CHJV 403A

evapco® for LIFE

THERMAL ICE STORAGE

Featuring Extra-Pak® Ice Coil Technology

冰 蓄 冷

先进的Extra-Pak® 蓄冰盘管技术

镀锌钢盘管

专为冰蓄冷系统设计

Galvanized Steel Coils

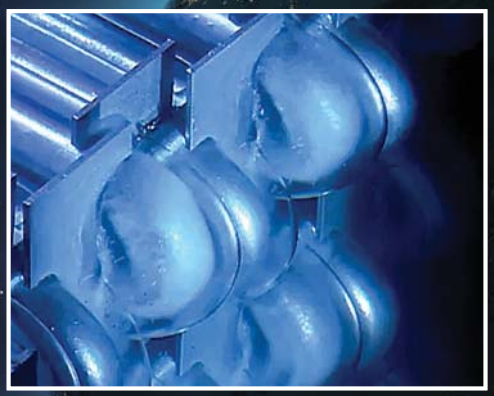
Designed for Thermal Ice Storage Systems

U.S. GREEN BUILDING COUNCIL MEMBER

INTERNATIONAL DISTRICT ENERGY ASSOCIATION MEMBER

冰蓄冷……在环保的同时满足您所有的能量需求。

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



冰 蓄 冷
THERMAL ICE STORAGE

冰蓄冷的主要优势
Major Benefits of Thermal Ice Storage:

1. 提高系统能效
   Improved System Energy Efficiency
2. 更低的冷冻水系统初投资
   Lower First Cost Chilled Water System
3. 降低能耗费用
   Reduced Energy Costs
4. 需求响应机制和智能电网的理想选择
   Ideal for Demand Response Programs and a Smarter Grid
5. 减少温室气体排放
   Lower Greenhouse Gas Emissions
6. 补充可再生能源发电
   Complements Renewable Power Generation
7. 获得LEED®分数的机会且符合绿色法规
   LEED® Point Opportunities and Green Code Compliance
8. 更小的蓄能占地面积
   Smaller Thermal Storage Footprint

益美高已成功地在全球范围内开发、制造并安装冰蓄冷系统。冰蓄冷系统降低了能源成本不受控、常规能源供应不稳定、以及可再生能源不可靠的风险。冰蓄冷是一项成熟的担负财政责任的蓄能方案。

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.

evapco

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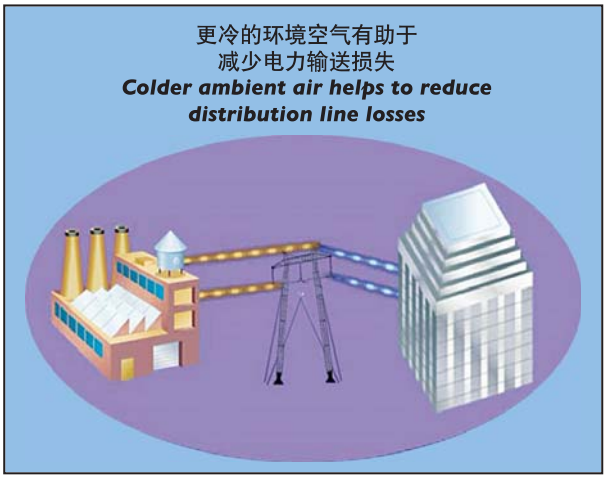
冰 蓄 冷 环境友好

THERMAL ICE STORAGE *Environmentally Friendly*

冰蓄冷能够减少用电高峰时段对电力的需求，因此在许多方面都体现出环保的优点。不过，这仅是冰山一角，更多的优点潜藏在水面以下……

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...



公共电力系统能够供应更多电力，减少新建发电厂
Allows the utility to supply more electricity with fewer building new power plants requirements

1 提高系统能源效率

冰蓄冷减少了对新发电厂的需求

冰蓄冷能够提高建筑物的能源效率以及相应的电厂发电效率。冰蓄冷将冷冻水系统的用电量转移至夜间的用电波谷时段，通过夜间制冰、白天融冰供冷来实现能源效率的提高。制冰主机在满负荷下运行的比例得到增加，与应用于常规冷冻水系统的部分负载冷水机组相比，这是一种更高效的运行模式。夜间发电对于发电厂来说是效率最高的工作时段。相比于简单循环、利用矿物燃料发电（火电厂），并可能需要在白天工作来满足高峰负荷需求的调峰电厂来说，24/7（每周工作7天、每天工作24小时）的基载电厂运行更为高效。

夜间工作时，环境空气更冷，发电厂运行效率更高。并且由于输电线比较凉，因此能够更好地传输电力。夜间的电力线传输损失一般比白天低4-5%。用冰蓄冷系统来备制低温冷冻水（1-2.2°C）的设计将降低空调系统的整体能耗，因为系统设计将采用体积更小且功率更低的水泵、空气处理机组，以及制冷主机。

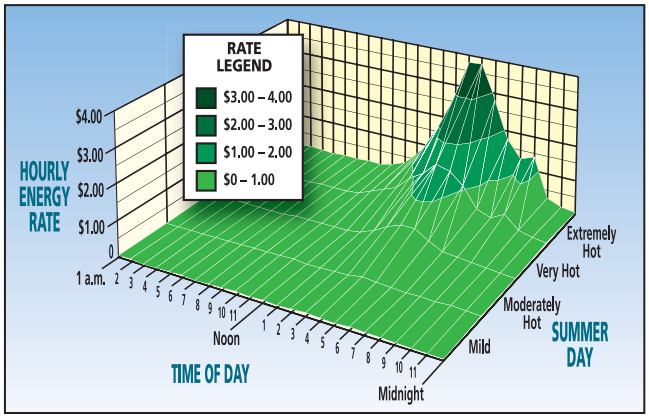
Improved System Energy Efficiency

Ice Storage Reduces 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 offpeak night time hours to build ice which is then melted during the day. The proportion of the ice making chillers operating at full load is increased. It's 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.

低温冷冻水和空气供给使得系统设备的配置更小
Low temperature chilled water and air supply results in smaller system components



将电力需求从白天转移至电费较低的夜间，
从而获得更低的能源成本
*美国南加州爱迪生公司实时电价
Lowers energy costs by shifting power usage from day time to less expensive night time hours
* Southern California Edison, Real Time Pricing

2 冷水机组的初投资更低

蓄冰设备减少系统设备的费用

采用低温供水的冰蓄冷系统后，可以节省许多初投资。例如，部分蓄冰的冰蓄冷系统需要的主机通常要比常规的冷冻水系统的主机小10-40%。除了环保和减少制冷剂充注量外，更小的主机还意味着更低的电力增容初投资。

此外，采用供应低温冷冻水的冰蓄冷系统的设计将具有更小的水泵、工艺管道、空气处理冷却盘管、通风管道系统和电气开关。更小的通风管道系统和空气处理系统可以降低建筑物层高，从而节省建筑围护结构的成本。总体结果是：一个大小适中的低温冰蓄冷系统能够节省初投资。

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.

3 降低能源成本

蓄冰设备将电力需求转移到低成本周期

冰蓄冷系统一个非常重要的优势是它能够通过“移峰填谷”来显著降低能源成本，降低峰值用电量，将需求转移至夜间或非高峰时段。电力公司往往对高峰时段的用电征收15美元/千瓦或更高的费用（根据时间和用量）。在大多数情况下，非高峰时段的电价低于高峰电价50%至80%，由此而节约的费用使得蓄冰设备的投资回收期比较短。一旦采用担负财政责任的冰蓄冷系统设计，业主在获得足够的建筑物供冷的同时，还可以通过减少需求而从中受益。

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 ratchetbased 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.

提高业主的灵活性来适应变化的公用设施和需求
Increases owners flexibility to adapt to changing utility structures and requirements

减少能源使用，减少温室气体排放
Reduces source energy with fewer green house gas emissions

4 需求响应机制和智能电网的理想选择

冰蓄冷系统减少了对公共电力系统的需求

需求响应机制鼓励消费者减少用电高峰期的电力需求，以得到可观的回报。由于在用电高峰时段，大部分的电力需求来自于空调系统，冰蓄冷系统既符合需求响应政策，又能够提供冷冻水来降低办公空间的温度，因此冰蓄冷系统是商业建筑的理想方案。需求响应是一种可持续性的技术，能够减少碳排放，并通过平衡电力供应和需求来提高电网的可靠性。智能电网结合了许多技术，包括智能电表、实时电价、能量控制、电动汽车充电和能源存储等。冰蓄冷有助于平衡电力需求、提供舒适性冷却，以及建设更智能的电网，是最经济的存储介质。

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.

5 减少温室气体排放

冰蓄冷减少了由于使用低源燃料而直接导致的废气排放

众所周知，将电力需求转移到非用电高峰时段能够减少温室气体排放。从当地可再生能源发电、到减少用电高峰时段的照明需求，再到利用冰蓄冷技术……无论采用哪种方法，通过将电力需求转移到非用电高峰时段而引起的温室气体排放量减少已经有了研究数据。加利福尼亚能源委员会（CEC）完成了一项研究（p500-95-005），该研究评估了两家加利福尼亚最大的电力供应商：太平洋煤气电力公司（PG&E）和南加利福尼亚爱迪生公司（SCE）。由这两家公司承担的当地蓄能系统将40-80%的年度空调系统用电从白天转移到了夜间，从而使源燃料的使用量减少了8-43%。由于燃料源减少，温室气体的排放量得以减少，成为附加效益！

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!.

为可再生能源策略提供了一种负载均衡的蓄能选择
Provides a load leveling, energy storage option for a renewable energy strategy

6 补充可再生能源发电

冰蓄冷能够提供大规模的蓄能，有助于平衡可再生能源的供应

当今区域性电力传输机构所面临的一个挑战就是将间歇性的可再生能源整合入电网。太阳能发电和风力发电并非总能在用电高峰时段提供电力。对于电力公司来说，有控制地利用可再生能源，使电网不至于超载是常规做法。解决可再生能源供需平衡的策略就是大规模蓄能。目前最具成本效益的蓄能方法就是蓄冰。太阳能或风力发电可以用来运行冷水机组，在非用电高峰时段进行制冰，制成的冰在用电高峰时段融冰供冷。还有一些其他类型的装置也能实现蓄能，比如蓄电池，蓄能飞轮或电容器，但这些尖端技术由于过于昂贵而无法被广泛接受。蓄冰设备的工作原理类似于蓄电池，经过数十年全球成千上万的安装使用实例，已被证明其投资费用低于其他高科技的蓄能选择。

加利福尼亚能源委员会报告“能源和环境对可再生能源热能存储战略的影响”P500-95-2005，1996年2月。

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.

California Energy Commission report “Source Energy and Environmental Impacts of Thermal Energy Storage” P500-95-005 February 1996.

7 获得LEED®分数的机会和符合绿色法规

冰蓄冷能够节约能源成本、减少用水、降低噪声以及减少用电高峰期的电力需求

能源和大气——优化能源绩效和需求响应

由蓄冰设备提供的能源成本节约有助于在优化能源绩效评价中的“能源与大气”部分中获得分数。蓄冰设备降低了在用电高峰时间段由于用电需求而产生的相关经济影响。分数的授予是由冰蓄冷冷冻水系统相比常规冷冻水系统所减少的能源费用百分比来确定的。在需求响应评价方面，蓄冰设备在依从于法规实现HVAC系统电力节约的同时，还满足需求响应期间的全部冷却需求。

节水效率——工艺用水的减少

益美高冰蓄冷系统与风冷式冷水机组配合使用，将减少建筑物空调系统的水耗及能耗。与常规的水冷系统设计相比，冰蓄冷系统和风冷式冷水机组不仅为最终用户显著节水，而且还更加节能。用户可以在夜间运行冷水机组进行制冰（此时干球温度通常比白天低11°C~17°C），从而节省能源。

室内环境质量——声学性能

所有建筑类型现在都可以申请声学性能评估。蓄冰设备有助于降低教室、礼堂、酒店、医院、办公大楼和数据中心的噪声水平。全蓄冰系统按照包括高峰冷却能力在内的整个系统负荷来设计选型，在学校上课期间或者有时课下需要格外安静的时候，全蓄冰系统通过融化存储的冰来供给冷冻水，而无需运行高噪声的水冷或风冷式冷水机组。

与风冷式冷水机组配合使用，显著减少用水
Provides significant water savings with air cooled chillers

Build Green Schools

Join your local green schools campaign, see what others are doing and saying, and learn about the LEED for Schools rating system.

www.buildgreenschools.org

建造绿色学校－安静的空调系统运行
Allows quiet air conditioning operation

节约能源成本
Provides energy cost savings

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

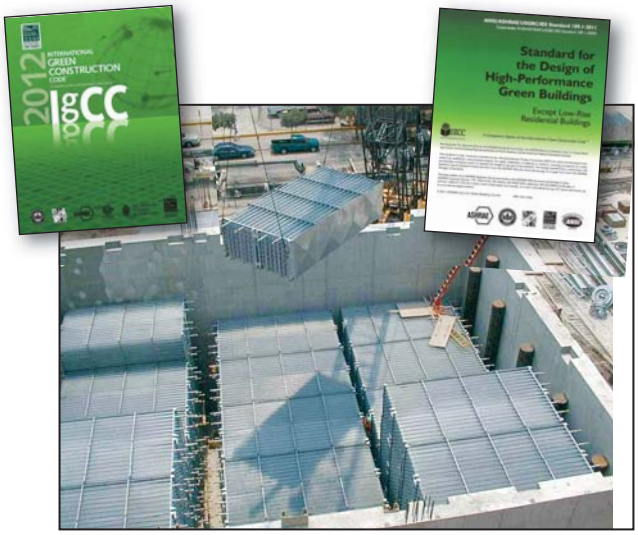
The energy cost savings provided by thermal ice storage contributes to points in Energy and Atmosphere under the Optimize Energy Performance credit. Thermal ice storage reduces the economic impact associated with using power during peak energy periods. Points are awarded by the percentage reduction in 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 11°C to 17°C 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.



冰蓄冷满足国际绿色建筑规范和***ASHRAE 189.1***
标准中“减少需求”的要求
Thermal ice storage meets the demand reduction requirements of the IgCC and ASHRAE Std. 189.1

冰蓄冷比水蓄冷减少***60%-80%***的占地面积
Reduces thermal storage footprint 60%-80% less than stratified chilled water storage

ASHRAE 189.1标准以及国际绿色建筑规范

蓄冰设备有助于满足ASHRAE 189.1标准以及国际绿色建筑规范中关于“减少需求”的要求。

ASHRAE 189.1标准—— 7.4.5.1能效章节

建设项目应包括自动化系统，比如需求限制或负载转移，这能够将建筑物的预计高峰用电需求至少降低10%。

国际绿色建筑规范，能源节约、效率和二氧化碳减排需求第604章节，响应自动化（Auto DR）基础设施。

在第604.3章节“供暖，通风和空调（暖通空调）系统”，有如下描述：“空调系统的需求响应自动化战略应能够在其工作时，至少减少10%的建筑物高峰冷却或HVAC的供热需求……”。

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….”

8 更小的蓄能占地面积

在同等的热容量下，蓄冰槽的占地面积只有水蓄冷占地面积的1/4至1/8。

与其他蓄能系统设计相比，冰蓄冷系统能够在最小的占地面积中提供最大的冷却能力。冰蓄冷比水蓄冷具有明显的空间优势。冰的潜热容量为144BTU/lb；而水的显热容量只有1BTU/lb/°F。冰蓄冷的空间要求是2.5-3ft³/ton-hour，而水蓄冷的空间要求是12-22ft³/ton-hour——是冰蓄冷的4到8倍。因此在房地产或建筑用地非常昂贵的地区，冰蓄冷是城市设施和改造项目的理想选择。

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 ft³ per ton-hour, whereas chilled water storage requires 12-22 ft³ 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.

经验，创新，性能保证

益美高现已拥有超过45项美国专利及国外授权。益美高凭借杰出的工程专业技术，成功地对各种系列的产品进行了革新。这些革新也促使客户能够在合乎环境安全要求的前提下获得更多的利益。

位于美国马里兰州塔尼镇益美高世界总部的现代化研发中心拥有超过6000平方米的热力分析及产品研发实验室。经验丰富的研发工程师常年在六个可控环境实验室进行产品测试与应用研究。

研发中心的可控环境实验室可以模拟实际应用中可能遭遇到的各种环境条件，由计算机数据采集系统记录数据并以图表形式显示连续结果，从而在一个连续性的基础上为研发工程师提供有价值的测试信息。

研发中心拥有的低温环境实验室可由氨系统转变成CO2系统，从而对钢结构的冷风机进行详细的热力分析。

研发中心的益美高水分析服务团队运用先进的化学药剂和水分析方法来为公司的Pulse~Pure®和Smart Shield™水处理业务提供支持。此外，研发中心还拥有一个包括乙二醇主机在内的冰蓄冷系统试验台，用于蓄冰设备制冰及融冰释冷时的性能评估；一个用于认定冷风机所用通风机性能的AMCA（国际空气与运动控制协会）通风机测试实验室；产品的噪声水平由实验室中专用的噪声测试仪来测量。

益美高的产品是经过广泛研究和热力性能测试的结果。因此，益美高的产品均能保证性能，使系统极为高效地运行。

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 meters dedicated to thermal analysis and product development. Experienced R&D engineers perform product and application research year round in six environmental test chambers.

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 CO2 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.

冰蓄冷系统试验台，用于蓄冰设备制冰及融冰释冷时的性能评估
Thermal ice storage test unit with glycol chiller utilized for developing charge and discharge performance ratings


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.

EVAPCO...Specialists in Heat Transfer Products and Services.

热力性能保证

冰 蓄 冷 环境友好

THERMAL ICE STORAGE *Environmentally Friendly*

综述

蓄能系统已经存在了很多年。尽管早期相关系统安装应用主要集中在奶制品厂、教堂和电影院，但当前大多数应用在舒适空调方面。蓄能系统的目的是制造能量并储存，以供其他时间段使用。

目前有几种不同的蓄能系统在使用，这些系统可分为全部蓄能与部分蓄能。在典型的全部蓄能系统中，制冷系统（冷水机组）在夜间制冰，此时为电力低谷期。在白天电力高峰期，冷水机组不工作，通过融化夜间蓄存的冰来为建筑物供冷。在部分蓄能系统中，可选用容量小一些的冷水机组或制冷系统，冷水机组24小时工作，由冷水机组与蓄冰装置联合供冷以满足高峰负荷。部分蓄能系统有几种形式，如何应用取决于建筑物负荷、系统设备及能耗。不论采用何种方法，大多数部分蓄能系统通常削去高峰能量需求以减少运行费用。

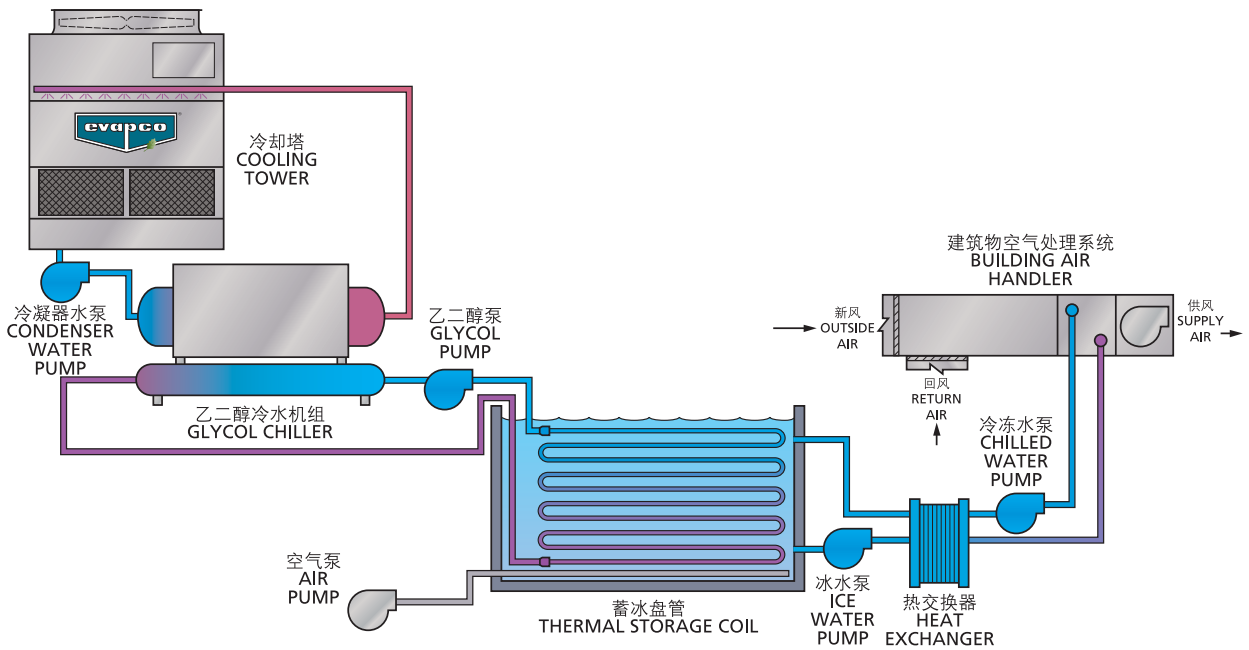
益美高向蓄能行业推出的产品技术被成为“ice on coils”(在盘管外表面结冰)。在这类系统中，热浸镀锌盘管的管子上会生成圆筒形的冰环。在大多数使用该技术的系统中，多层错排的盘管浸没在现场构筑的混凝土或钢制蓄冰槽中的水下。

GENERAL DESCRIPTION

Thermal storage systems have been in existence for many years. Although many early applications involved systems installed in dairies, churches, and theatres, 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 or steel tanks.



冰蓄冷系统示意图
Thermal Storage System Schematic

运行流程

蓄能系统使用乙二醇冷水机组或直接制冷系统，在盘管管壁上生成满足冷却需要的冰。一般来说，大多数舒适性空调采用乙二醇冷水机组，如第11页示意图所示。蓄能装置的空调系统主要由冷水机组、冷却塔、热交换器、水泵、蓄冰盘管以及建筑物的空气处理设备所组成。冰蓄冷系统有如下所示的两种运行模式：制冰和融冰。

制冰

在非高峰时段，乙二醇冷水机组运行。乙二醇冷却系统制取低温的乙二醇水溶液，送入蓄冰盘管中。循环的乙二醇带走蓄冰槽中的水的热量，使水冻结在蓄冰盘管的外表面上。

融冰

在融冰阶段，制冷系统关闭。根据内、外融冰模式的不同，或是乙二醇在盘管的管道内循环，或是蓄冰槽中的水流经盘管从冰中吸取能量。接下来，低温的乙二醇或冰水流经热交换器的一侧，同时建筑物的冷冻水回水也流经热交换器。在那里，冷冻水被冷却，然后送入空气处理设备，供给建筑物冷量。

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 utilizes glycol chillers, as is shown in page 11 schematic. 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.

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 exchcanger where it is cooled and sent to the air handling units to provide cooling for the building.

设计特点

盘管结构

益美高采用高质量的碳钢来制造蓄冰盘管。品质优秀的盘管由厚壁椭圆管组成。每一组回路都要经过检查以确保材料的品质，并在最终装配前进行测试。完成装配后，盘管要在水下做2.69MPa的气压试验，确保无泄漏。为了增强盘管的防腐蚀能力，整组盘管在高温的熔融纯锌槽内进行热浸镀锌。

对于部分应用，可能需要空气搅动装置。此时，每一组益美高的蓄冰盘管都在底部装有40号PVC空气搅动管。作为空气搅动系统的一部分，我们所设计的有穿孔的PVC管子能够恰当地分配盘管下的空气。注意：在有多组盘管进行多层垂直安装的大型工程中，只有底层的盘管配有空气搅动管。

DESIGN FEATURES

Coil Construction

EVAPCO manufacturers 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 390 psig air pressure under water to assure it is leak free. To protect the coil against corrosion, the entire coil assembly is dipped into molten zinc (hot-dipped galvanized).

For some applications, an air agitation system may be required. In these cases, 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.

盘管回路

盘管回路是设计冰蓄冷系统时必须考虑的一个问题。许多不同的制冷剂可被用作冷却介质，空调系统大多使用的是乙烯乙二醇水溶液。空调系统中的吸气温度不是非常低，通常使用的是25-30%浓度的乙二醇水溶液。

当使用乙二醇溶液时，在制冰阶段，随着乙二醇流经蓄冰盘管，乙二醇的温度升高。这使得在盘管入口处形成厚冰，而在接近盘管出口处形成薄冰。因此，最终形成的冰柱趋向于圆锥形。由于盘管中管子的间距取决于设计结冰厚度，可用的结冰空间也因此受到影响。假如盘管为并联平行回路，管子上圆锥形冰柱的尖端会浪费蓄冰槽的部分空间（请看图A）。在典型温度下，圆锥形冰柱会导致采用并联平行回路方案的盘管总蓄冰量损失近20%。

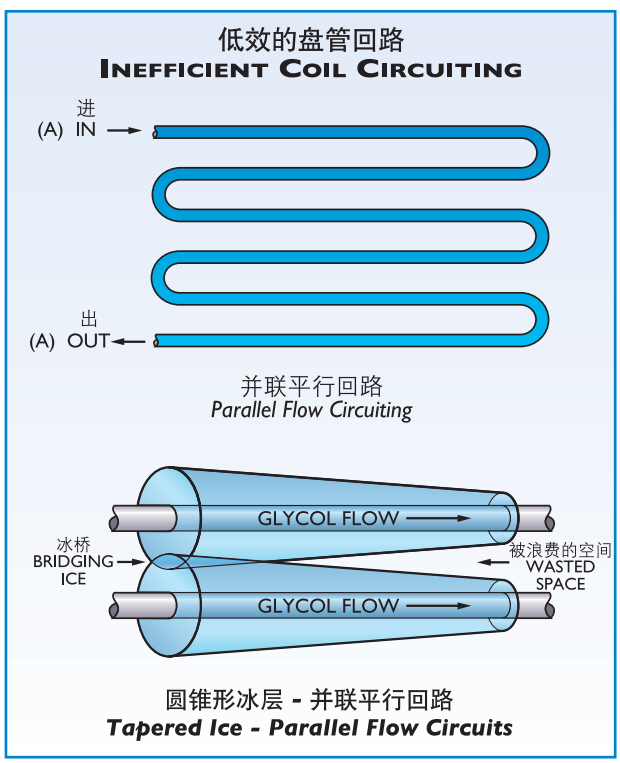
解决以上问题的方法就是修改盘管的回路方式。益美高的蓄冰盘管采用逆流的回路方式（请看图B），可以解决这个问题。圆锥形的冰柱可以形成一正一反，从而有效地利用盘管/蓄冰槽的容积。最终结果就是：采用乙二醇逆流方式制出的冰量相当于理想恒温状态下直接蒸发制冷剂而制出的圆柱形（非圆锥形）截面的冰量。

Coil Circuiting

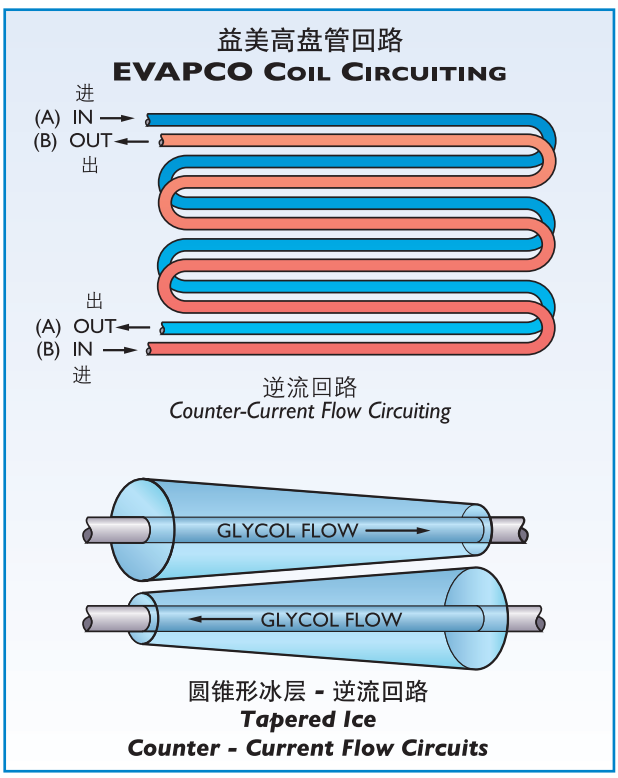
How the ice coil is circuited is an issue that must be considered when designing for thermal storage systems. Various refrigerants are used as the cooling medium, however, for most air conditioning applications, an aqueous solution of ethylene glycol is used. For air conditioning applications where the 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. This gives thick ice near the inlets of the coil and thin ice 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 the illustration A). 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. The EVAPCO Ice Coils are circuited for counter-current flow (See the illustration B), which alleviates this problem. The tapered ice cylinders nest with each other and make efficient use of the coil/tank volume. 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.



A



B

益美高先进的Extra-Pak®技术
The EVAPCO Extra-Pak® Advantage

盘管设计

蓄冰盘管技术已经存在了好多年，应用于不同的场合，比如奶制品厂和影剧院。最近几年，蓄能技术的应用开始从工业向商业空调方面转移。在这期间，蓄冰盘管设计上的改动非常小。只有少数几家制造厂可以提供蓄冰盘管技术，一些技术目前仍在大多数应用中使用。在少数工程中会使用到其他材质盘管，这些盘管被安装在预先建造好的蓄冰槽中。在多数大型应用中，多组钢盘管被安装在现场构筑的蓄冰槽里。这是益美高努力研究取得的较新成果。益美高极为重视产品的研究和开发，多年前就取得了该产品的主要先进技术。

益美高，盘管技术的革新者，拥有显热盘管（Sensi-COIL®）和高效换热翅片盘管(Therma-Pak Finned Coil®) 设计。采用这些技术发展起来的蓄冰盘管以“Extra-Pak®”技术为重要特点。在开发新设计前，益美高仔细研究了当时采用1.05”直径圆管的蓄冰盘管技术。

当时的蓄冰盘管工艺如图C所示。通常，盘管的构造为圆管在水平方向和垂直方向上均匀分布。在圆管设计中，圆柱形的冰生成在管壁上，如图中所示。盘管的几何学构造允许在垂直方向上产生冰桥，而在水平方向上成排的管子之间留有间隙。这个间隙对于蓄冰槽内水的循环十分必要，它可以在冰柱之间维持一条通畅的、蜿蜒的通道，从而使蓄冰槽中的水和盘管表面的冰进行有效的热交换。因此，对于能够提供最佳热交换的盘管构造，存在着一个冰量的定义，即这些圆管上能生成多少冰（也就是蓄冰效率）。蓄冰效率的定义为：冰实际生成并蓄存的体积与盘管组周围减去必要的净空间后剩下的可用空间的比值。蓄冰效率是益美高着力研究的重点，原因很简单，蓄能盘管的蓄冰能力完全取决于给定的容积内能制出多少冰。

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 other materials coiled tubing installed in pre-fabricated tanks. For the majority of larger applications, multiple steel coils are commonly placed in field erected 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 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.

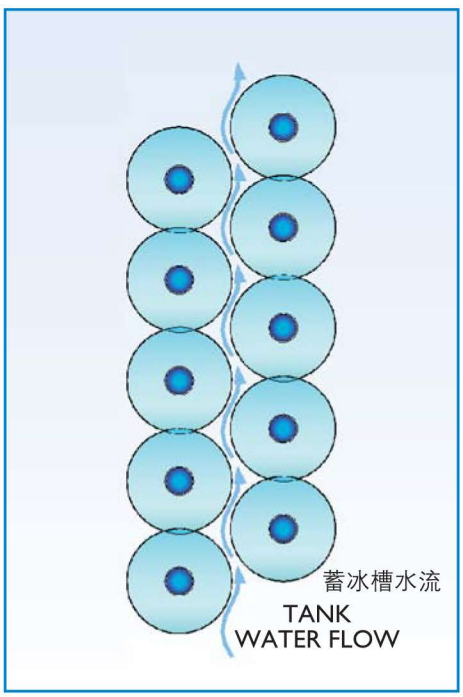
The current thermal storage coil technology is shown in the figure C. In general, the configuration of the coil is such that round tubes are evenly spaced in both the horizontal and vertical dimensions. In the round tube design, round cylinders of ice will build on the tubes, as the figure indicates. 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.

在分析测试当时的圆管技术后，益美高发现了这种设计的局限性，并预言应该会有更好的设计。益美高根据其他产品使用的椭圆盘管的设计理念，开发出了更为出众的蓄冰盘管。这种椭圆蓄冰盘管是技术发展的成果，它的性能超过了圆管设计。从此，采用Extra-Pak®技术的蓄冰盘管诞生了。

益美高的蓄冰盘管以Extra-Pak®技术为特点，如图D所示。益美高蓄冰盘管和其他厂家的圆形盘管拥有近似的垂直和水平方向上的空间，区别是使用的为椭圆管。由于椭圆管上生成的冰并非圆形，如图D所示，蓄冰效率高于圆管设计是毫无疑问的。因为生成的冰是椭圆形，会产生微量的重叠冻结（注意图中所示的重叠冻结区域），但仍然在冰柱之间留有一个适当的间隙。记住，留有足够的间隙非常必要，它可以使蓄冰槽中的水自由地接触管壁上结的冰，确保换热效率。因此，益美高椭圆管的蓄冰效率要高于原来的技术工艺。总之，益美高利用新技术开发出的蓄冰盘管比当今市场上任何一种蓄冰盘管在单位长度的盘管上能制出更多的冰（即容量更大）。

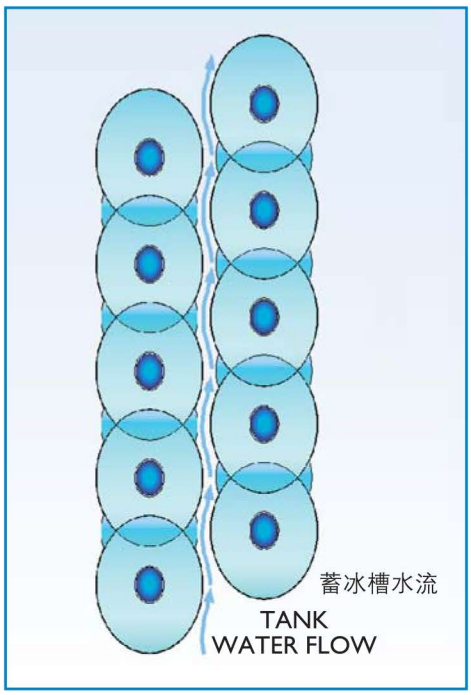
After analyzing and testing the current round tube technology, EVAPCO found limitations in this design and determined a better design was possible. EVAPCO called on its experience in elliptical tube coil design to develop a superior ice coil. The result is a state of the art elliptical tube ice coil 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 D 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 in the figue D 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.



圆管蓄冰盘管
Round Tube Ice Coil

C



益美高椭圆形蓄冰盘管
EVAPCO Elliptical Tube Ice Coil

D

应用信息

融冰

如前面提及，蓄冰盘管的管壁上结冰有几种不同的方式。在氨或氟利昂系统，或采用乙二醇冷水机组制冷的空调系统应用中，蓄冰槽中的水冻结在盘管表面。同样的，盘管管壁上的冰融化也有几种不同的方式。两种最普遍的融冰方式分别为外融冰和内融冰。

内融冰

所谓内融冰是指管壁上的冰从内部开始融化。在内融冰系统，用于建筑物供冷的乙二醇溶液流经蓄冰盘管内部，融化管壁上所结的冰。内融冰系统中蓄冰槽里的水从来不会流出蓄冰槽。

采用内融冰系统有截然不同的融冰性能特点。在每一个融冰周期，乙二醇溶液的出水温度先升高，随后下降。从下图可以看出，快速融冰的系统比慢速融冰的系统温度升高得更多，原因是在融冰周期前期，换热层的外表面积受融化冰层的内表面积限制，在温热的盘管和32°F(0°C)的冰中间仅有少量的缝隙可供融冰。在融冰后期，冰层破裂，形成冰水混合物，散碎的冰块从内侧和外侧同时融化。因此，内融冰方式最适合应用在融冰初始阶段有较小负荷，融冰周期后期有较大负荷的场合。

APPLICATION INFORMATION

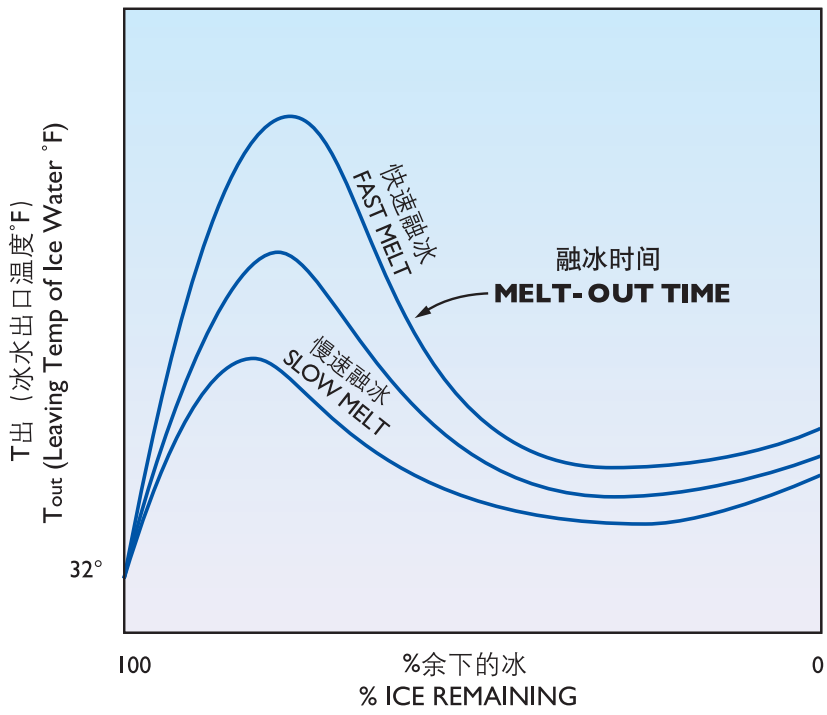
MELT-OUT

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 (0°C) 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.



内融冰曲线
Internal Melt Profile

外融冰

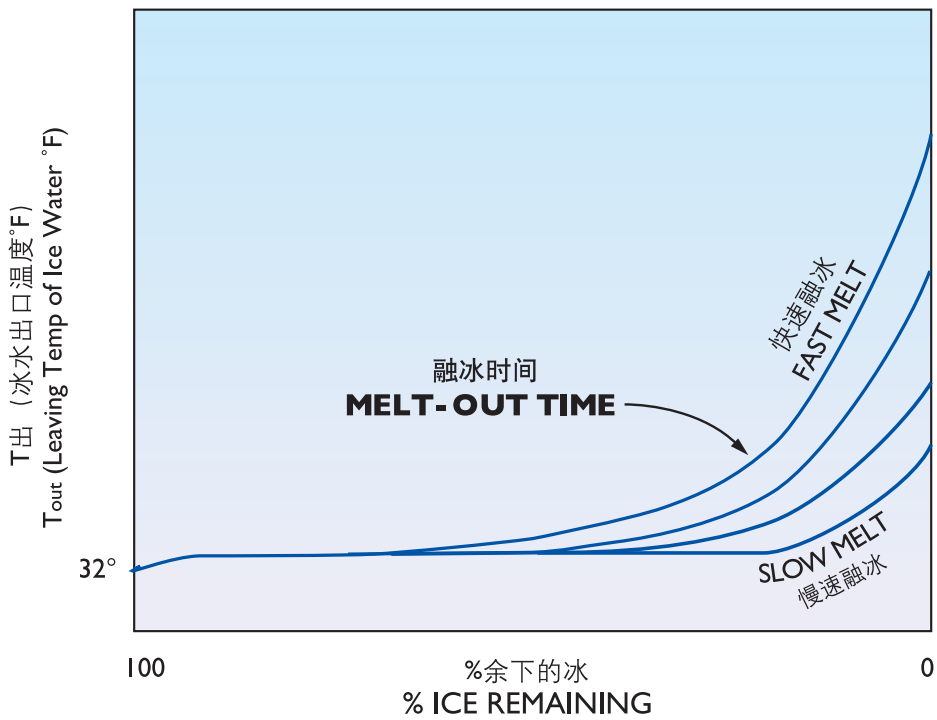
在外融冰系统，管壁上的冰从外层开始融化。蓄冰槽中的水流向负荷或建筑物，为其提供所需要的冷量，然后热水从系统中返回，融化一部分冰。

外融冰和内融冰系统的融冰性能有很大区别。融冰周期开始时，冰与蓄冰槽中的水之间的可用换热面积很大，所以在融冰周期的初始阶段，冰水的温度在32°F(0°C)左右。在融冰过程中，冰被消耗掉，冰与水的接触表面越来越少。由于表面减少，冰和蓄冰槽中的水的换热效率也随之降低。当管壁上的冰融化掉大约50%时，蓄冰槽中水的温度开始上升。从下图可以看出，冰水温度持续上升，直至冰全部融化。此外，如图中所示，快速融冰的系统比慢速融冰的系统冰水的出水温度更高。因此，外融冰方式最适合应用在融冰初始阶段有较大负荷，融冰周期后期有较小负荷的场合。

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 (0°C). During the melt, the ice is consumed and the surface 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 may be best suited for external melt.



外融冰曲线
External Melt Profile

储冰量测量

有几种不同的方式可以测量冰蓄冷系统中蓄冰槽内的储冰量。一种是通过测量蓄冰槽中的水位变化来得出储冰量。由于冰的密度比水小，在制冰阶段水变成冰时蓄冰槽中水位会升高。因此，储冰量可以通过测量蓄冰槽内液位升高量而计算出来。融冰时，蓄冰槽水位仍然是检查蓄冰槽现有储冰量的一个好指示器。

但是，当利用水位作为储冰量的指示时，有一些问题需加以考虑。假如使用的蓄冰槽大而浅，水位升高可能只有几英寸。通过测量很小的蓄冰槽水位变化而计算大量额的储冰量会产生较大的误差，不是十分精确。此外，由于蓄冰槽中的水非常冷，它会不断冷凝周围环境和搅动系统空气中的潮气。运行较长一段时间后，额外冷凝下来的潮气会影响蓄冰槽的水位，使人错误地以为比实际蓄存了更多的冰。在冰蓄冷系统调节装置上添加一个蓄冰槽底部排水管或尽量将全部冰量融化，便可避免这个问题。

有一种冰层厚度控制器可以通过传导率来探测冰层的厚度。此外，可以放几个冰层厚度控制器在盘管管壁上，通过测量冰层厚度得出现在处在制冰周期的哪个阶段（全部蓄冰的百分数）。一旦全部制冰完成，控制器就切断流向蓄冰盘管的乙二醇的通路。

尽管在制冰过程中，冰在管壁上冻结得非常均匀，但融冰过程并非如此。冰在气泵及鼓气装置周围融化得更快，在融冰周期后期，冰会从管壁上大块脱落。因此，在融冰阶段，不使用冰层厚度控制器测定现存冰量。

上面提及的两种储冰量测量方式各有利弊，在设计冰蓄冷系统控制装置时考虑多种控制器是上佳选择。系统的设计者应考虑到所有这些选项以确保控制系统最合乎应用之需要。

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.

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.

空气搅动装置

空气搅动装置是蓄冰系统的一个基本组成部分。空气搅动装置的基本组成部分是鼓气装置。对于大多数空调应用，需要的总压头应不小于103kPa，鼓气装置是一个回旋式正压空气泵或一台鼓风机。此外，鼓气装置的分配管道与位于蓄冰盘管底部凿孔的PVC管子相连。

空气搅动装置对于蓄冰系统的正常运行是必要的。空气搅动装置需要在制冰初期被开启，来冷却蓄冰槽中的水。工厂测试显示，一旦有冰产生，即可停止空气搅动装置的运行。总之，若要获得满意的融冰性能，空气搅动装置必不可少。

设计空气搅动装置时，需要考虑下述条件：空气搅动率应为每平方米1.9m3/h。空气分配管内部压力降为1.7kPa，这个压降应叠加在静压头上，继而选择大小合适的空气泵。

设备选型

每一个工程实例都不尽相同，所需要的蓄冰盘管的尺寸和数量也随之不同，正确充分的信息有助于我们作出最佳的选型方案。蓄冰盘管选型需要的信息如下所示：

- 蓄冰槽尺寸（长x宽x高）
- 蓄冰能力：冷吨－时
- 建筑物逐时负荷表
- 制冰小时数
- 融冰小时数
- 负荷侧需要的进水和回水温度
- 融冰方式（内融冰/外融冰）
- 乙二醇溶液浓度
- 乙二醇溶液流量
- 压缩机容量数据

有了以上信息，便可选出最适合您工程应用的蓄冰盘管的数量和型号。得出的数据如下所示：

- 盘管尺寸（长x宽x高）
- 盘管容量：冷吨－时
- 所需盘管数量
- 平均乙二醇温度（供液/回液）
- 乙二醇压力降
- 蓄冰盘管性能保证书
- 按照美国空调制冷协会（AHRI）发表的《T准则》格式的蓄冰盘管热力性能表

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 (103 kPa), 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 (1.7 kPa), which must be added to the hydrostatic head to properly size the air pump.

Equipment Selection

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 (LxWxH)
- Storage Capacity in Ton-Hours
- 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
- 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 Dimensions (LxWxH)
- Coil Capacity in Ton-Hours
- Number of Coils Required
- Average Glycol Charging Temperatures (Supply/Return)
- Glycol Pressure Drop
- Ice Coil Thermal Performance in AHRI Guideline T Format

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