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CHILLER & COOLING BEST PRACTICES

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COVER PHOTO. This month's cover features Chicago's Midway International Airport, the subject of our lead article provided to us by Burns & McDonnell.

FROM THE EDITOR

We have decided to begin publishing a feature article, every month, on a company in the food processing or packaging industry – including companies manufacturing packaging materials only. This is our single largest manufacturing reader segment. I hope you'll enjoy our cover story on Intertape Plastics Group Inc. This is a firm with a mature energy management program, recognized by ENERGY STAR®.

If you find our journalistic efforts worthwhile and want to help us, the best way to do this is to recommend our free publication to engineering firm and manufacturing personnel to help us grow circulation.

Quality, safety and reliability cannot be taken for granted. In some plants, two hours of downtime can offset the system energy-savings of an entire year. Product rejections have large scrap costs and potential liabilities. These three topics will continue to be a major focus of this publication.

I'd like to congratulate Steve Tredinnick, from engineering firm Burns & McDonnell, on his recent recognition as an ASHRAE Fellow and thank him for his article titled, "Modernization at Chicago Midway International Airport Central Heating and Refrigeration Plant."

Our printer is Quad Graphics and they've allowed our own Mike Grennier to profile, in two separate articles, their state-of-the-art efficient cooling and compressed air systems at their 1.7 million square foot plant in Wisconsin. We kick it off with the cooling system profile.

The Bayer Crop Science plant in Kansas City, Missouri optimized their cooling water system by replacing an older chiller with a new variable speed 900-ton chiller. Thanks go to Eric Kruzan, from the Evergy Business Energy Savings Program, for sharing this article with our readers.

Thanks also go to Frank Silva, from Carrier Commercial HVAC, for his article titled, "Waterside Economizer for Air-Cooled Chillers."

Thank you for investing your time and efforts into ***Chiller & Cooling Best Practices.***

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Modernization at Chicago Midway International Airport Central Heating and Refrigeration Plant

By Steve Tredinnick, P.E., CEM, Senior Project Manager, Burns & McDonnell

Airport History

Chicago's Midway International Airport (MDW) has changed a great deal over its 94-year history. MDW occupies one square mile located south west of downtown Chicago. From its dedication in 1926 as Chicago Municipal Airfield, the airport was Chicago's primary airport until O'Hare Field and eventually O'Hare International Airport (ORD) opened in 1955 and MDW was one of the world's busiest airports during that period. In 1949,the municipal airfield was renamed in honor of the Battle of Midway and has been operating since under that name.

Existing Chilled Water Plant

Since its inception, MDW has seen growth in air travel. To handle the increased passenger volume and modernize the airport, a larger terminal went under construction in 2000 and was completed in 2004 as part of a terminal development program. The program also included a new Central Heating and Refrigeration Plant (CHRP), which was completed in 2000 to serve the increased cooling and heating needs of the new terminals. The CHRP was a separate contract from the terminal modernizations and was awarded using a third-party design build contract. Unicom Thermal Technologies (UTT) was awarded the project with Hill Mechanical Group (HMG) as its contractor. UTT was an unregulated subsidiary of the local electrical company, Commonwealth Edison (ComEd), which at the time owned and operated the downtown Chicago district cooling system. The downtown system has been bought and sold several times with Enwave USA as the current owner. Eventually, the MDW CHRP was purchased by the Chicago Department of Aviation (CDA) which operates both MDW and O'Hare International Airports.

At the time the CHRP was constructed, Chicago had some of the highest electric rates in the country hence, the new CHRP was designed to economically provide comfort cooling using an ice-based partial shift thermal energy storage tank. Two (2) rotary screw ice chillers delivered R-22 refrigerant directly to the 14,000 ton-hour external melt ice tank. Two (2) nominal 1,655-ton centrifugal water chillers worked in tandem with the ice tank (1,590-tons peak hour tank capacity) to provide a plant peak capacity of 4,900-tons. The screw compressors also had a remote refrigerant to water heat transfer skid that could be used in an emergency to generate chilled water, just not as efficiently as the water chillers.

In the normal operating mode, the water chillers cooled 58°F return water to ~41°F prior to blending it with the ice tank water to deliver 34°F chilled water supply to the terminals. The operating scheme was to make ice at night when the electrical rates were cheaper and melt it during the daytime with support from the water chillers. The plant has operated successfully for 20 years under this scheme.

Redundancy was a critical criterion for plant operations since the airport was essentially operating 24/7 from April through November (the CHRP is a seasonal plant since the terminal air-handling units (AHUs) have outside air economizers, but it could also operate during the winter if needed). Therefore, the plant was configured with redundant pumps and several emergency modes of operation to provide redundancy in the case a water chiller malfunctioned, including the refrigerant to water heat transfer skids that could deliver 36.5°F or 41°F chilled water (dependent on water flow) as a backup for the water chillers.

The existing chilled water pumping scheme was a traditional primary-secondary configuration with constant flow primary with variable flow secondary pumping where the primary pumps were individually piped to each chiller. The condensing side of the plant had the water chillers using forced draft cooling towers and the screw chillers using forced draft evaporative condensers.

In 2008, the Illinois power market became deregulated and where customers could select from a list of multiple energy providers. After an initial period of keeping electrical rates artificially low, the rates increased dramatically again. Today, however, the rates are lower again and almost "flat" (only a small difference between on peak and off-peak electrical rates) since the City of Chicago negotiated a contract with the electrical provider. With lower electrical rates and little differential between on peak and off-peak electric rates, the CHRP was no longer fiscally efficient to operate and required further upgrading to reduce its operating costs.

Chilled water and condenser water pumps and 30" condenser water supply pipe.

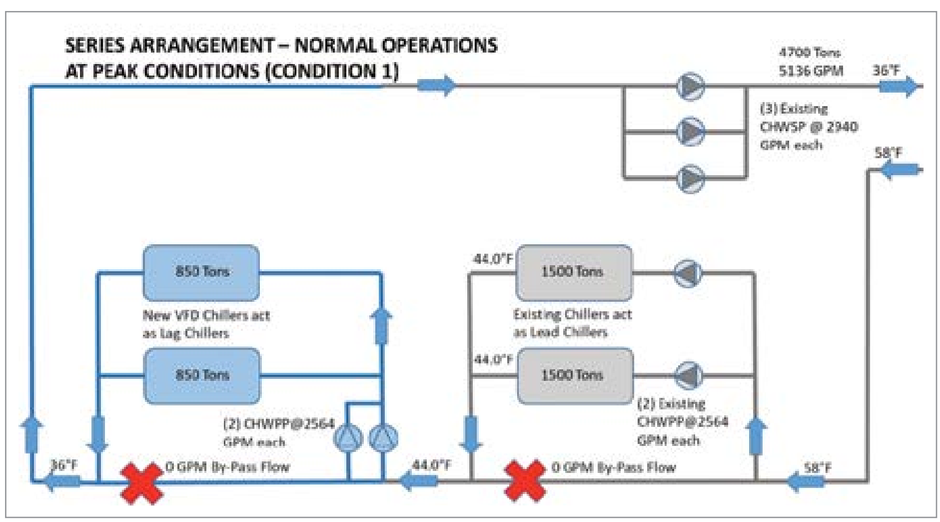

Figure 1. Normal Operating Mode at Peak Load

Modernization at Chicago Midway International Airport Central Heating and Refrigeration Plant

New Chilled Water Plant Upgrades

As part of a 2018 airport modernization project, the CHRP was designated to be upgraded to better utilize the current lower electrical rate structure. For the second time in the CHRP's history, a Request for Proposal (RFP) was issued for a Design-Build contract to complete the upgrades. The RFP was issued in early 2016 and was finally awarded to the original CHRP contractor, HMG, in 2018. HMG selected Burns & McDonnell as the Designer of Record for mechanical, electrical, and structural engineering for the CHRP upgrade project. The goal of the RFP was to make the plant more efficient while maintaining its robustness and reliability by configuring the plant to provide peak cooling capacity during several equipment failure modes. Therefore, the ice plant and its appurtenances were removed from the CHRP to make room for additional centrifugal water chillers since the ice plant was no longer the most efficient solution.

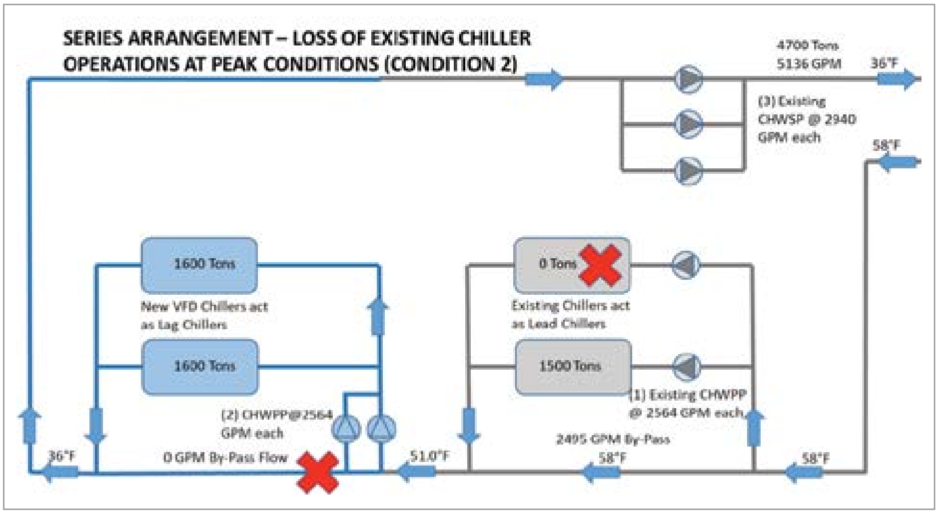

Figure 2. Operating Mode if One Lead Chiller is Lost

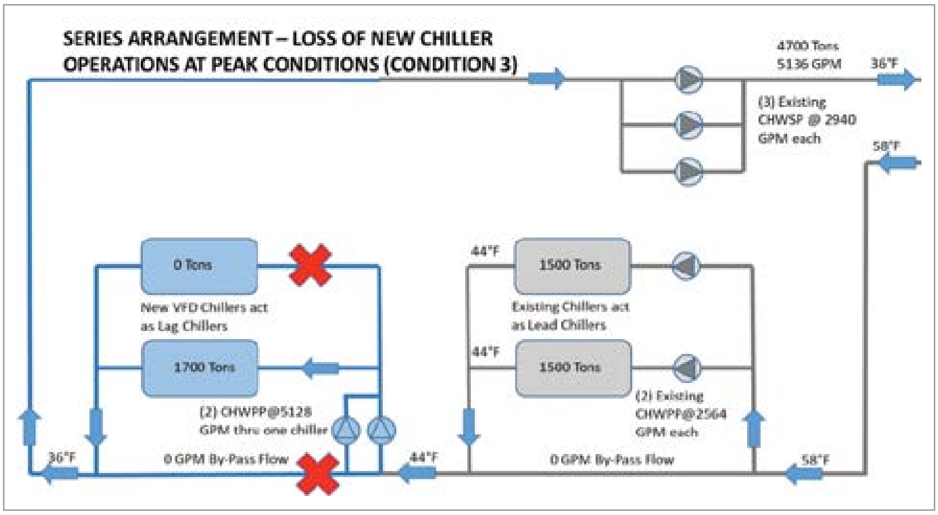

Figure 3. Operating Mode if One Lag Chiller is Lost

The existing electric centrifugal water chillers had undergone an extensive refurbishment just prior to the issuance of the RFP in 2016, so there was a strong preference to retain the chillers within the upgraded plant. The design team investigated multiple new chiller configurations including looking at different chiller technologies, quantities and capacities of chillers, and equipment configurations until a final solution was agreed upon by all stakeholders. The final solution was a team effort between HMG, Burns & McDonnell and the controls contractor, Inspiring Technologies Corporation (ITC), that configured the system into a series chilling, lead-lag approach.

The new solution modified the existing chiller operating conditions to take the return water from 58°F to 44°F for further chilling by the new lag chillers. The existing chillers were rerated to provide 1500-tons at peak conditions. The new lag centrifugal chillers were selected for 1700 tons of capacity at 44°F entering and 36°F leaving at peak conditions. The new chillers have remote mounted Variable Speed Drives (VFDs) for enhanced part load performance.

While the terminal cooling loads did increase due to the construction of a new Transportation Security Administration (TSA) security bridge over Cicero Avenue, the overall loads, with a 200-ton cushion for future growth, were reduced due to the removal of over 700-tons of pre-conditioned air (PCA) chillers and PCA AHUs system from the chilled water loop resulting in a new peak plant capacity of 4,700 tons.

Once again, the plant equipment was selected for several operating scenarios to provide peak capacity upon the loss of any unit of production. In lieu of having redundancy of an entire chiller

Figure 4. Image of New Lag Chillers

and cooling tower, the new layout incorporated the redundancy by oversizing the equipment and selecting them to operate in multiple emergency conditions. The new chillers were oversized so that any chiller, new or existing, could be lost and the peak capacity could be satisfied. Similarly, the cooling towers were oversized so that if a single cell was lost, peak capacity could still be met. This concept was extended to the pumping systems so that any chilled water (CHW) primary and condenser water (CW) pumps could be down, and the plant could still produce peak capacity.

A total of three operating conditions were developed to ensure that the equipment was sized adequately so the CHRP could sustain a peak capacity of 4,700 tons. Figures 1 through 3 illustrate the conditions. Figure 1 illustrates the peak load Condition 1 or "normal" operations were all equipment is functioning routinely with the existing chillers totaling 3,000-tons and the new chillers totaling 1,700-tons for a total of 4,700tons. The figures depict existing piping and equipment as grey, and the new piping and equipment is depicted in blue.

In this operating condition, there would be no flow bypassing either the lead or lag chillers.

Figure 2 highlights how the plant reacts when a single existing lead chiller is lost. Now half of the system return flow goes through the operating lead chiller and the remainder of the flow bypasses the lead chillers and mixes with the lead chiller's 44°F outlet water to create a new lag chiller blended inlet temperature of 51°F. The two operating lag chillers share the flow and almost double their output to 1600-tons each to retain the CHRP 36°F leaving water temperature and peak capacity.

Figure 3 demonstrates the final operating condition when one of the new lag chillers is lost. The existing lead chillers see full flow and no change in load, but the remaining lag chiller sees twice its normal flow and is selected to preserves the plant leaving water temperature and capacity. In this case no water is bypassed around either lead or lag chillers.

The chilled water portion of the plant was completed in April 2020 and the last cooling

Modernization at Chicago Midway International Airport Central Heating and Refrigeration Plant

towers and condenser water piping were phased in by early 2021. The air travel industry was dramatically impacted in 2020 by the COVID-19 pandemic and saw historic reductions in flights. The flight reductions translated into a reduction in passengers and ultimately airport cooling loads. Further impacts to reducing the cooling loads were updates to the variable air volume (VAV) control system and reheat coil control valve replacement with pressure independent control valves which significantly reduced simultaneous heating and cooling loads. Hence, the upgraded MDW CHRP never reached its previous peaks to prove its performance during the summer of 2020.

While the peak capacity performance was not proven during 2020 for MDW's CHRP, what was confirmed was a dramatic reduction in CHRP electrical energy usage due to a combination of the aforementioned lower cooling loads and more efficient equipment that can better handle the lower loads. So, while it may be too soon to state that the CHRP upgrades were 100% successful, the operators are extremely happy regarding the efficient operation of the plant and the resultant reduced operating costs. These plant upgrades will facilitate MDW to provide comfort cooling to the passenger airport experience while operating with more efficient equipment to handle upset conditions for the next 20-years to come. BP

Figure 5. View of New Lag Chillers on Left with Existing Lag Chillers in Center (photo courtesy of HMG)

Figure 6. View of New CHRP Cooling Towers from Parking Ramp (courtesy of HMG)

About the Author

Steve Tredinnick, P.E., CEM, ASHRAE Fellow, is a Senior Project Manager at Burns & McDonnell with over 38-years of experience, where he specializes in district cooling and heating plants and distribution systems; campus utilities and utility master plans. Steve is a member of the International District Energy Association (IDEA) and is active in ASHRAE Technical Committees. He is also a co-author of the ASHRAE District Cooling Guide (Second Edition) and Owner's Guide for Buildings Served by District Cooling.

About Burns & McDonnell

Burns & McDonnell is a family of companies bringing together an unmatched team of 7,600 engineers, construction professionals, architects, planners, technologists and scientists to design and build our critical infrastructure. With an integrated construction and design mindset, we offer full-service capabilities with more than 55 offices, globally. Founded in 1898, Burns & McDonnell is a 100% employee-owned company and proud to be on Fortune's 2020 list of 100 Best Companies to Work For. Learn how we are on call through it all: https://info.burnsmcd.com/critical-infrastructure?utm_campaign

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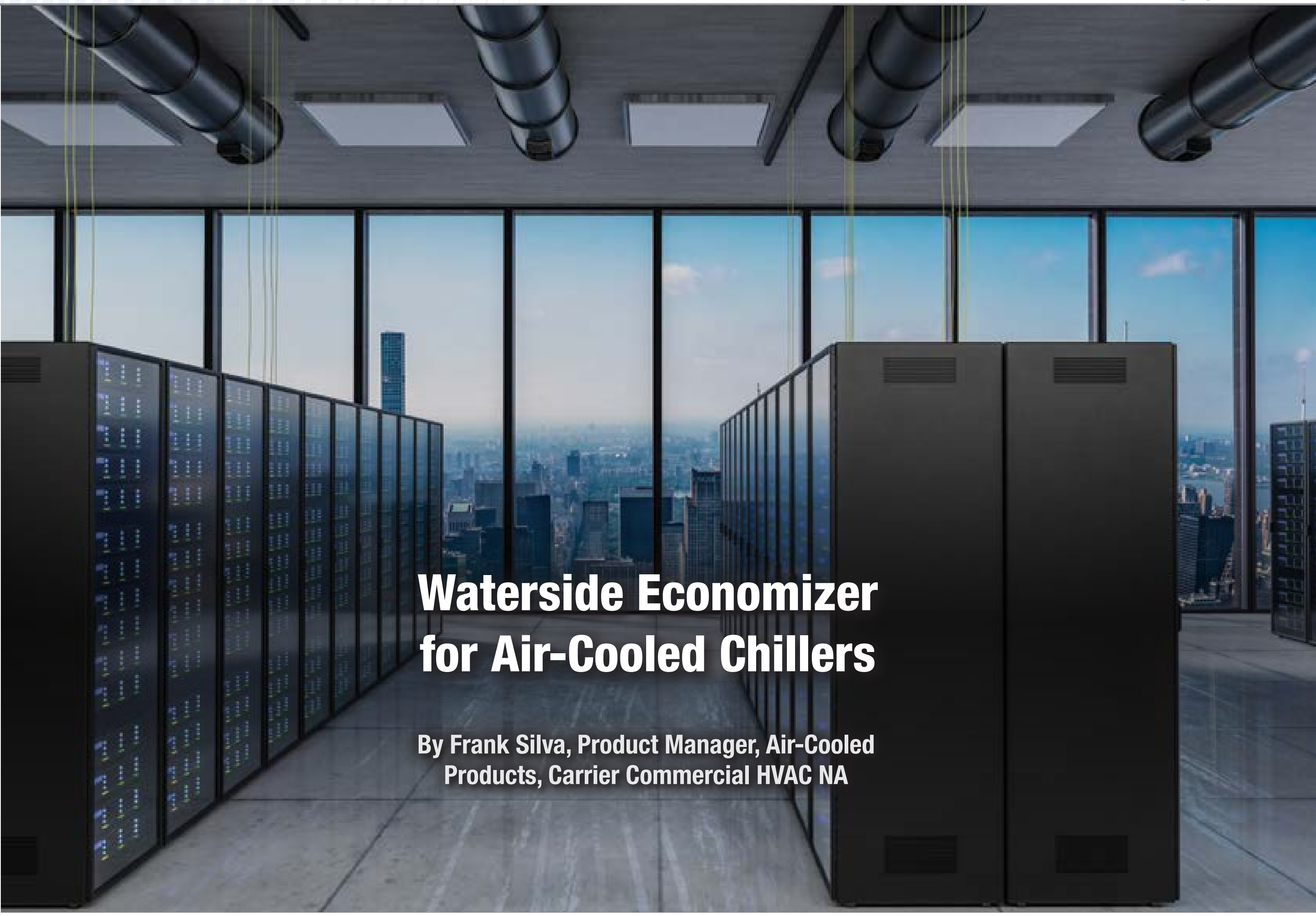

Waterside Economizer for Air-Cooled Chillers

By Frank Silva, Product Manager, Air-Cooled Products, Carrier Commercial HVAC NA

Author's note: This article discusses using devices known as "waterside economizers" and "dry coolers" as means to achieve "free-cooling". Free cooling (sometimes referred to as a "free cooling system") can reduce energy consumption and operating costs by using cold ambient air in lieu of running chiller compressors for cooling loads.

While it may not seem obvious, in many HVAC applications there's a need to provide cooling even in colder months because of internal loads driven by people, computers, machinery and lighting.

Running a chiller year-round is one way to meet that need but doing so can be costly and inefficient. Another solution is to operate a waterside economizer, sometimes known as

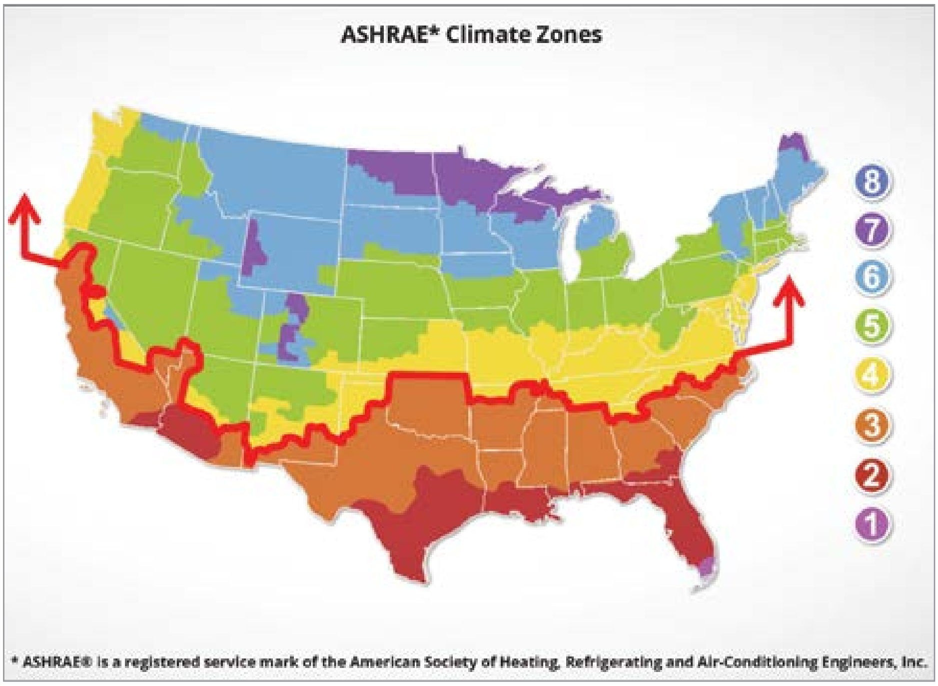

Figure 1. Source: www.ashrae.org

Waterside Economizer for Air-Cooled Chillers

a free cooling system. There are a few reasons a free cooling system might be used.

One reason to run a free cooling system is to meet ASHRAE Code 90.1 2016 requirements. ASHRAE breaks the country into different climate zones. If your local building code has adopted ASHRAE Code 90.1 2016, any location in Zone 4 (Fig. 1) or above needs to have either an air or waterside economizer to meet the code.

Another reason to use a free cooling system is to take advantage of colder weather to meet the building's setpoint, saving energy.

Figure 2.

Facilities such as data centers are particularly interested in these types of free cooling systems because of the vast amount of heat they generate in a 24/7 operation. This means they will use free cooling a good portion of the year in almost any climate.

When using an air-cooled chiller for mechanical cooling, all methods of obtaining free cooling utilize some type of "dry cooler," the only difference is where it's located.

There are various types of Dry Coolers as seen in Figure 2.

Remote Dry Cooler: a general-purpose cooler that sits apart from the air-cooled chiller. The two are piped together.

Stacked Coil Dry Cooler: free-cooling coils are mounted (or "stacked") next to the chiller's existing refrigerant condenser coils.

Bolt-On Dry Cooler (also known as modular design): This attaches directly to the air-cooled chiller. Available in a host of sizes, the modular design can provide the appropriate amount of free cooling for the application.

Stacked or Modular dry coolers are preferred in many cases because they are designed to integrate directly with specific chillers from the factory, improving performance. Where there is space available, the modular option can offer superior performance and convenience. Let's examine why:

A free cooling system will run in one of three modes:

- Mechanical Cooling only
- Free Cooling only

- Hybrid Mode where Mechanical Cooling and Free Cooling occur simultaneously

Mechanical Cooling Only

When the ambient temperature is too high to provide free cooling, the chiller operates in mechanical cooling only mode.

In this case, the fans on the stacked coil design need to force air through both the chiller condenser coils and the unused free cooling coils, which ends up wasting energy.

The modular design is different.

When it's in mechanical cooling mode, the air flows only over the mechanical cooling coils that are in use, while the fans for free cooling are turned off, thus, saving energy. (See Figure 3 for air flow diagrams.)

Free Cooling Only

When the ambient temperature is low enough, mechanical cooling can shut off completely, and the setpoint can be met by free cooling mode alone.

With the stacked coil design, air again needs to flow over both sets of coils when only one is active, which wastes energy.

With the modular design, only the free cooling section will be active, maximizing free cooling, while the fans for mechanical cooling will turn off. Once again, saving energy

Hybrid Cooling (Mechanical and Free Cooling simultaneously)

Even when the ambient temperature isn't low enough for free cooling only, some free cooling is still possible. This requires hybrid cooling mode, where both sections of the chiller work in tandem.

With the stacked coil design, air needs to flow over both sets of coils. This presents a problem for the fan control system.

The free cooling coils want as much air as possible to maximize free-cooling performance. Conversely, the mechanical cooling coils want to lower the fan speed to ensure the refrigerant doesn't get too cold, missing the setpoint and shutting down the chiller. As a result, the system can become less dependable with frequent nuisance trips. In addition, the system fails to make the most of the free cooling opportunity.

In the modular design, the mechanical and free cooling sections are able to operate independently.

So, in hybrid cooling mode, the air flows over the mechanical and free cooling coils separately. This allows the free cooling fans to speed up, extracting every bit of free cooling possible. At the same time, the mechanical cooling fans can slow down, to maintain setpoint and protect the system, again, saving energy (Figure 3).

It's important to note that when ambient temperatures allow a system to take advantage of free cooling, a large majority of the hours occur in the hybrid mode. For example, in data center applications it can range from 70 to 100% of the operating hours. Therefore, maximizing the free cooling capacity, especially in the high-hour hybrid mode operation, will be key to optimizing your energy savings goal.

Waterside Economizer for Air-Cooled Chillers

While the modular design is engineered and built to optimize its free cooling performance, one of the most desirable features of this design is its customizable nature. Instead of requiring customers to install an "all or nothing" option, they can customize how much free cooling they would like for each job. The modular design allows for many different configurations. While some jobs may only desire a limited amount of free cooling, others may want substantially more. With the modular system, the amount is completely customizable.

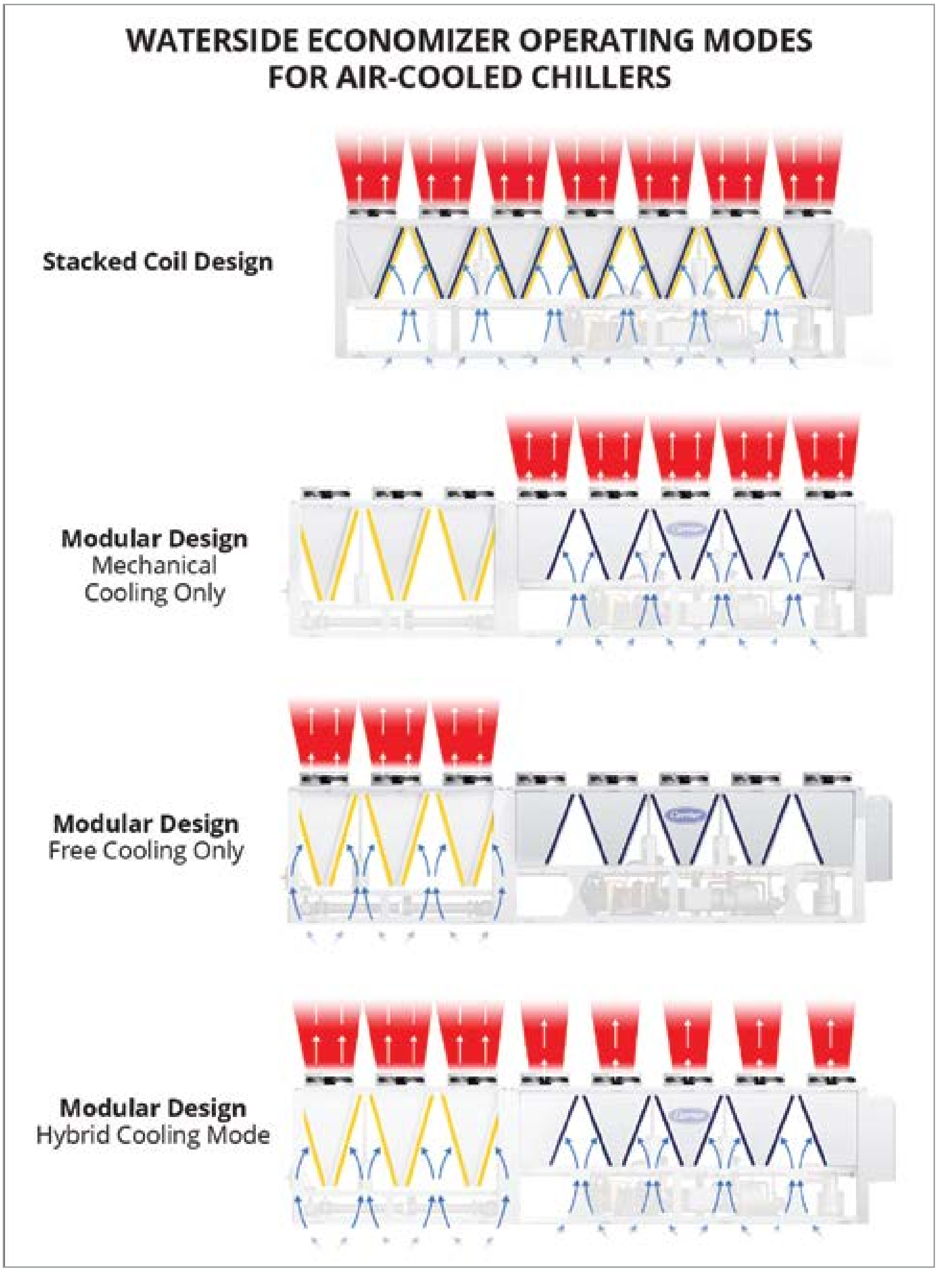

Figure 3.

The modular design not only offers superior performance and customization, it offers significant service advantages in all operating modes.

With the stacked coil design, as the air flows over two closely coupled coils one of them essentially becomes a filter, trapping dirt and debris between the coils. This can make cleaning and coil replacement extremely difficult (Figure 4).

With the modular design, there's only one coil, so most dirt is expelled by the existing fans. A normal coil wash can eliminate remaining dirt. In addition, service can be done on either the mechanical or free cooling side of the system, without taking the other side of the system offline.

Choosing between the two options can depend on a number of factors including desired free cooling performance, ease of service and space constraints.

Free cooling is a great opportunity to generate savings, but the choice of the type of waterside economizer may be crucial to maximize the benefits. BP

About the Author

Frank Silva is a Product Manager of Air-Cooled Products for Carrier Commercial HVAC North America. With over twenty-five years of experience in industrial sales and marketing management, Silva is responsible for development and implementation of marketing strategies and plans for new products and technology innovation. He works out of Carrier North America's Chiller manufacturing plant in Charlotte, North Carolina.

About Carrier

Founded by the inventor of modern air conditioning, Carrier is a world leader in high-technology heating, *air-conditioning and refrigeration solutions. Carrier experts provide sustainable solutions, integrating energy-efficient products, building controls and energy services for residential, commercial, retail, transport and food service customers. Carrier's HVAC business is a part of Carrier Global Corporation, a leading global provider of healthy, safe and sustainable building and cold chain solutions. For more information, visit www.carrier.com/commercial*

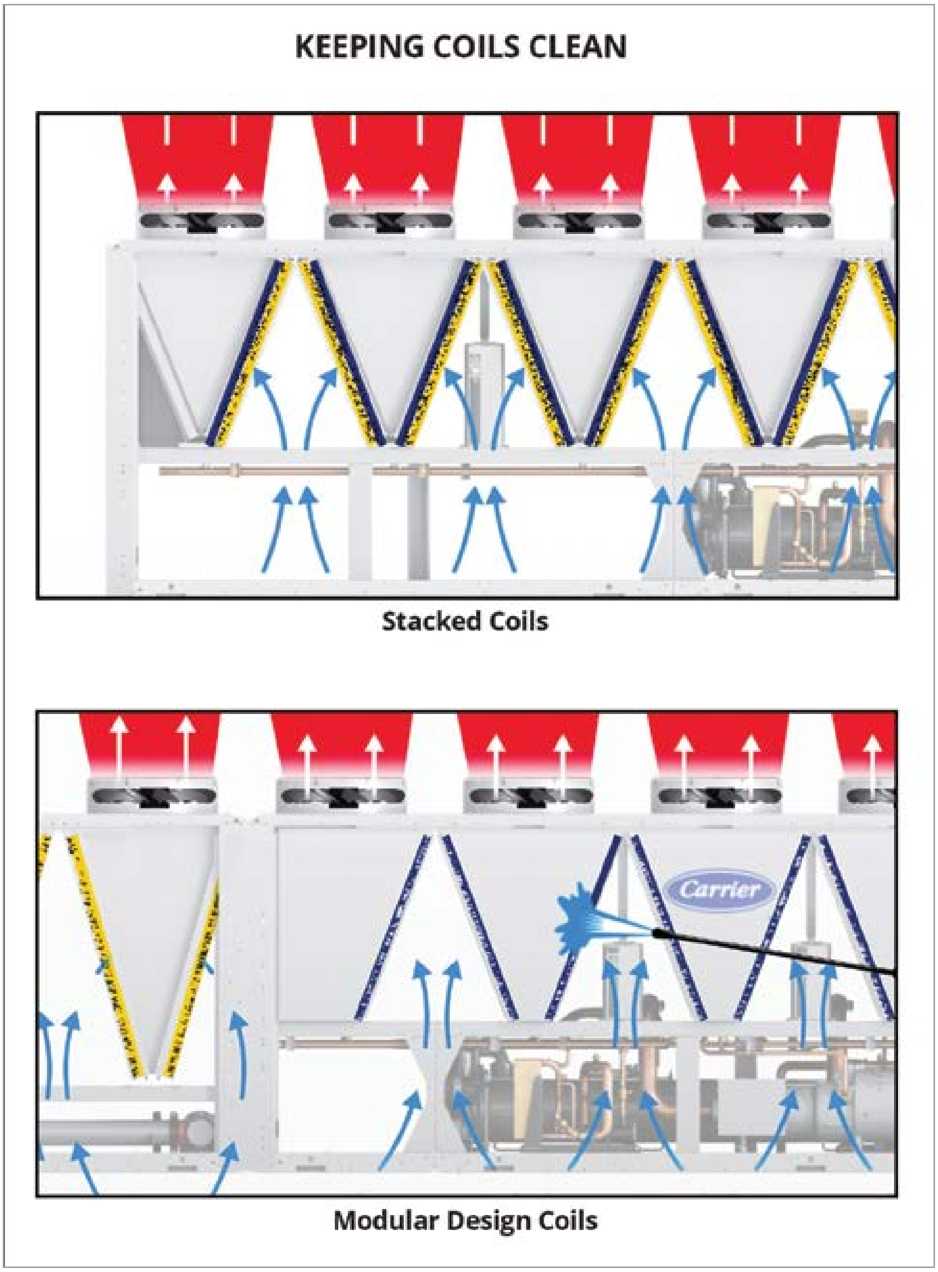

Figure 4.

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Bayer Crop Science Chiller Replacement Project

By Eric Kruzan, CEM, CEA, CDSM, Senior Business Development Representative, Evergy Business Energy Savings Program

Bayer Global is a well-known, life science company with more than a 150-year history and core competencies in health care and agriculture. Bayer's research and development of products for agriculture make an important contribution to providing a reliable supply of high-quality food, feed and plant-based raw materials to serve a growing population around the world.

Such is the role of the Bayer Crop Science plant in Kansas City, Missouri, in manufacturing herbicides, fungicides and insecticides to the serve the agricultural community. The 240-acre site employees a 550- member workforce in approximately 80 acres of production facilities.

Background

In 2010, an 800-ton water-cooled chiller was installed at the SFP plant to provide process chilled water to support the active diffusion process in the plant. The 800-ton chiller was connected to a common header with a 600-ton and a 1,000-ton chiller in a closed-loop system supporting the production process. The chillers run year-round to create a constant 40°F water temperature for production equipment in the plant.

Plant chillers are tested annually as part of the maintenance protocol at the plant, and in 2018 the 800-ton chiller showed that several tubes were fouled, leading to concerns about efficiency and reliability. Subsequent efficiency tests in 2019 showed increased fowling and corrosion in more tubes in the chiller, which lead to the crossroad decision between replacing the tubes or replacing the chiller.

Preliminary analysis showed that the incremental cost of replacing the chiller, versus tube replacements, was the more cost-effective approach. So, in the fall of 2019 Bayer Crop Science engineers developed an RFP for a 900- ton chiller.

Operational Priorities

Bayer's operational priorities impact all purchase decisions for plant equipment and the priorities are:

- Safety
- Community
- Environment
- Production
- Cost

"Purchases also must support our Sustainability Goal of being "carbon neutral" by 2030, and special consideration is given to purchases that contribute to that goal," according to Abhishek Dhuri, Project Manager at Bayer Crop Science.

The RFP resulted in replacement chiller proposals from three vendors. Of the three, Bayer selected a variable-speed 900-ton AquaEdge chiller from Carrier Corporation's Commercial Sales Office in Lenexa, KS, to be the replacement chiller and scheduled the chiller installation for September 2020. The AquaEdge 19XRV-900 chiller specs showed an impressive Full Load Chiller Efficiency of .6122 kW/ton and a NPLV of 0.3971kW/ton for the R-134a machine. The chiller is to deliver a constant 40°F chilled water temperature for production purposes and would be a base load machine operating 85% of the time. And for ease of maintenance, the chiller was fitted with hinged cooler and condenser water box covers.

Coincidently with the chiller selection, Bayer Crop Science applied for an energy efficiency incentive from the local utility Evergy's Business Energy Savers Program. Under the incentive program, high efficiency process chillers can qualify for incentives to help pay down the incremental cost associated with high efficiency equipment. After thorough review of the project's electricity savings, Bayer Crop Science was awarded a substantial incentive based on the substantial savings delivered by the new chiller.

So, by January of 2020, Bayer Crop Science had identified the need for a replacement chiller, had completed the selection of the new chiller, and received commitment for an incentive from Evergy to support the project and had a target date of September 2020 for the replacement.

The new 900-ton variable speed chiller.

Three chillers provide process chilled water to support the active diffusion process in the plant.

The Best Laid Plans…

In March of 2020, the original replacement plan began to unravel, starting with the failure of the 10-year-old chiller. Bayer reached out to Carrier to request expedition of the chiller order. At the same time the COVID-19 pandemic invaded the business practices of both Bayer and Carrier, with key project employees moving to a work-from-home environment. Uncertainty about availability, coordination of delivery and a new operating

Bayer Crop Science Chiller Replacement Project

schedule required close coordination between Bayer Crop Science, Carrier Commercial Sales and the Carrier chiller plant to create a new expedited installation plan.

The revised installation plan called for completing the chiller installation by May 2020. Vincent Masucci, of Carrier Commercial Sales, explained that a review of typical manufacturing and delivery process had to be modified to meet the new installation deadline, with the typical factory witness test being canceled and the Belzona tube coating process that typically is done at the factory, was done at the plant, once the chiller was delivered."

So, the expedited installation plan was set in motion and the chiller arrived on site, the second week of April. Bayer engaged the services of CDI Industrial & Mechanical to demolish the old chiller, complete the Belzona tube coating and complete the installation. Load testing of the chiller was completed shortly after the installation and it was put into operation in May of 2020, five months ahead of the original plan.

The process cooling savings are:

Non-Ambient Cooling (Baseload Chiller – IECC 2012) =	1,164,582 kWhs
Non-Ambient Cooling (Proposed Chiller – Carrier AquaEdge) =	491,359 kWhs
Project kWh Savings	673,223 KWhs
Project kW Demand Savings	140 kW

The Business Energy Savings Program is sponsored by Evergy Inc, the electric utility serving the former Kansas City Power & Light and Westar Energy territories in Missouri and Kansas. The current energy efficiency program is only available to Missouri customers and provides energy efficiency incentives for residential, commercial, institutional, and industrial customers. Evergy also offers several renewable energy programs in Missouri and Kansas territories. BP

The new 900-ton variable speed chiller.

About Evergy's Business Energy Savings Program

Provides incentives for a range of energy efficiency measures for business and industrial customers in and around Kansas City, Missouri, including process chiller replacements, chilled water system optimization, variable frequency drives for pumps, free cooling and thermal energy storage. For more information about the Evergy Business Energy Savings Program, please visit https://www.evergy.com/ways-to-save/resources

About TRC Advanced Energy

TRC Advanced Energy is a multi-discipline engineering, consulting and construction firm that provides advanced energy services in the environmental, power, energy infrastructure and oil and gas market sectors. TRC currently provides utility energy efficiency program management for 19 utilities, including Evergy, across the country, and renewable energy sources, energy storage, microgrids and distributed energy resources in the United States and abroad. Visit https://www.trccompanies.com

The author would like to thank and acknowledge the contributions to this article by Abhishek Dhuri, Project Manager, Bayer Crop Science. To learn more about the Evergy Business Energy Savings Program, contact Eric Kruzan at email businessrebates@evergy.com

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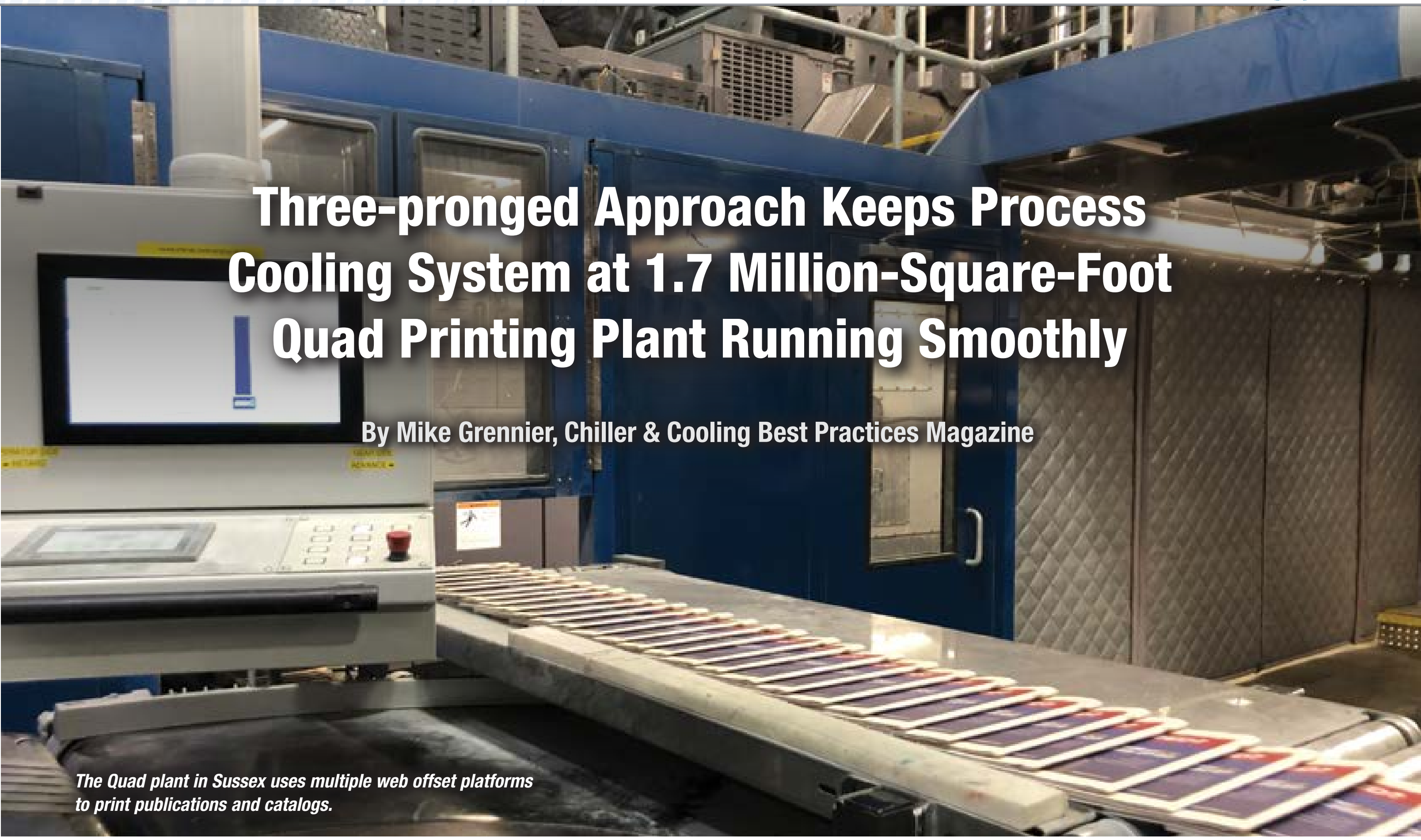

Three-pronged Approach Keeps Process Cooling System at 1.7 Million-Square-Foot Quad Printing Plant Running Smoothly

By Mike Grennier, Chiller & Cooling Best Practices Magazine

The Quad plant in Sussex uses multiple web offset platforms to print publications and catalogs.

For the Production Support team at the expansive Quad printing plant in Sussex, Wis., there isn't one way to manage the operation's complex and elaborate process cooling system. Rather, the formula for success involves a three-pronged approach that includes carefully measuring and monitoring system performance, diligently and proactively maintaining equipment to ensure peak efficiencies, and investing in updated equipment based on sound decision making.

All the while, said Quad Production Support-Regional Manager Joe Valoe, the team always keeps its eye on the prize.

"It's all about the quality of the print product. In order to do that, we have to supply our press network with cool water at the proper temperature for setting the ink," Valoe said. "Not only that, but the presses don't run if there's no cooling water; cooling is as important as the press itself."

An Industry Leader

Quad (formerly known as Quad/Graphics) is a worldwide marketing solutions partner. Headquartered in Sussex, it leverages its robust print foundation as part of a larger integrated marketing solutions platform with approximately 50 locations around the globe.

The company, founded in 1971, gained widespread recognition early on as one of the printing industry's foremost innovators and grew to become an industry leader with a A-list client base including some of most well-known media brands in the world. The company continues to print magazines (such as *Chiller and Cooling Best Practices Magazine*), along with other types of commercial solutions, and today leverages its data-driven print expertise as part of an integrated marketing platform that helps clients not only plan and produce marketing programs but also deploy, manage and measure them across all traditional and digital channels.

At its state-of-the-art, 1.7 million-square-foot plant in Sussex, Quad (www.quad.com) creates magazines, catalogs and other materials using high-speed web offset presses, along with advanced finishing techniques. Its more than 1,700 employees handle press room, printing, finishing, binding, maintenance, storage (including two High-Density Storage Systems) and distribution operations.

Like the company itself, the cooling system at the plant has evolved over time. Today, the system is constantly evaluated and re-evaluated to determine how best to support the printing operation – and do so cost-effectively.

Cooling Water for 17 Press Lines

The primary cooling system components at Quad's Sussex plant include seven, roof-mounted evaporative 400-ton cooling towers; a mix of seven, 400-ton rotary screw and centrifugal chillers; two 10,000-gallon sump tanks; and a 5,600-gallon sump tank. It also

Three-pronged Approach Keeps Process Cooling System at 1.7 Million-Square-Foot Quad Printing Plant Running Smoothly

consists of numerous plate-and-frame heat exchangers and 50 pumps. All components are duplicated for additional capacity and component redundancy. The system also includes nearly 2,000 feet of piping to transport cooling water throughout the sprawling complex.

Engineers designed the system to supply cooling water to two buildings housing 17 press lines, each of which operates multiple presses. The system also allows for cooling water to transfer for one system to the other if needed. In addition, the system supplies cooling water to a third dedicated loop for cooling a satellite high-pressure air mechanical room containing a mix of water cooled compressors and support equipment.

The system's main function is to deliver cooling water to presses where it's circulated through chill rolls for "setting ink" on paper in the printing process. In addition, oils, ink solutions and electrical components are also cooled. After water circulates through the press's cooling loops it returns to the evaporator side of a given chiller, giving up its heat load to the chiller's refrigerant. The heat load is then transferred to the condenser side of the chiller and onward to the cooling towers and out to the atmosphere.

The cooling towers at the plant sit on elevated roof superstructures with internal building tower sump tanks. The sump tanks accept both hot water from the condenser side of the chiller and cooled cooling tower water. The tanks are built with internal baffles to allow the two temperature water streams to mix. The condenser water loop temperature is controlled off the mixed sump tank water temperature. The cooling tower sump tanks allow for stable condenser water control for steady chiller operation.

Quad Production Support-Regional Manager Joe Valoe checks a control panel on one of seven chillers at the 1.7 million-square-foot Quad plant in Sussex, Wis.

The press chill loop system is designed to maintain a temperature of water from the chillers for the main press operation at 45°F (7°C) and 50°F (10°C) and for a second building featuring smaller press operations. The condenser water from the cooling tower/sump tanks is set to temperature of 75°F (24°C).

Maintaining Print Quality

The building featuring the plant's main press operation features several high-tech web offset presses. Normally, one to two cooling towers and one to two chillers are used to meet the press operation's cooling load, which varies from 350 to 1,000 tons. For the other building, one tower and one chiller is normally used to satisfy the 100-400 ton cooling load.

Printing press operators monitor and carefully control the temperature of cooling water for the press's chill rolls in both these buildings. The goal, said Valoe, is to keep the cooling water temperature between 60°F (15.5°C) and 70°F (21°C) to achieve the desired print quality on each press.

"The system is designed to support the press operations with a stable, steady-state volume of chilled water at a fairly constant temperature. Once ink is on the paper, it's run through a 'dryer' to drive off solvents in the ink. At that point, the ink is sticky and the chill rolls are used to set the ink. If the chill roll temperature is off by the slightest degree it affects the print quality and production, which is why the ability to maintain a stable and consistent cooling water temperature is critical," Valoe said.

Equally critical is the reliability of the system. As such, the operation's separate cooling systems are connected via a 10-inch diameter pipe. If one system needs to be shut down for any reason, such as an equipment upgrade, the plant can open the appropriate valving and activate the offline system and use it to supply cooling water to both press operations.

"We recently shut down one portion of our larger building's system to install a new centrifugal chiller, so we brought in cooling water from the other building to make sure we had enough capacity to keep the other pressroom satisfied," Valoe said.

Rigorous Monitoring and Maintenance

Ensuring reliability of the entire system at the plant is a priority because some components are well into their useful life. Valoe said the need for rigorous maintenance is paramount as part of the plant's continuous improvement process.

Shown is one of two 10,000-gallon sump tanks used to pre-mix cold and warm cooling water and supply it to the plant's chillers at 75°F (24°C).

"We're always looking at different strategies here," Valoe said. "What makes the most sense in terms of equipment in use and how can we maintain it and optimize what we have? What makes the most sense to replace and what's the return on investment?"

A key strategy involves the use of the plant's master control system to regularly monitor its performance and make improvements as needed. As an example, in 2020 the team spotted higher-than-normal condenser approach temperatures to the chillers. Since the temperatures increased beyond the desired setpoint, the team took action.

"Approach temperatures on chillers is a measurement of how good the heat exchangers are between the surfaces of the chillers' condenser and evaporator tubes," Valoe said, adding that an increase is unacceptable since it adversely affects chiller efficiency. The team subsequently commissioned Butters-Fetting Co., Inc., to thoroughly clean the evaporate and condenser tubes of every chiller. Butters-Fetting, a local mechanical contractor, also performs annual routine chiller maintenance at the plant.

Cleaning chiller heat exchangers saves the plant approximately $30,000 in energy costs per year and is one example of the team's ongoing efforts to gain system efficiencies using the plant's master control system, Valoe said.

Quad electrician/programmers also created an alarm to email the Production Support team when chiller condenser supply/return water temperature differential is greater than 10°F (-12°C) for more than 10 minutes. This simple change in the program on the master control system saves the chillers from dropping out due to no flow, or elevated condenser water temperature.

Another example of the value of monitoring with smart controls and maintenance is water treatment. The team actively monitors water treatment and contracts with local consulting firm Water Consultants of America to help maintain the proper chemistry of cooling water in the closed loop system and towers. Valoe said the consulting firm plays an important role in helping it maintain water chemistry and the manage the use of chemicals.

Monitoring the system regularly also helps the team improve ongoing energy efficiencies, Valoe said.

"We're looking at amps on all the chiller so we can determine the power draw," he said. "Our benchmark is one kilowatt per ton or less and we've been able to keep it there for the most part, depending on how the other equipment on the entire system is running."

Three-pronged Approach Keeps Process Cooling System at 1.7 Million-Square-Foot Quad Printing Plant Running Smoothly

System Optimization and Equipment Upgrades

Measuring and monitoring system performance and a diligent maintenance program represents two thirds of the formula for system efficiencies at the plant. The remainder involves changes in how the system is controlled, as well as investing in equipment upgrades.

The plant's master control system consists of a Texas Instruments program interfaced with Wonderware graphics package. The system provides the team with the metrics needed to ensure efficiencies and determine where changes are needed. In addition, the plant uses its own maintenance control algorithm for monitoring equipment and signaling the need for maintenance. The key, said Valoe, is to continually improve it.

"The control system is fairly robust and it works well," Valoe said. "We're now in the process of learning how to better program and streamline it as part of our continuous improvement process to further optimize the cooling system."

Continuous improvement also involves the replacement of older cooling system components. For the larger pressroom, the plant replaced an aging chiller in 2020 with a 400-ton Trane centrifugal chiller. Additionally, plans are underway to replace one of the cooling towers on main press operation building with a new, stainless steel unit to improve efficiencies and alleviate any potential problems with rust. In 2019, the company replaced an aging tower servicing the other building with a new tower.

"That's all part of the review process we've undertaken," Valoe said. "It's like, 'Okay. How do we make sure we have a steady state of chilled water with equipment?' One of them is looking at new cooling towers."

Mitch Koenigs of Quad monitors the Sussex plant's cooling system. As part of its continuous improvement process, the plant is working to improve on how it controls the system for further optimization.

Additional strategies involve an evaluation of initiatives once used to reduce the amount of energy required for cooling. It reinforces the goal of determining how to provide cooling for the plant as cost-effectively as possible.

One such initiative under review, as an example, involves a 430,000-gallon underground water tank in the building with smaller press operations that serves as a backup supply of water should city water be unavailable in the event of a fire. At one time, the plant chilled the water in the tank at night using a dedicated chiller. It then shut down a chiller and used the stored chilled water for cooling during peak utility hours, saving on electrical costs. The plant shelved the strategy years ago as production shifted over time, but the concept is back on the table since all ideas are welcome.

For Valoe and the company as a whole, it boils down to decision-making based on thorough analyses. Valoe also said it's a team effort, paying gratitude to all involved including Engineer Ted Tracy, Journeyman Electrician Mitch Koenigs, Master Electrician Bill Vetrano, Electrical Manager Jeff Berens, Master Electrician Jan Katcha and Building Maintenance Manager Greg White.

"We want to make sure that as a company we're making good decisions when it comes to the best use of existing equipment and how we wisely invest capital. Our goal is to be the lowest-cost provider of high quality services. Having a well-tuned cooling system helps us achieve that goal," Valoe said. BP

To read similar ***Cooling Tower and Chiller System Assessments*** articles, visit http://coolingbestpractices.com/system-assessments.

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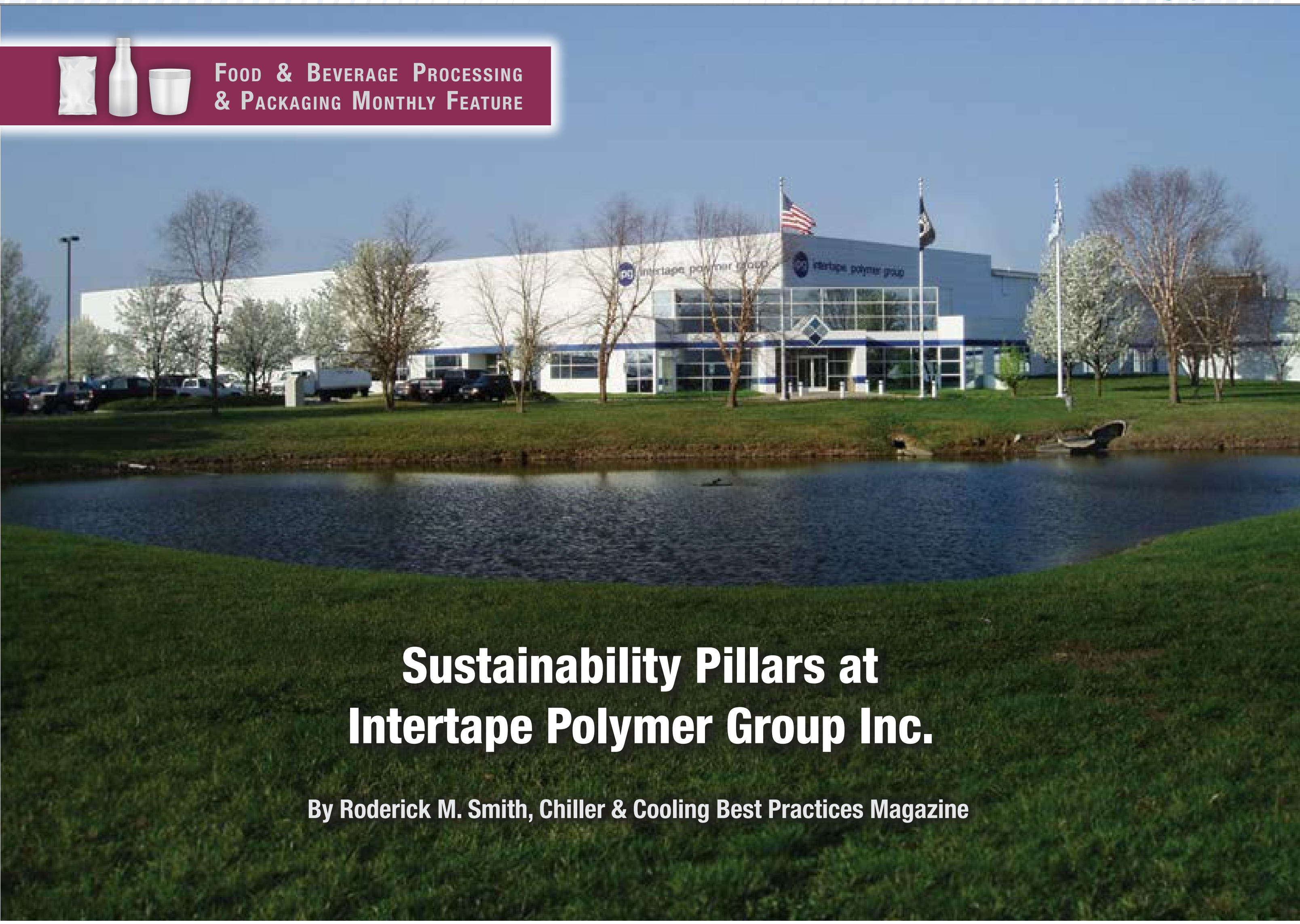

Sustainability Pillars at Intertape Polymer Group Inc.

By Roderick M. Smith, Chiller & Cooling Best Practices Magazine

In February 2021, Chiller & Cooling Best Practices Magazine interviewed members of the Intertape Polymer Group Inc. (IPG) Sustainability Pillars team to gain an understanding of the work being done to improve energy efficiency. The team members interviewed were Michael Jones (Director of Corporate Energy), Michael Deitering (Senior Project Engineer), Jarrod Knapp (Maintenance Manager) and Mark Secord (Engineering Group Leader).

Good morning, can you briefly describe IPG?

Good morning. IPG is a leader in the development, manufacture and sale of a variety of paper and film-based pressure-sensitive and water-activated tapes, polyethylene and specialized polyolefin films, protective packaging, engineered coated products and packaging machinery for industrial and retail use. For more information visit https://www.itape.com.

The Company employs approximately 3,600 employees with operations in 31 locations, including 21 manufacturing facilities in North America, four in Asia and one in Europe.

How does IPG approach sustainability and please describe your "Sustainability Pillars".

For IPG, embracing sustainability is a key strategy of doing business to drive operational excellence and realize our company vision of global leadership in packaging and protective solutions while also doing what is right for our employees and communities.

Optimizing our operational footprint is one of the four pillars of our sustainability strategy. This means we are managing environmental impacts like energy, greenhouse gases (GHG), water, waste, and other emissions.

Within our Intertape Performance System, there are many steering teams with different objectives. We have Sustainability Pillar Teams, in each plant, focused on energy/GHG, water and waste reduction. Sustainability Pillar Teams meet every other week, in each plant, and include members of plant management, engineering and plant maintenance.

How are projects identified and goals established?

Each plant has a 1 and 5-year Energy Action Plan (EAP). We use the A3 methodology (developed by Toyota) for our corporate energy action plan. This is a "plan-do-check-act" methodology which all fits on one A3 size page. You can pin it up on a cork board and has been popular in Lean Manufacturing techniques. In addition, we use the A3 methodology for solving problems and for planning. You state current condition, set a goal, do root cause analysis, state the action plan, and then track progress by keeping score.

Each plant prepares a deployment plan for the year, which identifies projects designed to help them achieve their EAP goal. We conduct a monthly Corporate Sustainability Pillar call with the leaders of all the plants. Leaders of each plant share best practices and progress towards our Sustainability and EAP goals. Sharing Best Practices rapidly is key and this call is how we share successes quickly. It might be something as seemingly simple as discovering a new compressed air ultrasonic leak detector. We put all our documents on our Microsoft Teams shared site and our team can access all the documents there with the details of the Best Practice.

The rotary screw air compressor installed at the Carbondale, Illinois plant.

What are some key tactics IPG uses to raise the profile of energy conservation projects?

The U.S. Environmental Protection Agencies' ENERGY STAR® program has made a big impact. In 2020 we were recognized as ENERGY STAR Partner of the Year-Sustained Excellence for the 5th year in a row. Across our plants, we achieved a 3.7% reduction in energy intensity in 2019 vs 2018.

We achieved the ENERGY STAR Challenge for Industry at IPG's Carbondale, IL manufacturing facility for the 4th time. In order to be recognized, a plant has to measure and reduce their energy intensity by 10% over a 5-year period. Since 2009, our individual plants have received this recognition 14 different times. Carbondale has been a leader in pursuing this recognition. Our plants tell us the ENERGY STAR Challenge for Industry program creates some healthy internal competition and satisfaction for being recognized for accomplishments in cost reduction and doing what's right for sustainability.

We have also held an annual IPG Energy Summit since 2007. All plants come and benefit from team building and educational opportunities. In 2020 we gave out awards juried by an awards committee consisting of the Director of Corporate Energy (Michael Jones), a VP of Operations, an SVP of Operations and a Continuous Improvement Leader. Specific criteria for each of the following awards were developed. The awards were:

a. Sustainability manager of the year

b. Best plant sustainability program

c. Best plant sustainability project

d. Lifetime achievement award

e. Sustainability impact award for the new acquisition plants (one which really knocked it out of the park)!

Please describe your "Air Strike Teams" and their focus on eliminating compressed air leaks.

Some of our plants have created Air Strike Teams to focus on compressed air, particularly compressed air leaks. The teams have purchased ultrasonic leak detectors, and we expect these will help us with our Energy Treasure Hunts. We have a newer acquisition (PolyAir), with 7 plants, and all have formed teams and bought leak detectors.

We have a deployment plan that we use which schedules a quarterly strike team to go look for leaks. Leak surveys are usually scheduled during plant down-time when it's quiet in the plant, and easier to hear the leaks. Additionally, some leaks can only be repaired when the production equipment is not operating.

A typical three to four-person Air Strike Team is made up by plant and production line supervisors, production equipment operators, and maintenance mechanics. During a leak survey, normally production personnel (equipment operators) will identify leaks. A second person logs the leak using the application provided by the ultrasonic leak detector vendor. The application (which is very useful and downloaded on iPhones) automatically tabulates data and gives you a spreadsheet containing information (size, location, dollar value, etc.…) on each leak. The third person involved is normally from maintenance to fix the leak on the spot if possible. An extra fourth person may be there for training to learn how to use the equipment. COVID-19 has forced us to use smaller teams with only one person using the meter.

Most of the time, repairing compressed air leaks is simple and the majority of the leaks are generally repaired during the leak survey. Maintenance is using wrenches, channel locks, screw drivers, and tightening up hoses. The team will carry some extra hose to replace pneumatic tubing and hoses-we don't patch. Having a parts strategy really helps with repairing leaks. Several of our IPG maintenance shops have a Fastenal vending machines carrying most of the air fittings we need. We also try to standardize certain brands of hoses, tubes and push-to-connect fittings. Some brands work significantly better than others and the premium is well worth the cost in compressed air leaks.

We have a red-tag system for the unrepaired leaks (after a leak survey) so we don't lose sight of them. We try to use same person who was originally there to follow up and fix the leak. When maintenance technicians are doing preventative maintenance, on production equipment, and see a red tag, they can quickly look up the leak value in terms of dollars. We hold fun competitions, within the maintenance staff, on the dollar value of leaks fixed in a given month.

Sustainability Pillars at Intertape Polymer Group Inc.

The free-cooling winter cooler installed at the Marysville, Michigan plant.

Your Carbondale, Illinois plant has achieved the ENERGY STAR Challenge for Industry recognition for the 4th time. Can you share some of the projects driving this?

Sure, let's ask Jarrod Knapp (Carbondale Maintenance Manager) to comment on that. In 2019, the Carbondale Facility was awarded the ENERGY STAR Challenge for Industry by reducing its energy intensity 11.8 percent within two years vs. the baseline. A minimum of a 10 percent reduction was required for recognition. We have established baselines which we keep rolling forward and working on. Here are some of the projects.

1. We did a complete plant lighting retrofit in 2016 in both the plant and our office space. This involved replacing our existing T12's with LED retrofit kits.

2. As mentioned, we do regular compressed air leak studies, which always give good results. We noticed, as the plant grew, we were

running our 100 hp rotary screw air compressor always at full capacity and a 75 hp rotary screw unit (both were older fixed-speed) units, at part-load to trim. We also had some shut-downs with these air-cooled units due to high ambient temperatures. We asked John Henry Foster, out of St. Louis, to do a complete compressed air system assessment to analyze things. Their analysis confirmed the dollar costs to run the 75 hp fixed speed unit inefficiently at part-load. Based upon the assessment, we installed two twin water-cooled 150 hp variable speed drive units – the second unit is for redundancy and we alternate them daily. John Henry Foster also recommended a receiver tank to smooth out our compressed air demand and a cycling refrigerated dryer.

3. We optimized our turn-off/shut-down procedure for our gas-fired regenerative thermal oxidizer (RTO). Our RTO unit has a 250 hp motor which was running at 40 Hz when idle due to individual dampeners being left open. We modified it to run off of duct pressure and now it runs at 20 Hz when closed and in idle. This has really helped us to reduce natural gas consumption.

Congratulations. Do you have any chiller/cooling water projects to comment on?

Yes, there have been many, we had a successful centrifugal chiller project using free-cooling, at our Turo, Nova Scotia plant. We've asked Michael Deitering (Senior Project Engineer), to quickly review a successful winter cooler project done at our Marysville, Michigan plant.

At our Marysville plant, we'd been running a 200-ton chiller year-round to provide glycol cooling for the extruders in our adhesives production department. The system was reliable but we thought we could take advantage of the low temperatures in southeast Michigan, seven to eight months per year, with free-cooling concepts. Our original chiller layout had glycol going through the plant.

We installed two roof-mounted "dry-cooler" coils with staged banks of 10 fans each to cool glycol. We separated the system to cool glycol to 50°F (10°C) which then cools plant water to 55°F (13°C). We had to add a pump tank and a heat exchanger to separate the system. This system has 30 hp of fans and a 20 hp pump running fluid to the roof.

The system went on-line in January 2020. We now turn off the 200-ton rated refrigerated chiller, whenever we see temperatures below 57–60°F (14–16°C). The chiller is replaced by coils and fans to produce same amount of tonnage using only 20 hp in pumps and 30 hp in fans. We run this 7-8 months out of the year. The 200-ton chiller runs during the warmer months. Today we are at 6°F (-6°C) ambient and we can turn off the fans, just run the fluid pump – and we are providing 41°F (5°C) water temperatures. The project was fairly straight forward. We feel it's underutilized technology – most plants aren't doing this sort of thing.

Thank you for sharing Best Practices and congratulations on your progress with energy efficiency. BP

For more information about Intertape Polymer Group Inc. visit https://www.itape.com

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CHILLER & COOLING INDUSTRY & TECHNOLOGY NEWS

Vertex Evaporative Condenser

Baltimore Aircoil has introduced the Vertex Evaporative Condenser. The Vertex Condenser offers maximum uptime with easy and safe accessibility and uses a direct-drive EC Fan System. It reduces installation costs by 30%, in part by aligning the upper section to the lower section in less than 15 minutes per cell, due to the industrial-grade rigidity of the unit. Water volume is reduced by up to 30%, saving on water and chemical costs. This helps reduce the operating weight by an average of 16%. It has an access door which easily accommodates a 6.5-foot tall person with a sturdy step and safety handle. Technicians' feet also stay dry while safely inspecting the low-volume basin from the internal walkway.

Baltimore Aircoil Company, www.baltimoreaircoil.com

KSE Series Outdoor Chillers

Thermal Care released a new outdoor packaged chiller, designed with the flexibility to provide process cooling year-round, with a wide range of operating conditions. Accuchiller KSE Series chillers are fully packaged, integral air-cooled outdoor units manufactured to work in the harshest weather environments. Energy saving variable speed EC fans allow the chiller to withstand ambient conditions from -20°F to 125°F. As an added bonus, the process fluid circuit allows for more flexibility with a set point temperature range from 20°F to 80°F. Available from 40 to 720 tons in a combined system, units come with or without integrated pumping packages in either low or high pressures designs with an optional redundant standby pump. The high-pressure design allows it to support entire plant wide cooling system needs.

Thermal Care, www.thermalcare.com

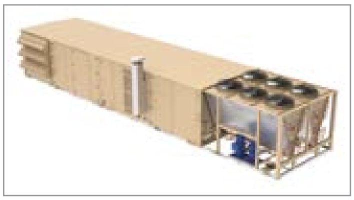
VFD Process Chillers

Delta T Systems has announced that its entire chiller product line can now be equipped with variable frequency drives (VFDs) to control the pump motor. This is accomplished by varying the frequency and voltage of the power supplied to the motor. The primary reasons for adjusting the motor speed on chillers is to control process variables. All of the process parameters can be set directly by user input on the chiller HMI or remotely through one of a variety of communication protocols. The Delta T Systems VFDs also have several parameters that can be adjusted to tune them to unique customer's process characteristics.

Delta T Systems, www.deltatsys.com

Commercial Rooftop Units

The YORK brand of Johnson Controls has expanded its line of premium commercial rooftop units now available in 25-80 tons with new, dynamic features. The expanded YORK Sun Premier platform is designed to offer contractors faster installation and simplified start-up, while providing building owners with best-in-class efficiency levels that significantly reduce operational costs over the life of the unit. The Premier platform meets aggressive Department of Energy 2023 energy efficiency standards. Offered in standard efficiency, high capacity or high efficiency, the units can provide up to 50 percent greater efficiency at part-load than is required, depending on the standard.



YORK brand of Johnson Controls, www.york.com

CHILLER & COOLING INDUSTRY & TECHNOLOGY NEWS

Danfoss Decarbonizes by Building Green Data Centers

Next year, Danfoss headquarters in Nordborg, Denmark, will be CO_2 neutral. And, in 2024, by utilizing excess heat, Danfoss' own data centers will provide 25% of the headquarters' heating need. Data centers are consuming vast amounts of energy to supply servers with power, but also to cool down server rooms and remove the huge amounts of heat they generate. This provides the opportunity to use oil-free heat-pump systems to transform the data center into a heat source. The excess heat from the data center can then be distributed to a local neighborhood. Utilizing this excess heat for use in heating applications, instead of allowing it to escape, represents a massive opportunity for Danfoss to provide an environmentally friendly solution that will help the company reach complete global decarbonization by 2030.

Danfoss, www.danfoss.com

HVAC Plant Powered by Wind Energy

Johnson Controls' 1.3 million square-foot HVAC manufacturing plant in Wichita, KS, is now powered by 100% wind energy. The plant is receiving its wind energy from Evergy's Soldier Creek Wind Farm, a 300-megawatt wind farm in Nemaha County, Kansas, that was completed in November 2020. The energy cost savings projections from the wind power agreement are expected to be approximately $2.7 million over the life of the 20-year contract – the equivalent of taking 100,000 passenger vehicles off the road. Johnson Controls set new commitments such as aiming to achieve zero carbon emissions before 2040, reducing the company's operational emissions by 55% and reducing customers' emissions by 16% before 2030. In addition, the company aims to achieve 100% renewable electricity usage globally by 2040.

Johnson Controls, www.johnsoncontrols.com

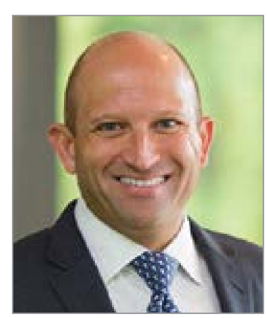
Daikin Acquires ABCO

Daikin announced a strategic alignment with ABCO HVACR Supply + Solutions, distributor of HVAC and refrigeration systems and supplies in the Northeastern United States. Daikin's acquisition will support the continued growth of ABCO, providing opportunities to expand and grow its business – retaining and growing its contractor customer base, hiring new talent, adding more business technology, expanding product lines, and pursuing new growth and strategic opportunities. ABCO will begin promoting the full line of Daikin ductless, residential unitary, light commercial, and commercial HVAC products, as well as controls, air quality, parts, and accessories throughout their distribution footprint while continuing to fulfill existing obligations. Michael Senter will continue as ABCO's Chief Executive Officer and ABCO will maintain the company name with established brand recognition in the Northeast.

Daikin Applied, www.daikinapplied.com

Emerson Appoints Lal Karsanbhai, CEO

Emerson appointed Lal Karsanbhai as Chief Executive Officer on February 5, 2021. During his tenure at Emerson, Karsanbhai has worked in Europe, Africa and North America Karsanbhai has a bachelor's degree in economics from the University of Michigan and a master's degree in business administration from Washington University in St. Louis. "I am humbled by the Emerson board and David's confidence in me," said Karsanbhai. "This is an exciting time for the organization as we continue growing Emerson's global software footprint and expanding the company's support of essential industries. I am honored to carry the legacy of Emerson's leadership into the future and look forward to working with the Office of the Chief Executive to drive these vital goals."



Emerson, www.emerson.com


Atlas Copco
The Dawn of a New Era in Industrial Cooling
The TCX range is a connected, plug-and-play, industrial process chiller solution. All models feature simple service, reliability, and efficiency guaranteed.
866-546-3588
www.atlascopco.com/process-chillers