ARID-Ice®
TECH BITS

Ice Arena Construction and Dehumidification

So you just completed repainting your arena and cleaning up all the rusty ceiling structure, mold stains and drip-marks on the bleachers. The roofers have completed their repairs and have left the site. Your shiny new dehumidifier is out back, next to the cooling tower. It's the end of October and your ice is installed. All systems are GO for another season. Business has been good, and the owners are happy. Spring comes with the first days of new green grass and the sharp, biting tang of winter air fast becoming but a memory. The weather is milder and the welcome southerly breeze hints of the summer to come.

In April the first wave of tropical humidity wafts up from the Gulf of Mexico and you feel that twinge of anxiety; wondering if that new DH system really will work better than those noisy old mechanical dehumidifiers that were mounted in the corners since the arena was new in 1977. Each morning you glance at the boards to make sure they are still clear. All good!

Then, after the first week of real sweaty weather, it happens. There it is by the far blue-line – a mushroom on the ice. A closer look reveals a few more stealthily growing down there, just where they were last summer before you convinced the owners to shell-out all that money for repairs and improvements. A close look up at the freshly painted ceiling joists reveals a telltale rivulet running across the bottom

flange and out of the corner of your eye you spy another drop falling with military precision onto the nascent stalagmite. The plastic liner that contains the fiberglass insulation seems to have a slightly pregnant appearance, too and you try to remember if it always looked that way. You note that it rained pretty good over the weekend, and conclude that it has to be a roof leak. A terse conversation with the roofers compels their return to find the offending roof leak, but a protracted effort does not find any defects. Nevertheless, a few tubes of gooey roof-caulk are liberally applied anywhere water might be getting in.

A month passes and the roofers are compelled to return twice more with similar findings. They no longer return your calls. Frustration mounts and you become desperate to correct this embarrassing problem. The new dehumidifier appears to be running fine and the dasher boards seem to be staying clear. Even though there's no fog, you go to the humidistat and push its set-point down a bit. Your humidity meter shows about 40% relative humidity and that's about what you've been told is right for an ice arena. Still, if it's not a roof leak it must have something to do with the dehumidifier. The factory service technicians are dispatched and evaluate the performance. It checks out OK. They offer some lame conjecture about maybe you leaving the Zamboni door open, and you secretly bristle at the suggestion. Well, if it's operating properly, it must somehow be too small for your arena.

The next call is to the mechanical engineer who specified this brand and model size. You sense him stiffening over the phone at the implication that he undersized your unit, however two days later he arrives with the dehumidifier representative in tow to review the design. The dehumidifier rep has brought an expensive-looking digital temperature and humidity meter and confirms that the arena is controlling the environment to the scheduled humidity conditions. The engineer justifies his moisture load analysis with a lot of mathematical word-salad, a psychrometric chart and a lot of pointing and hand-waving. He suggests a roof leak and the dehumidifier rep nods vigorously.

Now it's July. You're looking forward to taking down the ice. You've been chipping off bumps every day and the ice-paint is a disaster. Some rust stains are again evident through the new paint on the ceiling joists above the ice and a couple of troubling black streaks have appeared on the North wall.

That red-headed kid on the high school team managed to loft a puck into the rafters (better than you hit your sand-wedge last weekend) and punctured the plastic insulation liner. About a gallon of water poured out onto the ice. The other kids thought that was great fun and spent the remainder of the afternoon trying to duplicate his achievement.

Dramas like this are too common. So, what's going on here and why is it so difficult to diagnose and correct?

Ice arenas that operate in warm and humid months have to keep out the heat and moisture so that a good environment exists to support the ice sheet and be pleasant for the skaters and spectators, but because of the large difference in both temperature and humidity between indoors and outdoors, the forces that drive heat and moisture are also large. Unfortunately, typical arena construction is often less than perfect and large heat and moisture loads exist. Building designers generally have a good understanding about heat transfer and insulation, so any modern arena will have adequate insulation to retard heat-flow, but the water vapor that leaks in can cause the stealthy problems described above.

We accept that leaks in the arena are inevitable. That's why a dehumidifier is needed. In a simple sense, the moisture that leaks in is removed by the dehumidifier. If the dehumidifier is

large enough for the prevailing leak-rate and as long as the vapor that leaks in can dissipate into the dry air in the arena, all is well. However, anything that impedes moisture from easily dissipating into the dry arena results in condensation if that moisture-laden air cools to its dewpoint. It is important that the humid air leaking into the arena have a free pathway into the dry arena. It has to dissipate before it cools to its dewpoint.

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Ceiling insulation systems in arenas commonly consists of batt fiberglass with a plastic or foil liner to contain it. These insulation systems are efficient, economical and attractive, but can set up a scenario which results in the grief incurred by our mythical hapless arena above.

The problem with this style of insulation system is threefold. The first issue is the batt insulation itself. While a good heat insulator, it is permeable to water vapor. This means that moisture vapor can migrate through it.

The second problem is that the liner below it (what you see from the ice sheet) is impermeable and prevents or severely retards vapor above it from dissipating into our dry arena.

The third problem is that a large contributor to the moisture leaking into the arena happens at the joint where the walls meet the roof. This moisture has nowhere to go but into the batt insulation above the impermeable plastic liner. It can't dissipate, but it can cool down! The ceiling structure is often swallowed by insulation and the steel that penetrates it will be cold and sweat.

In theory, eliminating any one of these three factors would stop the problem. In the real world, however, that is very difficult or impossible to do. If the insulation were impermeable, no moisture would migrate through it to condense somewhere else. If the liner were very permeable, the moisture could easily dissipate into our dry arena before it cooled to the dewpoint. If there were no moisture leaks in the building envelope, there would be no moisture to condense…and I'd be out of business because you'd no longer even need a dehumidifier!

What can you do if you have this problem in your arena?

There are several remedies to be considered; some impractical and some financially "unpleasant". Here are the possibilities:

- **Remove the existing ceiling insulation system and replace with impermeable type.** This can be rigid insulation, spray-foam or built-up. The important point is that it be impermeable. Obviously, this is an expensive and invasive proposition. Conversely, if the building structure is at risk from chronic corrosion, it would be beneficial to remediate any damage to keep the building from falling down around your ankles; new insulation and all. Additionally, removal of the insulation offers a golden opportunity to find and correct concealed moisture leaks in the building and roof.

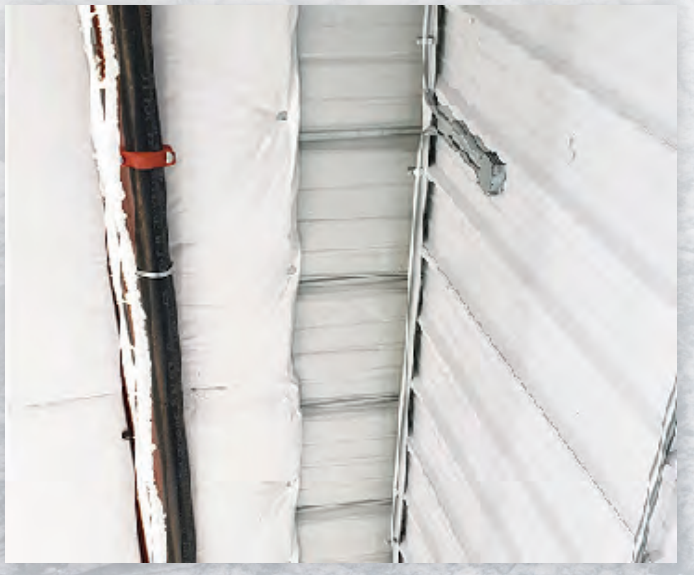
- **Install a low-emissivity ceiling below the existing ceiling in order to interrupt the heat transfer pathway from the ceiling to the ice.** In practice, this is a dubious solution because it is not likely to completely solve the problem. The intent is to keep the existing ceiling warm enough to inhibit condensation of trapped moisture within the batt insulation. Unfortunately, in summertime, the dewpoint of outdoor air can be in the low to mid-seventies degree F range, so it does not take much cooling to cause condensation. If this approach is taken, it is important that the Low-E ceiling membrane does not

extend wall to wall. This would merely recreate a problem above the new ceiling! A margin around the perimeter is necessary to allow moisture above it to easily dissipate into the dry air below it *(see photo)*.

- **Raise the temperature in the arena.** This is of limited value, but as an interim measure until a more permanent solution is effected, some heat in the arena will warm the ceiling and reduce condensation by some amount. Obviously, there is a diminishing return on this strategy. Keeping a cold ice sheet in a hot arena doesn't work very well. That said, heat is a valuable thing to have. A very cold arena needs to be kept drier than it otherwise would.

- **Perforate the existing ceiling liner to allow vapor to breathe into the arena.** This has been attempted by many desperate arenas with limited success. Even a very breathable liner represents some impediment to moisture vapor transmission, but a valiant effort to well-perforate an existing liner might be a worthy experiment before a more expensive solution is sought. The higher the breathability of the liner, the higher the tolerance to condensation within the batt insulation. There have been some "creative" and humorous solutions proffered and attempted including: BB guns, Garden-Weasel on a pole and a plywood board on a stick with nails pounded through it.

- **Prevent moisture from leaking in above the insulation liner.** While this sounds good in theory, in practice it is impossible to eliminate all moisture pathways. Even a small hole will eventually sink your boat. That said, any remedies for the ceiling should include a diligent effort to identify and reduce leaks; especially at the wall to ceiling joint. This includes interior walls! A can of spray-foam is a worthy weapon to attack any voids you discover. The difficulty is that access to these joints is commonly prevented by insulation and/or wall skins on the inside and decorative fascia and architectural soffits on the outside.



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- **Cut a 1-1/2' to 2' margin around the perimeter of the insulation to expose the wall to ceiling joint.** This exposed margin will then permit moisture that leaks in to readily breathe into the dry arena *(see photo)*. The exposed roof deck can be reinsulated with impermeable rigid insulation or spray-foam. This solution presupposes that the source of moisture vapor is at the wall to ceiling joint. If your arena is one of those that also has mechanical "things" mounted on the roof above the ice, you will need to ponder how to address those leaks.

Remember that you might not see immediate improvement, but do not despair! If your arena has had a chronic problem with condensation, the insulation will be damp for a long time. Until it dries, it will be rejecting moisture that can continue to cause visible drips. The insulation might not dry out for months; depending upon how the remediation was addressed.

Remember, too, that the same problem can occur within walls! This is especially true for arenas where the walls are close to the ice sheet. This makes them colder and more prone to condensation. Ponder this when considering your remediation plan.

As you can see, simply having an adequate dehumidification system might not fix your arena. Any investigation of dehumidification systems for existing arenas needs a candid evaluation of the building so that you can be assured of a superior result. A site visit by you friendly dehumidifier provider before you commit is time well spent.

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This information is advisory in nature. Your arena might involve several of the above scenarios and issues. Please consult a professional engineer to confirm your best course of action.