



## EXPERT SHARES INSIGHT INTO CREATING IDEAL ICE CONDITIONS

by JEFF THEILER

**H**ow would you describe the ice at your rink? Would you say it is great, or not so much? Is the ice smooth or bumpy? Slow or fast? Hard or soft? Brittle or solid? Unbeknownst to most people, creating an indoor artificial ice sheet requires more effort than just laying water down with a hose or the ice resurfacer and letting the refrigeration system freeze it. In order to make a high-quality ice sheet, the rink operators must have considerable experience and knowledge of ice-making principles.

What is good ice? In general there are four properties that we use to evaluate the overall quality of the ice sheet for figure skating:

- smoothness
- friction
- hardness
- brittleness

The ideal ice sheet for figure skating will be smooth as glass and fast so footwork can be done elegantly and effortlessly, just soft enough to plant and hold your toe pick for a jump, and solid enough to hold your edge on a landing without chipping out.

There are five factors that directly affect these ice properties, and in most cases, an experienced and knowledgeable rink operator can control them all:

- ice-making water quality
- ice-making water temperature
- ice temperature
- building air temperature
- building humidity level

### ICE-MAKING WATER QUALITY

Most everyone has heard the term *hard water*, and many of you may have a water softener in your home. Hard water causes many problems in plumbing system components and is easily identified by a white buildup found on faucets and shower heads. Hard water is defined as water that has a high concentration of mineral content; the hardness of water is often gauged by total dissolved solids (TDS). The optimal level of TDS in ice-making water is between 50 and 100 parts per million (ppm). Hard water negatively affects the properties of skating ice in a couple of ways. First, the minerals in hard water will tend to be forced to the ice surface as the water freezes from

the bottom up. This accumulation of minerals on the surface of the ice will reduce the surface smoothness and increase the friction between your skate blade and the ice surface. Second, the ice will be much softer because the water molecules will not be able to compact themselves together as tightly to form a dense sheet of ice due to the high concentration of minerals. Finally, the high concentration of minerals in hard water will require the ice temperature to be kept lower than necessary to freeze the water quickly. This low temperature will lead to brittle ice.

### ICE-MAKING WATER TEMPERATURE

One would think that cold water would be better than hot water for making skating ice, but this is not the case. Ideally, ice-making water should be between 140 and 160 degrees Fahrenheit when it is spread out on the refrigerated ice rink floor or ice surface. Water that is in this temperature range when it is used to make ice is beneficial because it carries minimal oxygen molecules. As with hard water, a high concentration of oxygen molecules will prevent the water molecules from compacting together during the

## SCIENCE PROJECT TACKLES QUALITY ICE EQUATION

by SARA KURKO

Why is ice quality different from rink to rink? What can ice technicians do to create quality ice? I looked at these questions for my 8th grade science fair project.

After talking with a number of ice technicians and researching the subject, I learned technicians recommend using water that is low in mineral content and heated prior to resurfacing the ice.

For my project, I tested the impact of both water mineral composition and water temperature on ice quality. I hypothesized that ice made with distilled water heated to 140°F (60°C) prior to freezing would make the best quality ice, because distilled water has no minerals and heating the water removes dissolved gases.

I created three identical miniature ice rinks using glass pans: one using distilled water; the second using city water with small mineral content from Rink A; and the last using well water with large mineral content from Rink B.

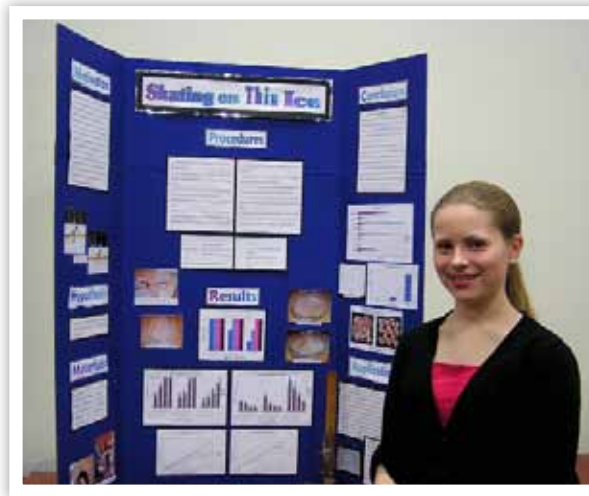
I froze equal amounts of water in shallow layers in each setup to create the rinks, replicating the layering process used when making ice

at an actual rink. I froze the ice until it reached a temperature of 24°F, the recommended ice temperature for figure skating.

I made ice using each water type at room temperature (68°F/20°C), then made ice with each water type heated to 120°F (49°C), 140°F (60°C) and 160°F (71°C). I tested each water type and temperature combination five times and collected data on three criteria: 1) ice texture (smooth/bumpy/sticky), 2) amount of shatter

when a figure skate was dropped toe pick-down from a constant height into the ice and 3) depth of toe-pick penetration with the skate drop.

My hypothesis was proven correct: Distilled water heated to 140°F (60°C) consistently produced ice of a quality ideal for figure skating. The ice was smooth and not sticky, had good toe-pick penetration with little shattering. This demonstrates the advantage of water purification or reverse osmosis technology to remove minerals. Minerals and dissolved gases are pushed into pockets within the ice when ice crystals form, resulting in a sticky or bumpy surface and shattering with toe-pick impact. Water with low mineral content also produced good quality ice when heated to 140°F (60°C), offering a more practical and economical option for ice rink managers. Ice made with water with a high mineral content did improve some in quality when dissolved gases were removed by heating, but the ice quality was still poor.



Sara Kurko, a skater who's working on her pre-juvenile tests as a member of the Colorado College SC, received the COOL Science Award for the junior division at her regional science fair, and third place in the eighth grade physical science division.

freezing process, and will require a lower refrigeration system temperature to freeze the water quickly. Using cold water to make ice will result in ice that feels soft and is brittle, with deep grooves and an abundance of snow buildup on the surface after a short period of skating.

### ICE TEMPERATURE

We all learned in science class that the temperature required to change water from a liquid to a solid is 32 degrees Fahrenheit. However, this is not the temperature we need to maintain the ice surface in an ice rink. The ice sheet surface is constantly subjected to heat from the air in the building, humidity, lights, people, ice-making water and radiant heat from outside through the walls and roof. This heat load would lead to surface melting if the ice sheet was kept at 32 degrees. Therefore the ice surface temperature is best kept between 24 and 26 degrees for figure skating. Unfortunately there are rink operators who believe that the colder the ice the better, and they keep their ice surface temperature below 20 degrees. This low temperature normally leads to hard but brittle ice. The brittle ice will develop deep grooves that adversely affect the smoothness

of the surface, and when you plant your toe pick for a jump, a large chunk of ice will break out.

### BUILDING AIR TEMPERATURE AND BUILDING HUMIDITY

As I mentioned in the previous paragraph, the higher the heat load on the ice surface, the lower the ice surface temperature will need to be kept to avoid melting. The building air temperature and even more so the humidity levels are large contributors to this heat load. We have all been in ice rinks that are so cold and damp that you can hardly stand it, because many people believe that the colder the air temperature in the rink the better the ice will be. This is just not true. Good ice can be made in a rink where the air temperature is 60 degrees Fahrenheit and the relative humidity is 40 percent. Unfortunately there are also many rinks that don't have dehumidification equipment or have inadequate equipment; therefore their ice quality suffers. If you have ever skated on an ice sheet early in the morning, and it was slow due to frost built up on the surface, you have experienced one of the ways humidity can affect the ice.

Hopefully none of these ice conditions ex-

ists at your home ice rink, but if they do, rest assured that they can be corrected. Serving The American Rinks (STAR) a program of U.S. Figure Skating has been dedicated to improving all aspects of the ice rink industry since 2000 and provides training programs around the country every year for rink operators.

*Jeff Theiler is the chief operating officer for Serving The American Rinks (STAR) and has more than 20 years of experience operating ice rinks in New Jersey, Pennsylvania and Washington.*

