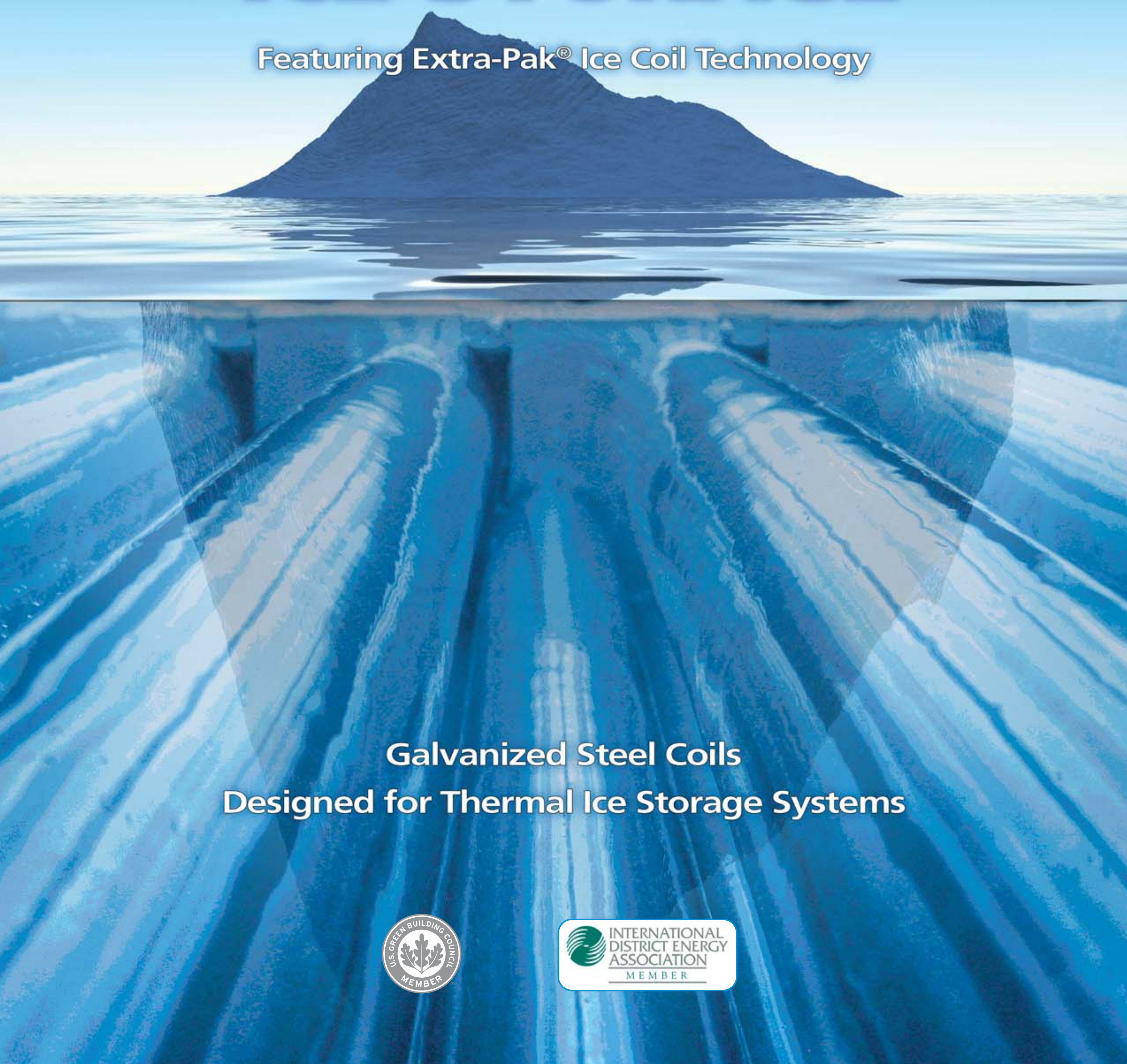
THERMAL ICE STORAGE

Featuring Extra-Pak® Ice Coil Technology



Galvanized Steel Coils
Designed for Thermal Ice Storage Systems

U.S. GREEN BUILDING COUNCIL MEMBER

INTERNATIONAL DISTRICT ENERGY ASSOCIATION MEMBER

Thermal Ice Storage…meets all of your energy demands while preserving the environment

THERMAL ICE STORAGE

Major Benefits of Thermal Ice Storage:

1. Improved System Energy Efficiency
2. Lower First Cost Chilled Water System
3. Reduced Energy Costs
4. Ideal for Demand Response Programs and a Smarter Grid
5. Lower Greenhouse Gas Emissions
6. Complements Renewable Power Generation
7. LEED® Point Opportunities and Green Code Compliance
8. Smaller Thermal Storage Footprint

EVAPCO has successfully developed, manufactured and installed Thermal Ice Storage systems around the globe. Thermal Ice Storage reduces the risks of unrestrainable energy costs, uncertain conventional energy supplies and unreliable renewable power sources. Thermal Ice Storage provides a proven, fiscally responsible energy storage solution.

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THERMAL ICE STORAGE *Environmentally Friendly Technology*

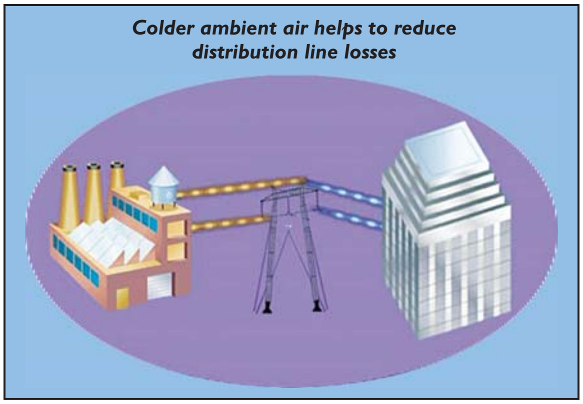
Thermal ice storage provides many environment-friendly opportunities that are a result of reduced peak electrical demand. This is just the tip of the iceberg, below the surface the opportunities are much larger…

1 Improved System Energy Efficiency

Ice Storage Eliminates the Need for New Power Plants

Thermal ice storage increases the energy efficiency of a building and the electricity generated to operate it. The efficiency increase is achieved by shifting the power consumption of the chilled water system to off-peak night time hours to build ice which is then melted during the day. Ice making chillers will operate at full or peak load during this time period to generate ice, a more efficient mode of operation compared to partially loaded chillers used in conventional chilled water systems. Power generation at night is the most efficient operating condition for power plants; base loaded power plants that operate 24/7 are more efficient than simple cycle, fossil-fuel peaker plants that may be brought on during the day to meet peak load demand.

By operating at night, with colder ambient air, power plants operate more efficiently and transmit electricity through power lines that are cooler and better able to transmit the power generated. Line distribution losses at night are generally 4% to 5% lower than during the daytime. Lastly, thermal ice storage systems designed with a low temperature chilled water supply (34-36°F) will reduce the overall energy consumed by the air conditioning system because smaller, lower kW pumps, air handlers and chillers will be incorporated into the system design.



Allows the utility to supply more electricity without building new power plants

2 Lower First Cost Chilled Water System

Ice Storage Reduces the Cost of System Components

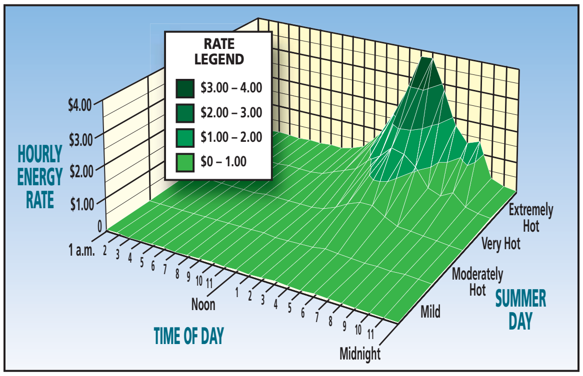
There are many first cost savings realized with a thermal ice storage system using low temperature supply water. For example, a partial storage system will typically require a chiller that is 10-40% smaller in size than a conventional chilled water system. Smaller chillers equate to lower installed costs in addition to an environment friendly reduced refrigerant charge. Additionally, ice storage systems using a low chilled water supply will be designed with smaller pumps, piping, air handling cooling coils, ductwork and electrical switchgear. Smaller ductwork and air handling systems can reduce the cost of the building envelope by reducing ceiling height. The overall result of a properly sized low temperature ice storage system is a low installed first cost.

Low temperature chilled water and air supply results in smaller system components

3 Reduced Energy Costs

Ice Storage Shifts Power Demand to Low Cost Periods

An extremely important benefit of thermal ice storage is its potential for significantly reducing energy costs by shifting power demand to night time or off peak periods. To reduce peak power use and shift demand to off-peak times, utilities often impose time-of-use rates and ratchet-based demand charges of $15/kW or more. With off peak electricity rates 50% to 80% lower in most cases, the cost savings can provide short payback periods for ice storage installations. Building owners can benefit from reducing peak demand and provide cooling for the building with a fiscally responsible thermal ice storage system design.



Lowers energy costs by shifting power usage from day time to less expensive night time hours

* Southern California Edison, Schedule TOU-8-RTP General Service-Large, Real Time Pricing

4 Ideal for Demand Response Programs and a Smarter Grid

Ice Storage Diminishes the Demand on Utilities

Demand response programs incentivize consumers to curtail their electricity use during peak demand periods in order to receive substantial rebates. Since most of the electricity used during peak demand periods is for air conditioning, thermal ice storage is the ideal strategy for commercial buildings to comply with demand response and still provide chilled water for cooling the office space. Demand response is a sustainable technology that reduces carbon emissions and improves the reliability of the grid by balancing electricity supply and demand. A smart grid combines many technologies including smart meters, real time pricing, energy control, electric vehicle integration and energy storage. Thermal ice storage is the most economical storage medium that helps to balance electricity demand, provide comfort cooling and contribute to a smarter grid.

Increases owners flexibility to adapt to changing utility structures and requirements

5 Lower Greenhouse Gas Emissions

Ice Storage Reduces Air Emissions as a Direct Result of Lower Source Fuel Use

It is well known that shifting power demand to off-peak periods reduces greenhouse gas emissions. Regardless of the method used, from on-site power generation with renewables, reducing lighting during peak demand to using thermal energy storage, studies have quantified air emission reductions that occur as a result of shifting electrical demand to off peak. The California Energy Commission (CEC) completed a study (P500-95-005) that evaluated the two largest electricity suppliers in California: Pacific Gas & Electric (PG&E) and Southern California Edison (SCE). Thermal Energy Storage systems in the regions served by PG&E and SCE shifted 40-80% of the annual kWh's of electricity used for air conditioning from Day to Night. The result was an 8 to 43% reduction in source fuel use. Since the fuel source was reduced, it has the added benefit of reducing greenhouses gas emissions[1].

Reduces source energy with fewer green house gas emissions

6 Complements Renewable Power Generation

Ice Storage Provides Large Scale Energy Storage to Help Balance the Supply of Renewable Power

One of the challenges that face regional transmission organizations today is the integration of intermittent renewable energy sources into the electric grid. Solar and wind generated electricity are not always supplied at peak demand periods. It is common for electricity suppliers to shed renewables so that they do not strain an overloaded grid. A strategy to balance supply and demand from renewables is large scale energy storage. The most cost effective storage method is thermal ice storage. Solar or wind supplied electricity can be used to run chillers to bank ice during off-peak periods, then this ice can be melted during peak demand. There are other storage devices that could be implemented including batteries, fly wheels or capacitors, but this expensive cutting edge technology has not been widely executed. Thermal ice storage, principally a thermal battery, is proven, used in thousands of installations worldwide for decades and its capital costs are less than other high technology storage options.

Provides a load leveling, energy storage option for a renewable energy strategy

1 California Energy Commission report *"Source Energy and Environmental Impacts of Thermal Energy Storage"* P500-95-005 February 1996.

7 LEED® Point Opportunities and Green Code Compliance

Ice storage provides energy cost savings, reduced water use, lower sound levels and meets peak demand reduction requirements

Energy and Atmosphere-Optimize Energy Performance and Demand Response

The energy cost savings provided by thermal ice storage contributes to points in Energy and Atmosphere under the Optimize Energy Performance credit. Thermal ice storage reduces the economic impact associated with using power during peak energy periods. Points are awarded by the percentage reduction in energy costs of the proposed thermal ice storage chilled water system versus a baseline conventional chilled water system. For the Demand Response credit, thermal ice storage can provide full cooling requirements during a DR event while realizing a reduction in HVAC system power to achieve compliance.

Water Efficiency-Process Water Use Reduction

EVAPCO thermal ice storage systems used in conjunction with air cooled chillers will reduce water and energy used for air conditioning buildings. Thermal ice storage with air cooled chillers will provide the end-user not only with significant water savings, but with incremental energy savings when compared to conventional water cooled system designs. Energy is saved by operating the chiller at night to build ice when dry bulb temperatures are typically 20°F to 30°F lower than during the day.

Indoor Environmental Quality-Acoustic Performance

All building types are now eligible for the Acoustic Performance credit. Thermal ice storage can help to reduce sound levels in classrooms, auditoriums, hotels, hospitals, office buildings and data centers. A full storage ice system, sized for the entire system load including on-peak cooling capacity, would allow a school to be extraordinarily quiet during the class day or special off hour event by melting the stored ice for its chilled water supply without the operation of high noise level water- or air-cooled chillers.

ASHRAE Standard 189.1 and the International Green Construction Code

Thermal ice storage contributes to meeting the demand reduction requirements of ASHRAE Standard 189.1 and the International Green Construction Code.

ASHRAE Standard 189.1-Energy Efficiency Section 7.4.5.1

Building projects shall contain automatic systems, such as demand limiting or load shifting, that are capable of reducing electric peak demand of the building by not less than 10% of the projected peak demand.

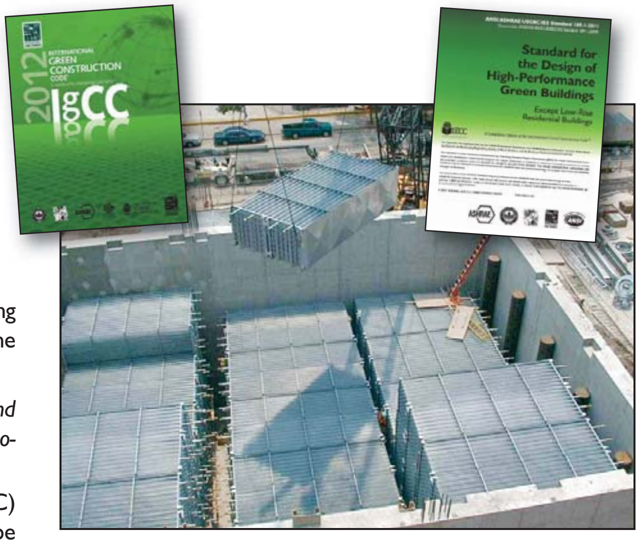
International Green Construction Code-Energy Conservation, Efficiency and CO2e Emission Reduction Section 604 Automated Demand-Response (Auto-DR) Infrastructure

In Section 604.3 Heating, ventilating and air-conditioning (HVAC) systems, it states: "The Auto-DR strategy for HVAC systems shall be capable of reducing the building peak cooling or heating HVAC demand by not less than 10 percent when signaled…."

Provides energy cost savings

Provides significant water savings with air cooled chillers

Allows quiet air conditioning operation



Thermal ice storage meets the demand reduction requirements of the IgCC and ASHRAE Std. 189.1

8 Smaller Thermal Storage Footprint

Ice storage tanks are 4-8 times smaller than chilled water storage of the same thermal capacity

Thermal ice storage provides maximum cooling capacity in the smallest foot print when compared to alternate thermal storage system designs. The cooling capacity provided by thermal ice storage provides a significant space advantage versus chilled water storage.

The latent heat capacity of ice is 144 BTU per pound; by comparison water has a sensible heat capacity of 1 BTU per pound per °F. Thermal ice storage has a space requirement of 2.5-3 ft^3 per ton-hour, whereas chilled water storage requires 12-22 ft^3 per ton-hour – 4 to 8 times more space compared to ice. Thermal ice storage is ideal for urban installations and retrofit projects where real estate or building space is at a premium.

Reduces thermal storage footprint 60%-80% less than stratified chilled water storage

EXPERIENCE, INNOVATION, GUARANTEED PERFORMANCE

EVAPCO engineers are credited as inventors on more than 45 U.S. Patents and their foreign counterparts. This engineering expertise speaks for itself and provides an exceptional foundation for various product development projects. This foundation is the catalyst for providing customer driven features and benefits in an environmentally safe manner.

The state of the art Research & Development Center, located at EVAPCO's World Headquarters in Taneytown, Maryland USA, has over 60,000 square feet dedicated to thermal analysis and product development. Experienced R&D engineers perform product and application research year round in six environmental test chambers.

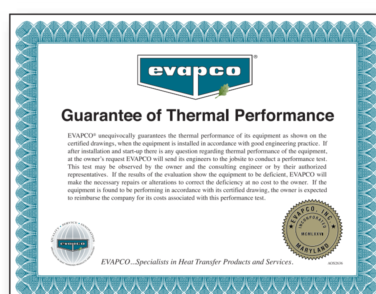
Thermal ice storage test unit with glycol chiller utilized for developing charge and discharge performance ratings

The Research & Development Center features customized laboratories that are designed to conduct tests through a wide range of environmental conditions. The computerized data acquisition system records the data and graphically displays continuous results, thereby providing the R&D engineers with valuable test information on a continuous basis.

The Research & Development Center also has the industry's largest Low Temperature Environmental Test Chamber. This test chamber was converted from ammonia to CO_2 refrigerant in order to perform detailed thermal analysis on steel evaporators.

In addition, the R&D Center houses EVAPCO's Water Analytical Services group which performs advanced chemical and water analysis in support of *Pulse*~Pure® and Smart Shield™ Water Treatment Systems, an ice thermal storage system with glycol chiller for developing charge and discharge performance ratings, and an AMCA Fan Test Chamber for evaporator fan performance verification. Product sound ratings are measured on a dedicated Sound Test Pad located on the property.

EVAPCO products are the result of extensive research and thermal testing. As a result, EVAPCO products deliver guaranteed performance in order to maximize system performance.



evapco®

Guarantee of Thermal Performance

EVAPCO® unequivocally guarantees the thermal performance of its equipment as shown on the certified drawings, when the equipment is installed in accordance with good engineering practice. If after installation and start-up there is any question regarding thermal performance of the equipment, at the owner's request EVAPCO will send its engineers to the jobsite to conduct a performance test. This test may be observed by the owner and the consulting engineer or by their authorized representatives. If the results of the evaluation show the equipment to be deficient, EVAPCO will make the necessary repairs or alterations to correct the deficiency at no cost to the owner. If the equipment is found to be performing in accordance with its certified drawing, the owner is expected to reimburse the company for its costs associated with this performance test.

QUALITY • SERVICE • INNOVATION evapco SPECIALISTS IN HEAT TRANSFER PRODUCTS AND SERVICES

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AOS2636

THERMAL ICE STORAGE *Environmentally Friendly Technology*

General Description

Thermal storage systems have been in existence for many years. Although many early applications involved systems installed in dairies, churches, and theaters, most current applications are used for continuous comfort cooling. The purpose of a thermal storage system is to create thermal energy and store it for use at another time.

There are several types of thermal storage systems in use today. These systems can be either the full or partial storage type. In the typical full thermal storage system, the refrigeration system (chillers) generates ice at night when electrical utility rates are typically lowest (off-peak). During the day, when utility rates are higher (on-peak), the ice is then melted to provide cooling to the building. In the partial thermal storage system, a reduced size chiller or refrigeration system operates in conjunction with the ice storage to meet the peak loads. There are several types of partial storage systems whose application is dependent on building loads, system equipment and energy costs. However, many partial storage systems are used to "shave off" peak energy demands to reduce operating costs.

The product technology that EVAPCO provides for the thermal storage industry is referred to as "ice on coils". In this type of system, cylinders of ice are built onto the tubes of hot dipped galvanized steel coils. In most systems that use this technology, multiple banks of coils are submerged under water in field constructed concrete tanks.

Sequence of Operation

Thermal storage systems use either glycol chillers or direct refrigeration systems to provide the cooling necessary to generate the ice on the tubes of the coils. However, the most common system used for comfort cooling applications utilize glycol chillers, as is shown in the schematic below. The air conditioning system that incorporates thermal storage has major components consisting of chillers, cooling towers, heat exchangers, pumps, thermal storage coils, and the building air handling equipment. The **FULL** thermal storage system has two modes of operation; ice build and melt-out that are described below.

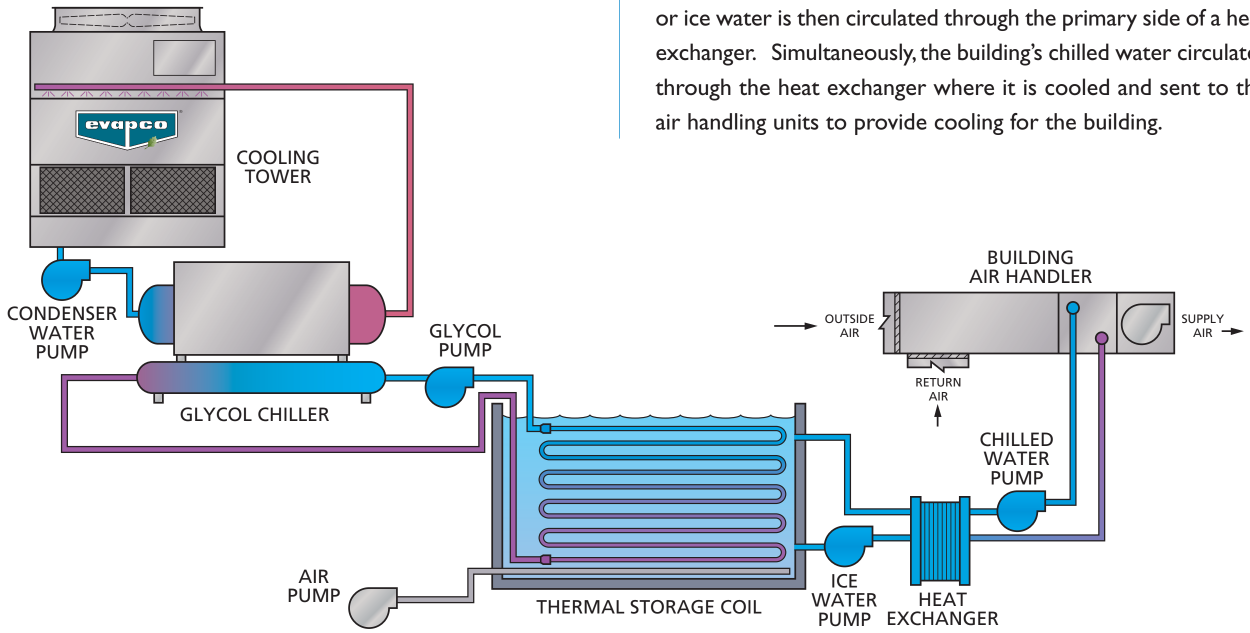
Full Build Operation

Ice Build

During the off-peak period, the glycol chiller is operational. The glycol chilling system is generating low temperature glycol that circulates through the tubes of the thermal storage coils. The circulating glycol removes heat from the water in the tanks which causes this water to freeze onto the exterior surface of the thermal storage coils.

Melt-out

During the melt-out phase, the refrigeration system is off. Depending on the melt-out type, either glycol is circulated through the tubes of the coils or the tank water is circulated over the coils to extract the energy from the ice. This cold glycol or ice water is then circulated through the primary side of a heat exchanger. Simultaneously, the building's chilled water circulates through the heat exchanger where it is cooled and sent to the air handling units to provide cooling for the building.



Thermal Storage System Schematic

Design Features

Coil Construction

EVAPCO manufactures its Ice Coils from high quality steel. The industrial quality coils consist of heavy wall elliptical tube circuits. Each circuit is inspected to assure the quality of the material and then tested before final assembly. After final assembly, the coil is tested at 400 psig air pressure under water to assure it is leak free. Finally, the entire coil assembly is hot-dipped galvanized to protect it from corrosion.

Each EVAPCO Ice Coil is provided with schedule 40 PVC air agitation pipes that are installed under the coil assembly. The perforated PVC tubing is designed to properly distribute air below the coil as part of the air agitation system. Note that on large installations where multiple coils are stacked vertically, only the bottom coils are furnished with air agitation piping.

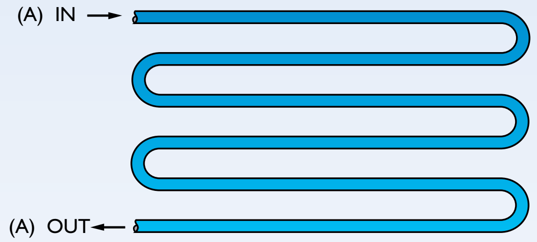
Coil Circuiting

How the ice coil is circuited is an issue that must be considered when designing for thermal storage systems. Various refrigerants are used as the cooling medium, however, for most air conditioning applications, an aqueous solution of ethylene glycol is used. For air conditioning applications where the suction temperatures are not extremely low, 25 to 30 percent glycol solutions are normally used.

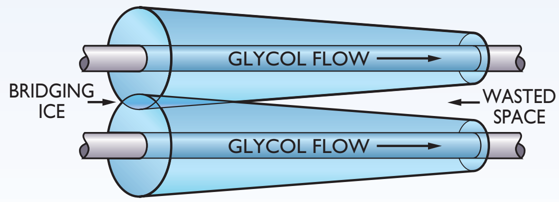
When using a glycol solution, the temperature of the glycol increases as it flows through the ice coil during the build cycle. Thicker ice forms near the inlets of the coil and thinner ice forms near the outlets. Therefore, the resulting cylinders of ice tend to be tapered. Since the tube spacing is dependent upon the design ice build thickness, the useful volume for the ice to build is affected as well. If the coil is set up for parallel circuiting, the tapering ice can lead to wasted volume in the thermal storage tank (See top illustration shown). At typical temperatures, the tapering of ice for parallel circuits can penalize the total storage of a coil by approximately twenty percent.

The solution to the above-mentioned problem is to modify the method of coil circuiting. EVAPCO Ice Coils are circuited for counter-current flow which alleviates this problem. The tapered ice cylinders nest with each other and make efficient use of the coil/tank volume (See bottom illustration shown at right). The end result is that the same amount of ice can be built with the counter-current glycol configuration as can be built with an idealized constant temperature directly evaporating refrigerant, where the cylindrical sections of ice would have no tapering.

Inefficient Coil Circuiting

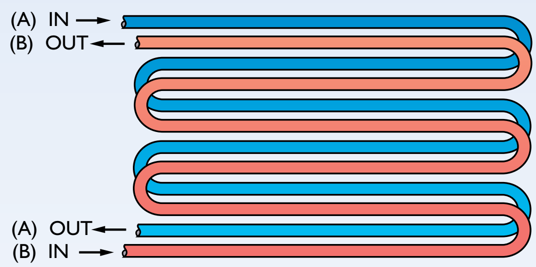


Parallel Flow Circuiting

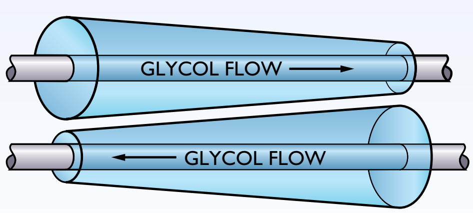


Tapered Ice - Parallel Flow Circuits

EVAPCO Coil Circuiting



Counter-Current Flow Circuiting



Tapered Ice
Counter-Current Flow Circuits

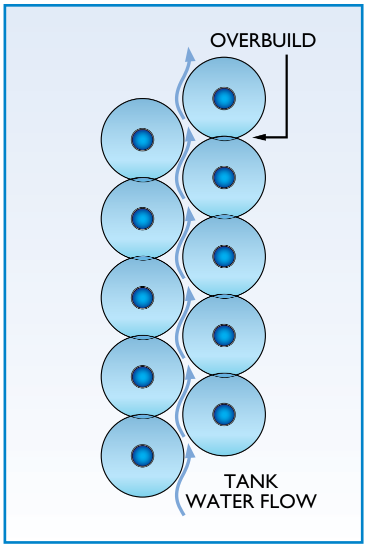
The EVAPCO Extra-Pak® Advantage (Patented Design)*

Coil Design

Ice on coil technology has been around for many years in various applications such as dairies and theaters. In recent years, however, the application of thermal storage technology has shifted from the industrial to the commercial air conditioning sector. During this time, very little has changed in the design of thermal storage coils. There are only a few manufacturers that offer ice on coil technology; of which, several designs are currently in use for most applications. For the smaller applications, there are systems that use plastic coiled tubing installed in pre-fabricated tanks. For the majority of larger applications, multiple steel coils are commonly placed in field erected concrete tanks. It is the latter technology on which EVAPCO focused its efforts. Therefore, EVAPCO set forth on an intensive research and development program to create the first major technological advancement this product has seen in many years.

EVAPCO, an innovator in coil technology, with patents** for its Sensi-COIL™ and Thermal-Pak® Finned Coil designs, used this expertise to develop an ice coil that features the Extra-Pak® technology. Before creating a new design, EVAPCO examined the existing ice on steel coil technology which uses 1.05" diameter round tubes.

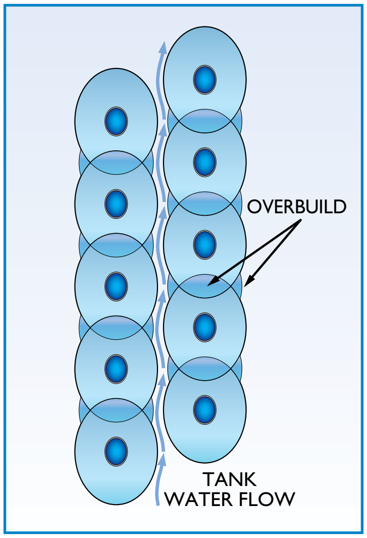
The current thermal storage coil technology is shown in the figure below. In general, the configuration of the coil is such that round tubes are evenly spaced in both the horizontal and vertical dimensions. In the round tube design, round cylinders of ice will build on the tubes, as the figure indicates. The geometry of the coil configuration allows the cylinders of ice to bridge vertically but provides a clearance gap between rows in the horizontal dimensions. The clearance gap is necessary for circulation of the tank water and to maintain an open, serpentine passageway between the ice cylinders, which allows efficient heat transfer between the tank water and the ice on the tubes of the coil. Therefore, for this coil configuration to provide maximum heat transfer there exists a defined amount of ice that can be built (i.e. packing efficiency) for the round tube design. Packing efficiency is defined as the ratio of the volume of ice actually formed and stored in comparison to the available space for ice around the coil assembly excluding the necessary clearance spaces. The packing efficiency of the ice coil is where EVAPCO concentrated its research efforts. The reason is simple; the thermal storage capability of the ice coil is based upon how much ice can be built in a given coil volume.



Round Tube Ice Coil

After analyzing and testing the current round tube technology, EVAPCO found limitations in this design and determined a better design was possible. EVAPCO called on its experience in elliptical tube coil design to develop a superior ice coil. The result is a state of the art elliptical tube ice coil that provides improved performance over the round tube design. Hence, the Extra-Pak® technology for thermal storage coils was born.

The EVAPCO Ice Coil featuring the Extra-Pak® technology is shown in the figure below. The EVAPCO Ice Coil configuration has similar vertical and horizontal spacing as the round tube coil but uses elliptical tubes. Due to the non-circular shape of the ice that builds on the elliptical tubes, as shown below, an increase in packing efficiency over the round tube design is achieved. Because the ice is an elliptical shape, it can be slightly overbuilt (note the areas of overbuild in the sketch shown below) but still provide an adequate clearance gap between the ice cylinders. Remember, an adequate clearance gap is necessary to allow the tank water to be in free contact with the ice on the tubes to ensure heat transfer efficiency. Therefore, the packing efficiency of EVAPCO's elliptical tube design is greater than the current technology. In summary, EVAPCO has developed an ice coil with new technology that builds more pounds of ice per foot of tube (i.e. greater capacity) than any ice coil on the market today.



EVAPCO
Elliptical Tube Ice Coil

* US Patent No. 6,178,770 B1
** US Patent Nos. 7,296,620 / 5,425,414 / 6,889,759

Application Information

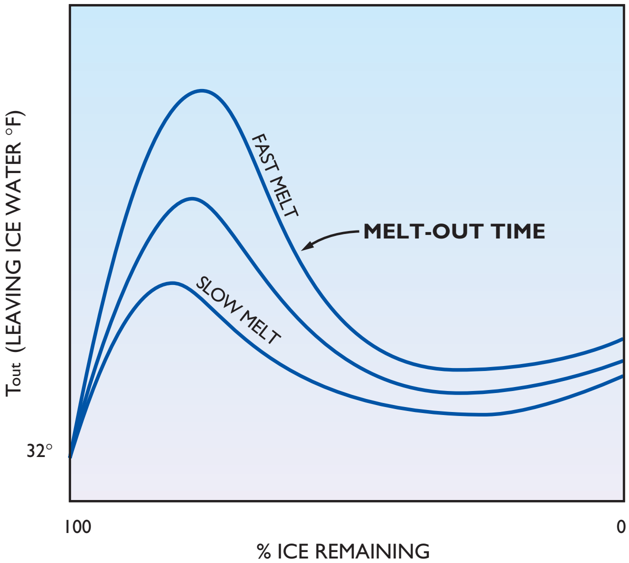
Melt-Out

As was previously mentioned, there are a variety of methods that are used to generate ice on the tubes of the thermal storage coils. Ammonia refrigeration systems, or more commonly in HVAC applications, glycol chillers, generate the thermal energy to freeze the tank water onto the thermal storage coils. Similarly, there are several methods to melt the ice that has formed on the tubes of the coil. The two common methods for melting the ice are referred to as **internal** or **external** melt and are described below.

Internal Melt

In an internal melt system, the ice on the tubes is melted from the inside out, hence, the name internal melt. In the internal melt system, the glycol that cools the building circulates through the thermal storage coils melting the ice that was generated during the ice build. The tank water never leaves the tank in an internal melt system.

There are distinct melt-out performance characteristics associated with an internal melt system. Early in the melt-out cycle, the leaving glycol temperature rises and then drops off later in the cycle. As shown in the figure below, the temperature rises more for a fast melt system than it does for a slow melt system. The reason for this is that the surface area of the heat exchanger is limited to the inside surface of the melting cylinder of ice early in the melt-out cycle. There is only a small stagnant annulus of melted ice in between the warmer coil and the 32°F ice. Later in the cycle, the ice annulus break up into the agitated (ice water) section of the tank and the pieces of ice cylinders are melted from the inside and the outside surfaces. As a result, a load profile with smaller loads at the beginning of the melt-out cycle and higher loads at the end of the melt-out cycle may be best suited for internal melt.

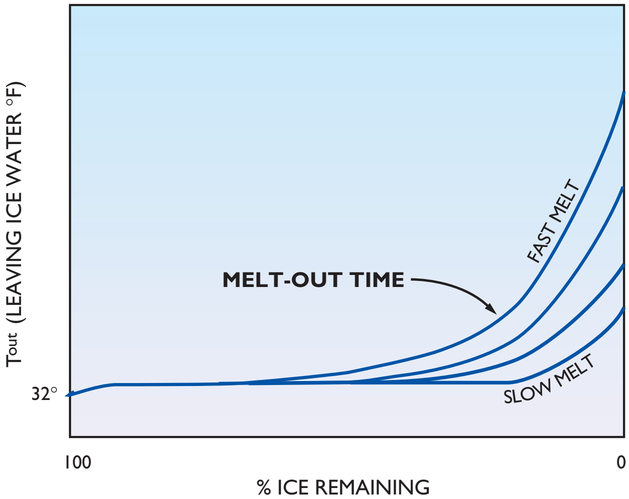


Internal Melt Profile

External Melt

In an external melt system, the ice on the tubes is melted from the outside in. The 32°F tank water is circulated to the load or through the building to provide the required cooling. Warm water returns from the system and melts a portion of the ice.

The melt-out performances of external and internal melt systems are very different. At the start of the melt-out cycle, there is a lot of surface area available for the transfer of heat from the ice to the tank water. So, at the early stages of the melt-out cycle, the temperature of the ice water is around 32°F. During the melt, the ice is consumed and the surface area decreases. As the surface area decreases, the rate of thermal energy that is transferred from the ice to the tank water is reduced. With approximately 50 percent of the ice left on the tubes, the tank water temperature begins to rise. As can be seen in the figure shown below, the ice water temperature continues to rise until all of the ice has been melted. Again, as the figure illustrates, fast melt systems tend to have higher leaving ice water temperatures than slow melt systems. Therefore, an application that has higher loads early in the melt-out cycle and low loads at the end of the melt-out cycle would best be suited for external melt.



External Melt Profile

Measuring Ice

There are several methods of measuring the amount of ice in the tank of the thermal storage system. One method of measuring ice is by tank water level. Since ice is less dense than water, as water is converted into ice during the build cycle, the tank water level will rise. Therefore, the amount of ice in the tank can be determined from this increase in water level. As the ice melts during the melt-out cycle, the tank water level is still a good indicator of the inventory of ice in the tank.

However, there are a few items to consider when using water level as a way of ice inventory. If large, shallow tanks are used, the water level may rise only a few inches. Measuring a large quantity of ice with such a small change in tank water level may not be very accurate. In addition, since the tank water is very cold, it will continually condense moisture out of the ambient environment and the air from the agitation system. Over a long operating period, the additional moisture that has condensed in the tank will affect the tank water level and mistakenly indicate more ice in storage than actually exists. A drain down of the tank or zeroing the amount of ice should be built into the thermal storage system controls to avoid this problem.

Another way to measure the amount of ice in the tank is to measure the size of the cylinders of ice. There are ice thickness controllers that can sense the thickness of the ice by conductivity. In addition, several thickness controllers could be placed on the tube of the coil to measure levels of ice thickness to detect stages (percentage of full build) in the build cycle. When the full build is reached, the controllers can shut off the glycol flow to the ice coils.

Although ice building on tubes is very uniform, the melting process is not. The ice melts faster in the area of the bubblers, and it breaks off the tubes in chunks later in the melt-out cycle. As a result, ice thickness control is not to be used as a measure of ice inventory during the melt-out process.

Since both of the above-mentioned methods of ice inventory have their pros and cons, it may be advantageous to consider multiple types of controllers when designing the controls for the thermal storage system. The designer of the system should consider all of these options to ensure that the control system is appropriate for the application.

Air Agitation System

The air agitation system is an essential part of the thermal storage system. The essential component of the air agitation system is the bubbler. For most HVAC applications, with total head requirements less than 15 psig, the bubbler is a rotary, positive displacement, air pump or a regenerative blower. In addition, distribution piping from the bubbler is connected to perforated PVC pipes that are located underneath the ice coils.

The air system is necessary for proper operation of the thermal storage system. The air system is necessary to agitate the tank water during the initial build period and the tank cool down. Factory testing has shown that once the first portion of ice has been built, the air system can be shut off. **However, operation of the air system is absolutely essential for satisfactory melt-out performance.**

When designing the air agitation system the following data should be incorporated. The air agitation rate should be **0.1 SCFM per square foot of tank plan area**. The air distribution piping has an **internal pressure drop of 0.25 psig**, which must be added to the hydrostatic head to properly size the air pump.

Equipment Selection

For any of your thermal storage applications, contact **EVAPCO, Inc., Thermal Storage Department at 410-756-2600** for sizing and selection of ice coils. Since each application is unique, the size and quantity of ice coils will vary. However, with the proper information, EVAPCO can select the best option for your application. The information that EVAPCO requires for ice coil selection is as follows:

- Tank dimensions L x W x H
- Storage Capacity in Ton-Hrs.
- Building load profile
- Build time in hours
- Melt-out time in hours
- Required supply and return temperatures for the load
- Melt-out type (Internal/External)
- Glycol solution percentage
- Glycol flowrate in gallons per minute (GPM)
- Compressor capacity data

With the above information, EVAPCO can select the quantity and size of ice coils best suited for your application. The output of data will be as follows:

- Coil dimension L x W x H
- Coil capacity in Ton-Hrs.
- Number of coils required
- Average glycol charging temperatures (Supply/Return)
- Glycol pressure drop
- Ice coil thermal performance in AHRI Guideline T format

EVAPCO PRODUCTS ARE MANUFACTURED WORLDWIDE.

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