Ice Thermal Storage: A Tool for New Construction and Retrofits

by Steve Benz
Baltimore Aircoil Company

Cooling systems in many buildings have become inadequate over the years due to increased people and electrical loads.

Ice Storage System Retrofit Solves Power and Cooling Deficiencies

The installation of an ice thermal storage system at this school in Hawaii solved inadequate power and cooling capacity problems while reducing daytime power demands. Ice is generated at night and melted during daytime hours to provide chilled water for air conditioning, thereby shifting the bulk of power demand to off-peak night rates.

Locating the ice storage tank under the outdoor basketball court solved space problems. A classroom building was structurally enhanced to temporarily accommodate a new chiller plant on the roof. The TES system was installed for less cost than a conventional system, constructed under budget, and finished within the two-month summer vacation schedule. The system also qualified for a state tax credit and has seen energy costs reduced by 50%.

Much attention has been given to the application of ice thermal storage because of the significant benefits it offers to building owners. Benefits include reduced capital and operating costs, improved building/tenant comfort, and increased building asset value. For design build contractors, ice storage systems provide another, often overlooked option to solve customer problems on both new construction and retrofit projects.

In spite of its many advantages, ice thermal storage is not considered by a majority of system designers. Reasons for this generally boil down to fear, ignorance, or habit. A relatively small number of firms have overcome these issues. Doing so, they have enhanced their business reputation as being innovative and multi-dimensional. The same opportunity exists for you to grow your business and make more money.

A key to successful implementation of ice thermal storage is to take full advantage of the inherently lower fluid temperatures available from stored ice, a 32°F heat sink. Depending upon storage equipment configuration and design, temperatures of 34°F to 38°F are possible. Colder water allows system components to be optimized for reduced capital and operating costs. It is also critical to humidity control and improved building air quality yielding greater tenant comfort.

Tool for New Construction Projects

For new construction, chiller and condenser/cooling tower sizes are reduced with the addition of ice thermal storage. But more importantly, colder chilled water supply temperatures allow a reduction in chilled water flow resulting in smaller pumps and piping. Combined, these capital cost savings often offset the first cost of the storage equipment.

Designing a system with a chilled water rise of 14°F (38°/52°) instead of 10°F (42°/52°) results in a flow nearly 30% lower. For a 200-ton system, chilled water flow is reduced from 480 GPM to 340 GPM, and chilled water

distribution pipe size is reduced from 6" to 4". With proper chilled water coil design, flow reductions of 50% are possible and practical.

Further savings are possible by using colder supply water temperatures to drive supply air temperatures lower. Similar to the downsizing of chilled water system components derived from colder water, colder supply air temperatures of 48°F to 53°F can markedly reduce air handling unit and distribution duct sizes. A 40% size reduction is certainly achievable.

Tool for Retrofit Projects

Cooling systems in many buildings have become inadequate over the years due to increased people and electrical loads. Personal computers on every desk have become a major contributor to the problem and in many cases push building electrical capacity to its limit. Adding new cooling units can be quite costly if electrical upgrades are required.

With inherently smaller system components, ice thermal storage systems can solve electrical concerns. Substantially more cooling can be added without increasing building transformers, electrical switchgear, or motor control centers.

The colder water available provides similar benefits to the chilled water and air distribution systems. Lowering the existing chilled water temperature by 2°F (44°F to 42°F or 42°F to 40°F) boosts the cooling capacity of the pumping and piping system by 20% if the original design called for a 10° delta T. Similarly, the air handling unit leaving air temperature can be reduced by 2°F (55°F to 53°F) for an increase in the air cooling capacity and lower humidity levels. In the process, existing system problems, such as poor air circulation and high humidity problems, may be solved.

As buildings age, owners are forced to consider replacement of air conditioning system components. Water chiller replacements may be contemplated due to age and maintenance liability or CFC refrigerant phase-out. Owners are generally aware of the liability and budget funds accordingly.

While capital funds may be in place for replacement equipment, they often receive low priority due to poor rates of return. As Murphy's Law dictates, an untimely equipment failure frequently speeds the decision. Unfortunately, when decisions are made under duress, planned, long-term objectives are generally ignored in favor of short-term needs. An opportunity exists for you to offer ice thermal storage as energy management tool, in much the same way that DDC controls, variable speed drives, etc. are considered and, at the same time, address equipment replacement issues.

Water chiller replacements should be considered when poor operating (electrical) efficiency is experienced. Many existing water-cooled chillers operate at 0.8 kW/ton or higher and air-cooled chillers operate at 1.35 kW/ton or higher. Ice storage systems operate at 0.45 kW/ton or lower during hours of peak demand.

System reliability and redundancy is improved when ice thermal storage is added to a building that incorporates the older, less efficient chiller(s) into the system. The older chiller(s) can act as stand-by for most of the year and be used only on peak cooling days, thus reducing operating hours and extending equipment life. This approach may also defer capital costs by allowing replacement equipment to be installed in phases.

Packaged Air Unit Replacement

An understandably overlooked ice thermal storage replacement opportunity is with packaged, rooftop units. There is tremendous potential here due to very inefficient equipment, generally poor performance, and high maintenance costs. Think "outside the box" and consider conversion of a DX system to chilled water system. Replace the coil, reuse the remaining air handling components and controls, and add a new water (glycol) chiller. Leaving the rooftop unit in place and adding ice storage system can reduce overall replacement costs. Energy cost savings can be enormous and overall maintenance and serviceability improve.

Ice thermal storage should not be treated as a shopping list item like lighting retrofit, high efficiency chillers, DDC control upgrade, variable frequency drives, high efficiency motors, or power factor correction devices, but rather as an owner benefit unmatched by any other energy reduction offering. You should consider making ice thermal storage a part of your offering of services to differentiate you from your competitors and a tool to grow your business! ■

You should consider making ice thermal storage a part of your offering of services to differentiate you from your competitors and a tool to grow your business!

Steve Benz is Manager of Global Thermal Storage for Baltimore Aircoil Company in Jessup, Md. He can be reached at sbenz@BaltimoreAircoil.com.