same patron will be comfortable. The cool temperature is the result of the large ice surface that dominates the square footage of the arena space. While the ice plant constantly removes heat from the ice floor, the cold ice surface above it cools others surfaces around and above it (called radiant heat transfer). All the cool surfaces bring down the arena air temperature through convective heat transfer.

The comfort level in the cool arena is easily lost, when the moisture / humidity level (we call the latent heat) in the arena's air is not properly controlled. Patrons will now perceive the indoor environment to be damp. Radiant heaters can compensate for some of the discomfort from this damp air, but this high humidity still causes concerns with potential building damage as well as a reduction in operational efficiency.

One of the more accurate and reliable methods for measuring humidity is to read the dew point level in the air. The easiest check to see if moisture is going to condense on a surface is to measure the temperature of the cold surface and compare it to the arena's dew point level. If the dew point has climbed above the cold surface's temperature – moisture will condense on the surface causing problems such as drips and moisture damage. This condensation that forms from a high dew point is very much like the drips that form on a cold glass on a hot summer day.

It's not uncommon to measure temperatures of 42 °F (5 °C) on the steel beams directly above the ice surface. If the dew point has reached a level above that surface temperature, condensation will occur. When enough condensation occurs on the beams, drips start to form on the ice.

Ice plant operation and efficiency is impacted by dew point as well. When the dew point climbs too high above the freezing point, unwanted frost will form on the ice surface. This moisture that condenses on the ice from the high humidity in the air creates an additional refrigeration load on the ice plant (called a latent heat load). A dew point as high as 45 °F, can cause the equivalent of an additional 32 ton load on the ice plant (ref. 2006 ASHRAE Refrigeration Ch 35 – air at 55 °F db, ice at surface 22 °F).

So what causes these high humidity levels or too a high dew point level in an ice arena. The largest contributor is the movement or migration of outdoor humidity into the rink. Moisture comes through any opening in the rink and of course the fans that ventilate fresh air that are full of high humidity. Warm air can hold high levels of moisture and warm humid air also has a high vapor pressure. For example a spring day that is 20 °C (68 °F) and 60% RH has dew point of **10 °C** (50 °F). The indoor arena is trying to hold the conditions at a 60% RH level but at a 50 F db level, which has a low dew point of **2.6 °C** (37 °F). The high outdoor vapor pressure (or dew high dew point) will push through any opening or crack into the rink that is at the lower vapor pressure (or dew point). So in other words, we have this warm outdoor air at 60% RH that is adding moisture to the cool dry air inside the rink and when left unchecked (or not dehumidified), the moisture migrating into the rink will eventually raise the dew point inside. It is this large difference between the high outdoor and low indoor dew point that alerts the building operator to potential moisture concerns. In periods of low or no occupancy the high indoor humidity in the cool air will form fog over the ice surface.

So how can we control the dew point in an ice arena? We know that high outdoor humidity as well as the internal sources of humidity (skaters, spectators, ice resurfaces) are constantly adding humidity that will raise the humidity level or dew point, we need to counteract these sources of humidity with the correct capacity of dry air. The dry or dehumidified air must be introduced to the arena with a dew point that is lower than the design humidity level of the arena space (reference the NHL for a design level = 35 to 40°F dew point) In other words if a dew point of 3°C (38°F) is to be maintained, the dehumidifier must introduce air at a dew point of 1°C (33°F) or lower. Dehumidification systems that include desiccants can easily condition air down to a low dew point. If the facility requires large continuous levels of ventilation air, the ventilation systems should include desiccant technology as well.

History of Dehumidification in Ice Rinks

The first generation of arenas were built to provide a comfortable indoor environment from the harsh cold outdoor conditions for skaters and spectators alike. Ice was put in for a much shorter season. Most of the operating hours were the cold winter months where humidity was not a concern. In fact in the coldest days, a build-up of indoor humidity inside the building would find its way out through many of the many of the openings in the building (remembering the indoor vapor pressure would now be higher than the outdoor vapor pressure in winter).

Some of the oldest arenas in Ontario have only recently been modernized with the proper dehumidification capacity to handle a longer season of ice operation (e.g. Maple Leaf Gardens and Varsity Arena). Up until 1963, the Stanley Cup finals were finished up by the third week of April. With the NHL expansion of teams after 1967, the Cup finished up in mid-May. As the end of the NHL season moved later into the spring, humidity became a bigger factor. The third game of the 1975 cup finals held in Buffalo on May 20th, made history for the uncontrolled heavy fog in the rink. The new Buffalo rink has retrofitted leading edge dehumidification equipment to maintain ideal conditions and should never encounter fog in high humidity conditions.

As demand for ice time increased at the recreational level as well as the demand for offseason practice camps, tournaments and summer leagues, humidity issues became more apparent. An early attempt at removing the formation of fog was moving air over the ice with fans. Unfortunately this caused more problems with the ice quality. Exhausting air continuously was tried but unfortunately the air that replaced the exhausted air (or what we might call make up air), was not treated or dehumidified properly and just made a bad situation worse.

To offset the formation of condensation on the glass, refrigeration based dehumidifiers were developed to push high volumes of slightly drier over the glass to allow skaters and spectators alike the opportunity to see through the glass.

As the impact of high a humidity coming in contact with cold surfaces was studied further, the concerns moved beyond the problems with beams and boards and the unwanted drips on the ice. When left unchecked, the build-up of heavy condensation on the walls and floors could allow the formation of unwanted biological growth on those same surfaces.

Ice technicians are challenged to keep a safe and good sheet of ice when the indoor humidity level or dew point increases to a point that is well above freezing, because the rate at which frost builds up on the ice also increases. To keep the ice from being too soft, operators are forced to run the ice plant at very low temperatures, resulting in the easy build up ruts and heavy snow accumulation from skaters. Typically these periods that require colder ice are the same periods when the outdoor temperatures are elevated; which negatively impacts the ice plant's efficiency and the total hours of operation.

Some of the best ice conditions and the easiest to maintain sheets of ice are achieved when the dew points are just above the freezing level. This allows the operator to run a warmer surface temperature on the sheet of ice. Beyond ice quality, a warmer surface temperature reduces the load on the ice plant as well.

Modern Dehumidification Systems

Today arenas should be designed with a dehumidification system that will provide a reliable source of very dry air. In recreational facilities, desiccant based systems have proven to be the most cost effective source of very dry air. In larger facilities, large air handlers using low temperature chilled water have been used with mixed results but more recently the desiccant based ventilation systems have shown they can produce the preferred low dew point levels.

The goal for any arena is to have a source of ventilation that provides drier than the arena design level of humidity. In other words the net dew point from all the air handlers supplying the arena must be below the arena dew point design level. This will make for successful conditions.

Hints to Help Technicians Control Humidity

1/ Get Comfortable knowing the Dew Point Levels inside your rink.

There are number of low cost devices on the market today that provide operators an instant reading of the dew point inside their rink. Whenever the dew point remains at a constant level close to the freezing point, the ice can be set up to achieve a high quality condition.

2/ Study the impact of high outdoor humidity on the operation of your rink.

With the same dew point sensing device, measure and record the dew point levels of the air outside. Any time the outdoor humidity climbs above the ideal indoor humidity, monitor the ability of the dehumidification's capacity to hold the proper indoor conditions. Adjust your ice conditions appropriately.

3/ When the outdoor dew point level moves above the ideal indoor dew point, minimize the time intervals that doors are open.

Any door or opening into the arena space allows the higher outdoor humidity to migrate into the rink area. Remember that high humidity has a high vapor pressure (also a high dew point). Your indoor preferred level or designed level of humidity has a lower vapor pressure. All that high vapor pressure surrounding the outside of your building wants to move to the low vapor pressure indoors. The greater the difference between the two vapor pressures (or dew points), the quicker the humidity will move through an opening into the rink. Even the newest dehumidification technology installed in a recreational arena cannot keep up with the load produced by an open resurfacing door in the summer.

4/ Avoid the trap of just watching (RH) Levels.

Warm air can hold more moisture. Operators have fallen in the trap of thinking if the air coming into my building has a lower RH level than the RH level in the building, the indoor humidity will drop. Introducing outdoor air at 18°C (65°F) and 50% RH would elevate the indoor dew point above NHL conditions. Operators of even larger venue rinks have thought by heating the space up they controlled humidity. At a great energy cost they may have heated a large indoor arena to a warmer temperature and observed the Relative humidity dropping, but unfortunately not removed any moisture from the arena. For example arena air at 15.5°C (60°F) db and 60% RH that is heated to a level of 23.9°C (75°F) db will drop the RH level to 36%, but the absolute humidity or dew point remains at a constant 7.8°C (46°F). If the air is cooled back down to 15.5°C (60°F) db, the RH will move back to 60%.

The only sure way to remove moisture from the air is to provide a drier source of air (or lower dew point) to the indoor arena space

Useful Terms When Discussing Humidity

Dry Bulb Temperature – most common temperature discussed. It is measured with a standard thermometer that measures dry bulb levels.

Relative Humidity – Refers to the percentage of saturation in the air. It expresses the moisture content of air as a percent of what it can hold when it saturated (or at 100% RH). It is not a measure of the absolute humidity in the air, but it measures moisture content in the air relative to the associated dry bulb temperature at 100% RH (or saturation). If we raise the temperature of air and without changing the absolute humidity level, the RH level drops. In the same way, if we cool the temperature of the air without changing the absolute humidity level, the RH level goes up. Remember warmer air can hold more moisture.

Specific Humidity – is an absolute measurement of humidity or water vapor in the air. The units used to measure specific humidity are grains of water vapor per pound of air. It is actually the weight of water molecules measured in grains against the weight of air. There are 7000 grains in a pound.

Vapour Pressure – another measurement of humidity in the air Measurement is inches of mercury. Desiccant systems remove moisture in the vapor phase by attracting the vapor pressure found in the arena air to the low vapor pressure on the surface of their desiccant material.

Dew Point – It is the temperature point at which the moisture in the air will condense out of the air onto any surface that is cooler than the dew point level. It is most common way of determining absolute humidity levels. The dew point can be readily obtained from sources like weather data web sites.

Sensible Heat - is the measurement of dry bulb energy in the air. The flow of sensible heat is always from a warm source to a cooler space, surface or object.

Latent Heat – is the measurement of the moisture energy in the air. In reducing latent heat in the air we introduce a source of air with a lower specific humidity or lower dew point.

Conductive Heat – is the heat that is transferred through the direct contact between two surfaces. An ice surface touching a colder pipe is transferring conductive heat.

Convective Heat – is the transfer of heat from a warmer source or surface through the movement of air. A unit heater introduces warmer air into a space to bring the temperature up.

Radiant Heat – is the transfer of heat from hot or warm surface radiating heat unto colder surfaces. Radiant heaters are not designed to heat the air in the space but to heat the people standing below them.

Conclusion

The issues of air quality, humidity and building health can be a complex topic that at times requires expert evaluation to determine how best they can be controlled. Not one plan will work for every ice rink. There are a variety of companies that provide evaluation, assessment and equipment options. The first step is understanding the issues so that discussions with these professionals can occur in a manner that both parties understand each other. We hope this paper lends to this objective.

Source:

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