The Magazine for ENERGY EFFICIENCY and WATER CONSERVATION in Cooling Systems

CHILLER & COOLING BEST PRACTICES

coolingbestpractices.com

March 2020

COOLING TOWERS & CHILLERS

WATER TREATMENT & COOLING SYSTEM ASSESSMENTS

BEST PRACTICES

2020 EXPO SEPTEMBER 20-23 CHICAGO, IL

COMPRESSED AIR / VACUUM / COOLING

OPTIMIZE ON-SITE UTILITIES

Powering Automation

Research and Identify Innovations

to Enhance the Efficiency and Reliability of Your Systems

Compressed Air

Air Compressors
Air Compressor Controls
Air Purification & Piping
Condensate Management
Pneumatics

Blower & Vacuum

Aeration Blowers
Industrial Blowers
Vacuum Pump Systems
Inlet Filtration/Oil Separators

HVAC & Process Cooling/Steam

Chillers
Heat Exchangers
Cooling Systems
Cooling Towers
Water Treatment
Boilers
Steam Traps

Motors & Drives • Lubricants • Measurement Instruments • IoT Automation & Monitoring

EXPO HOURS

Monday, September 21 12:00-6:00pm
Tuesday, September 22 12:00-6:00pm

SAVE THE DATES ON YOUR CALENDAR!

Located at the modern Schaumburg Convention Center just 10 minutes from Chicago O'Hare International Airport.

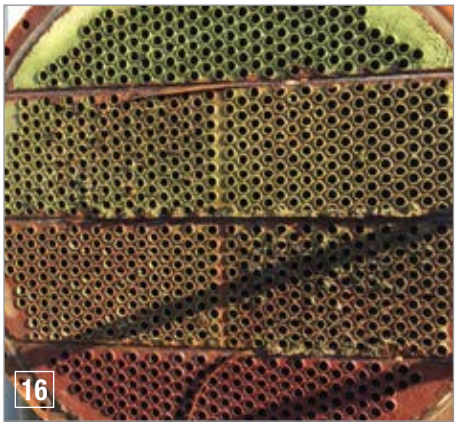
www.cabpexpo.com

Sponsored by CAGI Compressed Air & Gas Institute

FEATURES

COOLING TOWER & CHILLER FEATURES

WATER TREATMENT & COOLING SYSTEM ASSESSMENT FEATURES



COLUMNS

FROM THE EDITOR

Hudson Technologies kicks off this issue with a case study detailing their work deploying an optimization software platform on the central chiller plant at the University of Tulsa – a system with seven (7) water-cooled chillers proving 7,000 tons of cooling capacity to all university facilities. The project provided a $300,000 repair avoidance on three water-cooled chillers plus $51,000 in annual energy savings.

Maintaining heat exchanger performance is a topic of particular importance to this publication. This is where maintenance "best practices" truly impact energy efficiency and sustainability objectives. How many heat exchangers are thrown out due to poor water treatment practices? I'd like to thank ChemTreat for writing an article examining the challenges with phosphorous-based programs, key factors to controlling cooling water chemistry and the advantages of phosphorous- and zinc-free cooling water treatment technology.

Danfoss invests tremendously in refrigeration compressor educational initiatives. I highly recommend visiting their website www.danfoss.com for resources. In this issue, they have sent an excellent article on their solutions for HVAC part-load efficiency.

Chiller plant monitoring, and the energy-waste opportunities monitoring uncovers, is the subject of an article provided to us by the ETC Group. The article includes three excellent case studies with guidance on how to interpret the data-logging tables.

Please remember to submit an abstract to be considered as a Speaker (receiving a FREE PASS) at the 2020 Best Practices Expo & Conference, located in Schaumburg, IL, near the Chicago O'Hare International Airport. Visit www.cabpexpo.com.

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

ROD SMITH
Editor
tel: 412-980-9901, rod@airbestpractices.com

2020 MEDIA PARTNERS

INDUSTRIAL COOLING SYSTEM NEWS

Trane Earns TVA's Excellence in Customer Service Award

Trane®, a leading global provider of indoor comfort solutions and services, has earned the Tennessee Valley Authority's (TVA) Excellence in Customer Service Award for the second consecutive year. This annual recognition honors contractors in TVA's Preferred Partner Network based on customer survey ratings. Trane received the highest number of customer survey responses, with a maximum possible average rating and perfect score: 5 out of 5. Trane is the only business to receive this honor two years in a row.

Trane's team of dedicated energy experts in Tennessee work hand in hand with public school systems, community colleges, and city and county governments on numerous comprehensive energy-saving projects. When surveyed, these entities positively reflected on Trane's quality of service and products, delivery, communication, professionalism and ability to navigate the incentives application process. "Trane is a trusted partner, helping us address the issues in our facilities," said Chris Marczak, superintendent of schools, Maury County Public Schools. "Their assistance has been absolutely amazing; they are a true partner in helping us, help more kids learn."

Trane energy projects often include major upgrades to heating and air conditioning systems, LED lighting, plumbing and building envelopes, as well as building automation and control system installations, which save and track energy usage. Many aspects of these projects advance the physical learning environment for students by improving light levels in classrooms, and more closely controlling temperatures and ventilation requirements, which improve indoor air quality. These projects typically require no new tax dollars and fund themselves through the energy savings they create.

Trane's performance-based contracts deliver significant energy and operating cost reductions with a guarantee of performance. This structure allows savings to be used as debt service capacity – paying for projects partially or in full, with Trane guaranteeing the energy savings. Trane pursues additional funding resources for these projects through the State of Tennessee Energy Efficient Schools Initiative (EESI), benefitting K-12 customers with a low interest loan from the State of Tennessee.

Since Trane started implementing these guaranteed energy saving projects, Tennessee customers have saved more than $400 million dollars in utility costs – money that can be reinvested in the classroom and the community. "At Trane, our customers count on us to help navigate the complex energy space and find solutions that create the best environment possible while delivering energy and operational savings," said Brian Durr, vice president and area general manager for Trane. "We are creating more comfortable places to learn and work and reducing energy use, both of which have a positive impact on our future. We're honored to be recognized by Tennessee Valley Authority and our customers for this important work."

About Trane

Trane advances the quality of life by creating comfortable, sustainable and efficient environments. Trane solutions provide comfortable indoor environments through a broad portfolio of reliable, energy efficient heating, ventilating and air conditioning systems, parts and supply. For more information, visit www.trane.com.

Johnson Controls Breaks Ground on Expansion at Mississippi Plant

Johnson Controls broke ground on an expansion of its air-handling unit manufacturing facility in Hattiesburg, Mississippi. The 22,000 square-foot expansion will create 40-50 new assembly jobs to boost production and the local economy. The facility, which manufactures both YORK and Miller-Picking brand systems, is increasing its footprint in response to the growing demand for custom air-handling units. "We're excited to start this project, create attractive employment opportunities for area residents and serve the growing needs of the heating and air conditioning industry," said Ramiro Rodriguez, plant manager, Johnson Controls. "This expansion is another chapter in our long-term commitment to employees, Forrest County and area business partners."

The expansion, which will increase the facility's size to 120,000 square feet, includes the relocation of several sub-assembly cells and opens more manufacturing space in the main plant. Johnson Controls will also install a new crane system that will move products during the manufacturing process. The project is slated to be completed in May 2020. "It is always welcome news when one of Hattiesburg's longstanding manufacturing employers adds additional jobs," said Hattiesburg Mayor Toby Barker. "We congratulate Johnson Controls on this expansion. It is a testament to the company's forward-thinking leadership and to Hattiesburg's dynamic and skilled workforce."

Johnson Controls currently employs 225 workers at the facility. It is one of the top five preferred manufacturing employers in Hattiesburg. The existing plant was built in 1968, and the last building expansion was completed more than 20 years ago. The new

INDUSTRIAL COOLING SYSTEM NEWS

expansion involves ongoing collaboration among many partners, including the City of Hattiesburg, Forrest County and Area Development Partnership. The general contractor is Rustin Metal Buildings and Construction, Laurel, Mississippi.

Chad Driskell, chair, Area Development Partnership, said: "Johnson Controls' expansion in Hattiesburg speaks to our pro-business operating environment and the quality of our regional workforce. Employees drive from across South Mississippi to work in the regional hub, which also creates more opportunities here for them to dine, shop and play." David Hogan, president of the Forrest County Board of Supervisors, said: "We're honored to hear Johnson Controls is expanding here in Forrest County. The company has a history of success here in the Forrest County Industrial Park that dates back 50 years, and we look forward to the company's presence for another 50 years as a major contributor to our strong manufacturing sector."

While the expansion is a boon to the local economy, it also demonstrates the continued investment and leadership of Johnson Controls in the heating and air conditioning industry. Manufactured in Hattiesburg, YORK and Miller-Picking air-handling units are used in commercial buildings throughout the world. The plant complements the company's Airside Center of Excellence in York County, Pennsylvania, which features 40,000 square feet of office space and 285,000 square feet of manufacturing space.

About Johnson Controls

At Johnson Controls, we transform the environments where people live, work, learn and play. From optimizing building performance to improving safety and enhancing comfort, we drive the outcomes that matter most. We deliver our promise in industries such as healthcare, education, data centers and manufacturing. With a global team of 105,000 experts in more than 150 countries and over 130 years of innovation, we are the power behind our customers' mission. Our leading portfolio of building technology and solutions includes some of the most trusted names in the industry, such as Tyco®, York®, Metasys®, Ruskin®, Titus®, Frick®, Penn®, Sabroe®, Simplex®, Ansul® and Grinnell®. For more information, visit www.johnsoncontrols.com.

Process Cooling Systems Winner of Impact Award

MassEcon, the state's private sector partner in promoting business growth in Massachusetts, recently announced its 16th Annual Team Massachusetts Economic Impact Award winners, honoring Process Cooling Systems, Inc. among 15 other companies for their outstanding contributions to the Massachusetts economy. The companies were selected on the basis of job growth, facility expansion, investment and community involvement. The winners were honored at a luncheon at the Renaissance Boston Waterfront Hotel.

"We applaud the leadership of the Massachusetts' business community in growing the economy, investing in the state's workforce, and strengthening the cities and towns they call home," said Secretary of Housing and Economic Development Mike Kennealy.

"For nearly 60 years, we've run our operations from our company headquarters in Leominster. We are proud to provide our employees with rewarding careers and are committed to helping them reach their full potential," said Ted Rudy, President of Process Cooling Systems. "100% of our engineers graduated from Massachusetts colleges and universities and our skilled tradesmen and women are graduates of local trade schools. The strength of our talented workforce coupled with the support of the state and local government have allowed us to increase the size of our office and manufacturing space by more than 200% as we grow to better serve our customers."

Process Cooling Systems, Inc. recently expanded its operations with the opening of its new 60,000 square foot facility in Southgate Business Park in Leominster, MA where they design, build, install and service process water systems for customers across the state and around the world.

About Process Cooling Systems

Founded in 1963, Process Cooling Systems, Inc. designs, builds, installs and services process water systems for the plastics and metal manufacturing industry. For more information about Process Cooling Systems, Inc. visit www.processcooling.net.

Danfoss to Establish an IoT Collaboration with Microsoft

Danfoss has entered into a collaboration with Microsoft to bring domain expertise in Refrigeration and HVAC to the cloud. Through this collaboration customers will benefit from long-standing industry knowledge on a new platform powered by Microsoft Azure. The new cloud services will enable major savings, operational efficiency and can further increase sales effectiveness for Refrigeration and HVAC system owners and professionals.

With this collaboration, Danfoss extends its application expertise and becomes a recognized independent software vendor (ISV). Together, Danfoss and Microsoft will bring modern technology and domain expertise to Refrigeration and HVAC system owners and professionals.

The cloud-based services will enable food retailers to reduce food loss, reduce energy consumption and optimize overall store performance. They will benefit from Danfoss' 80+ years of experience as a solution provider in refrigeration and HVAC. The cloud infrastructure of Microsoft™ Azure will provide scalability and data security.

For food retail stores today, operations are getting increasingly complex. Staying compliant as well as reducing food loss requires a lot of manual work. Ensuring that refrigeration, lighting, HVAC etc. run efficiently can be time-consuming and often requires specialist knowledge. With more assets getting integrated with renewable energy, e-mobility,

INDUSTRIAL COOLING SYSTEM NEWS

and decentral energy systems on the rise, new potential but also complexity is introduced for Food Retailers. The result can be that stores end up spending more time and energy to run daily operations.

The Danfoss Cooling Cloud Suite enables full transparency around the clock allowing Food Retailers to focus on the core of their business. The cloud-based services increase operational efficiency by processing and analyzing data from refrigeration assets, HVAC, lighting and other assets. The data is managed in a secure way and delivers valuable insight to the food retail store in easy to use user interfaces.

"We bring more than 80 years of domain expertise and leadership in cooling & refrigeration solutions to a world-class cloud solution" said Dr. Jan-Hendrik Sewing, Danfoss Senior Vice President Electronic Controllers & Services Division and Global Head of Danfoss Food Retail Vertical. "The Danfoss Cooling Cloud Suite will help food retail stores focus on their core business by optimizing and automating current processes as well as providing actionable insights by eg. bench marking stores to identify top and low performers. This will lead to reduced operational costs and energy consumption and an increase in sales and marketing effectiveness."

With the Danfoss Cooling Cloud Suite, food retailers will be able to eliminate up to 80% of the time used to manage issues with store equipment as the connected assets are monitored and analyzed ensuring immediate action in case of compressor failure, refrigerant leaks or other issues. They will also realize up to 40% reduction in food loss as temperature is automatically monitored and alarms are sent to the store if temperature thresholds are above limit. Finally, stores can realize above 30% total net savings energy consumption by peak load shavings and reducing energy consumption from lights, refrigeration, HVAC and other electrical appliances.

Realizing operational costs and reducing energy consumption with the Danfoss Cooling Cloud Suite is easy as sensors, controls, and gateways can be retrofitted in any store. The services are cloud-based and require no on-premises hosting allowing rapid deployment and scalability for any store needs.

"With Danfoss' application expertise, we see a great opportunity to add value in the Food Retail sector," said Paul Maher, General Manager of Industry Experiences at Microsoft. "With Danfoss we bring one of the strongest IIoT use cases to date in refrigeration to our customers. The implementation brings tangible value to Food Retail today – and other industries in the near future. We look forward to supporting our joint customers meet their efficiency and sustainability goals."

"The collaboration with Microsoft will deliver tangible results to both existing and new customers of Danfoss and Microsoft. We will build on this collaboration and continue to invest in new cloud services to the industries we have served successfully for more than 80 years with the ambition to reduce food waste and energy consumption" said Jürgen Fischer, President Danfoss Cooling.

About Danfoss

Danfoss engineers advanced technologies that enable us to build a better, smarter and more efficient tomorrow. In the world's growing cities, we ensure the supply of fresh food and optimal comfort in our homes and offices, while meeting the need for energy-efficient infrastructure, connected systems and integrated renewable energy. Our solutions are used in areas such as refrigeration, air conditioning, heating, motor control and mobile machinery. Our innovative engineering

dates back to 1933 and today Danfoss holds market-leading positions, employing 27,000 and serving customers in more than 100 countries. We are privately held by the founding family. Read more about us at www.danfoss.com.

Delta Expands TM Series Cooling Tower

Delta has expanded TM Series cooling tower single unit capacity to 2,400 Tons.

Delta has expanded TM Series cooling tower single unit capacity to 2,400 Tons. These expanded capacity units are CTI Certified. Delta's engineering team is constantly working on improving their products and expect other improvement announcements later this year. Note that even higher capacities than the 2,400 Tons can be achieved when the approach to the wet bulb is above nominal 7 °F or the range of cooling is allowed to be greater than 10 °F. This is for the 6-cell unit with 180 total fan HP. The 5-cell unit has been expanded to 2,000 Tons.

The TM Series Cooling Tower has many industry leading features including Seamless Double-Wall Engineered Plastic (HDPE) shell carrying a 20-year Warranty. The direct drive fan systems eliminate maintenance and downtime frustrations with belt-driven or gear reducer systems prevalent in the industry. The towers are factory assembled for simple installation, typically a lot less time than metal towers. The tower has high efficiency fill, non-clog large orifice water distribution nozzles, VFD rated motors with 5-Year warranty. For more information, visit www.deltacooling.com.

INDUSTRIAL COOLING SYSTEM NEWS

Bacharach Refrigerant Management Software Now Free

Bacharach, an industry expert in gas detection and analysis instrumentation, announces its' award-winning Parasense Refrigerant Tracking and Compliance Software is available for free with full-feature capabilities and unlimited users, sites, and refrigeration assets. The cloud-based software includes usage, tracking, and reporting for unlimited users, sites and refrigeration assets and is ideal for any organization looking to reduce refrigerant emissions and support regulatory tracking and reporting needs while eliminating reliance on spreadsheets or other less sophisticated methods.

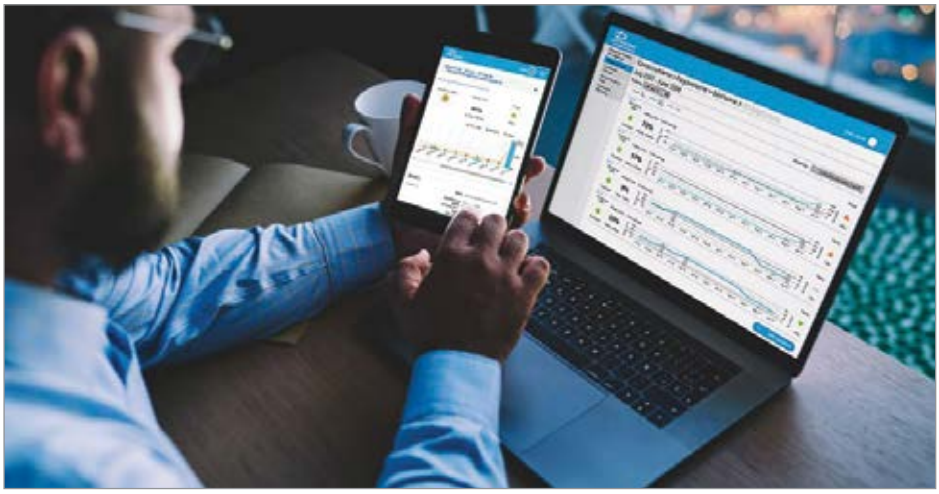
The software is an enterprise-scale system to track refrigerant usage, leak inspections, and leak events, as well as provide compliance reporting for EPA 608, CARB, F-Gas and GreenChill.

Parasense Refrigerant Tracking software is designed for facility managers and compliance officers who support multi-site organizations like supermarkets, food processing plants, cold storage warehouses, hospitals, universities, or K-12 schools. The software is also valuable for smaller organizations, as well as for mechanical and refrigeration contractors that want to offer refrigerant management as part of their service.

The use of Bacharach's high-performance fixed and portable refrigerant leak detection systems provides organizations with a complementary, proven solution for identifying low-level refrigerant leaks, reducing refrigerant emissions, and achieving best-in-class leak rate performance (less than 10%/year). The Parasense software portfolio is in use by over 1,000 sites including supermarkets, food processing, and data centers.

About Bacharach

Bacharach is a provider of cleantech solutions for gas and refrigerant leak detection and identification, refrigerant tracking, combustion and emissions analysis instrumentation, and high-purity oxygen gas analysis in commercial and industrial applications. Bacharach products make the heating, ventilation, air-conditioning, refrigeration (HVAC-R), and process industries safer, cleaner, and more energy-efficient, enabling customers to increase productivity, reduce costs, and protect lives and the environment. For more information, visit www.mybacharach.com.



Parasense Refrigerant Tracking and Compliance Software is available for free.

Frigel Group Introduces the MRS & MRM Air-Cooled Industrial Chiller

With the introduction of its MRS and MRM Industrial Chillers in 23 models with cooling capacities ranging from 3.5 to 125 tons, Frigel Group now offers the broadest line of packaged air-cooled chillers in the industry. Each model, which can be installed indoors or outdoors (a unique feature for air-cooled chillers in the MRS size range) is engineered to give users in a host of plastics applications more options than ever for highly efficient, cost-effective and environmentally friendly cooling. Frigel Group is the world leader in Intelligent Process Cooling.

The MRS line of eight compact air-cooled chillers are rated from 3.5 to 15.4 tons, while the MRM line of 15 air-cooled chillers are rated to deliver 16 to 125 tons of cooling capacity and both are available in a wide choice of configurations. MRS and MRM chillers are equipped with one to four high-efficiency hermetic scroll compressors per unit and feature world-class components, including all-aluminum microchannel condensers to minimize refrigerant charges and air flow pressure drops. In addition, the condensers can be easily cleaned with pressure washers, reducing maintenance costs and maximizing uptime. The use of R410A refrigerant provides an environmentally friendly cooling solution. Greater efficiencies are also achieved with a choice of vane axial condenser fans controlled by refrigerant condensing pressure.

The MRM line of air-cooled chillers are engineered to deliver highly efficient operation in heavy-duty industrial applications. Additionally, the chillers offer a wide operating set point range from 32 to 77 °F with glycol required below 50 °F – and also deliver increased system connectivity for reliable

New additions increase user flexibility and maximize efficiency, while lessening environmental impact.

temperature control in the most demanding and extreme environments. Standard ambient temperature ranges from -13 to 118 °F, with the opportunity to extend the range to up to 131 °F (glycol required below 32 °F).

Both the MRS and MRM chillers offer options that optimize performance with real-time troubleshooting and automation. With greater control, companies are able customize their processes for each unique cooling need. For more information about the MRS and MRM chillers, or the full line of Frigel industrial chillers, call Frigel North America at (847) 540-0160.

About Frigel Group

Frigel Group has been a worldwide market leader in Intelligent Process Cooling since the 1960s. Solutions include centralized cooling systems, machine-side cooling and temperature control units, and water- and air-cooled chillers, as well as advanced control technology. Visit www.frigel.com for more information.

Asahi/America Expands Asahitec™ PP-RCT Product Line

Asahi/America, Inc., the leader in thermoplastic fluid flow technologies, has expanded its Asahitec™ PP-RCT piping system for commercial applications to include the Type-57AT butterfly valve and Type-21AT ball valve.

The Type-57AT butterfly valve meets the pressure and temperature guidelines in ASTM F2389 for up to 12" and integrates seamlessly into Asahi/America's Asahitec™ PP-RCT piping systems for plumbing and HVAC applications. The polypropylene body and disc are injection molded for durability, and the 316 stainless steel stem is non-wetted. It is available in both wafer and lugged styles. Asahi/America's Type-57AT butterfly valve is available in sizes 1-1/2" through 8" with a green lever, and in 1-1/2" through 14" with our Plasgear™ operator. The Type-57AT top flange features an ISO 5211 F07 – F14 bolt circle, all sizes can be electrically or pneumatically actuated, and are assembled to customer specification and tested in our Lawrence, MA facility.

The Type-21AT ball valve meets the pressure and temperature guidelines in ASTM F2389 for sizes 1/2" through 2" and comes standard with PP-RCT socket-weld end connections for homogenous joining with Asahi/America's Asahitec PP-RCT piping systems. Ball valves have double O-ring seals on the stem for added protection and are true-union design for easier installation and maintenance. Valves are full port in sizes 1/2" through 2".

Asahitec includes both molded socket fusion fittings (1/2" – 5") and molded butt fusion fittings (6" through 24"). Asahitec is NSF 14-pw certified for potable water applications and features lead-free brass adapter fittings. Asahitec is complemented by Asahi/America's extensive welding equipment fleet and valve product line. Ideal Asahitec applications include potable water, HVAC, food and beverage grade water, and water distribution.

About Asahi

Asahi/America is the premier provider of thermoplastic fluid flow solutions for industrial, commercial and environmental applications. Our piping systems, valves and actuators have been installed with confidence for over 40 in a variety of industries and are supported by our team of designers, engineers, fabricators and trainers in our Massachusetts headquarters. For more information, visit www.asahi-america.com.

Asahitec™ PP-RCT now includes the Type-57AT butterfly valve and Type-21AT ball valve.

COOLING TOWERS & CHILLERS

Chiller System Optimization Platform SAVES ENERGY AT UNIVERSITY OF TULSA

By Senthil Kumar, CEM, Derrick Shoemake,
Riyaz Papar, PE, CEM, Fellow ASHRAE, Hudson Technologies

The University of Tulsa Oklahoma serves more than 4,500 students.

The University of Tulsa (TU) places a premium not only on education but the judicious use of energy for the growing campus. It's why TU installed an optimization software platform on its central chiller plant, which allowed it to reduce the kilowatt (kW) per ton of cooling capacity of three water-cooled chillers by 25% – resulting in an annual savings of $51,000. The system also eliminated the unplanned shutdown of the chillers, allowing the university to avoid as much as $300,000 in costs to restore them to their original design condition.

Chiller Efficiency a Top Priority

Founded in 1894 and located on 200 acres in Tulsa, Oklahoma, TU is a private educational institution serving more than 4,500 students. It also employs more than 1,200 faculty and staff and has experienced steady growth. The university's central plant houses equipment used to heat and cool campus facilities, comprised of more than 100 buildings, including classrooms, labs, residence halls and sports facilities, as well as Gilcrease Museum.

> "By the third year of operation, the kW/ton of cooling capacity of the three inefficient chillers improved by 25% for a savings of $51,000 per year in energy costs."
>
> — Senthil Kumar, CEM, Derrick Shoemake, Riyaz Papar, PE, CEM, Fellow ASHRAE, Hudson Technologies

As TU continues to grow, administrators wanted to ensure the institution's utility infrastructure efficiently delivers heating and cooling in support of its sustainability goals. Managing peak load and optimizing energy usage of is a cornerstone of these efforts.

The need to pay close attention to the university's central chiller plant has always been a priority given the energy required to power the chillers, said Michael Bolien, Manager of Central Plant Operations, University of Tulsa. At TU, seven water-cooled chillers provide 7,000 tons of cooling capacity to all university facilities.

"Over the past five years, TU has had a 17% increase in cooling load, based on the square footage of new buildings. Because our central chiller plant is our biggest energy user, optimizing its operations is our first line of defense," said Bolien.

More Chiller Monitoring and Measurement Needed

The ability to gain chiller efficiencies – while meeting the need for more chilled water – isn't without its challenges, driving the need to address the chillers' existing control system.

TU uses a Building Automation System (BAS) and a separate chiller control system to operate its chillers. At most industrial and commercial facilities, these systems work together to ensure optimal chiller performance. The university, however, only used the legacy BAS system to turn equipment on and off and make setpoint changes. The chiller control system also didn't have the ability to collect or interpret data needed to continually improve chiller performance. Additionally, existing monitoring equipment didn't provide accurate sensor data necessary for fault detection and diagnostics, making system optimization difficult.

Another challenge, which is common for many, was the need to collect and assess data without requiring unnecessary time and attention given a lean operations staff.

Calculated Part Load Value (CPLV) Curve Reveals Inefficiencies

To support TU's need for better chiller system control and data acquisition, Hudson Technologies Global Energy Services installed its SMARTenergy OPS® optimization platform to provide real-time continuous monitoring of the chiller system and gain access to key data points to improve system performance.

The installation of the Managed Software as a Service (MSaaS) solution included the use of nine calibrated sensors for collecting data on a wide range of operating fields, including pressure, temperature, flows and electrical power of each individual chiller. With the installation of sensors, Hudson Technologies collected data to establish an accurate operating chiller plant baseline kW/ton.

The data includes a Calculated Part Load Value (CPLV) curve to illustrate chiller efficiency across varying loads based on the difference between the actual operating kW/ton and CPLV kW/ton. The CPLV curve demonstrates the maximum efficiency achievable by a chiller under any operating condition – including part-load, not just full load. The ability to assess efficiency in all conditions is important since more than 95% of the time the chillers run at part-load conditions. This means that without access to the part-load data from the chiller manufacturer, the efficiency of a given chiller won't be known more than 95% of the time. The use of a CPLV curve also offers the ability to identify mechanical, heat transfer, and fluid chemistry issues within a chiller system and quantify the associated energy penalty.

An analysis of the data generated based on proprietary algorithms showed the loss of

CHILLER SYSTEM OPTIMIZATION PLATFORM SAVES ENERGY AT UNIVERSITY OF TULSA

efficiency in three of the university's seven chillers. The CPLV curve also identified the need for critical maintenance to address a plugged heat exchanger inlet on each of the three chillers. If not addressed, the inlet could result in an unplanned shutdown of 42% percent of the chiller system capacity. This would lead to unscheduled chiller system downtime and a disruption to the university's functions.

Heat Exchanger Cleaning Improves Chiller Performance

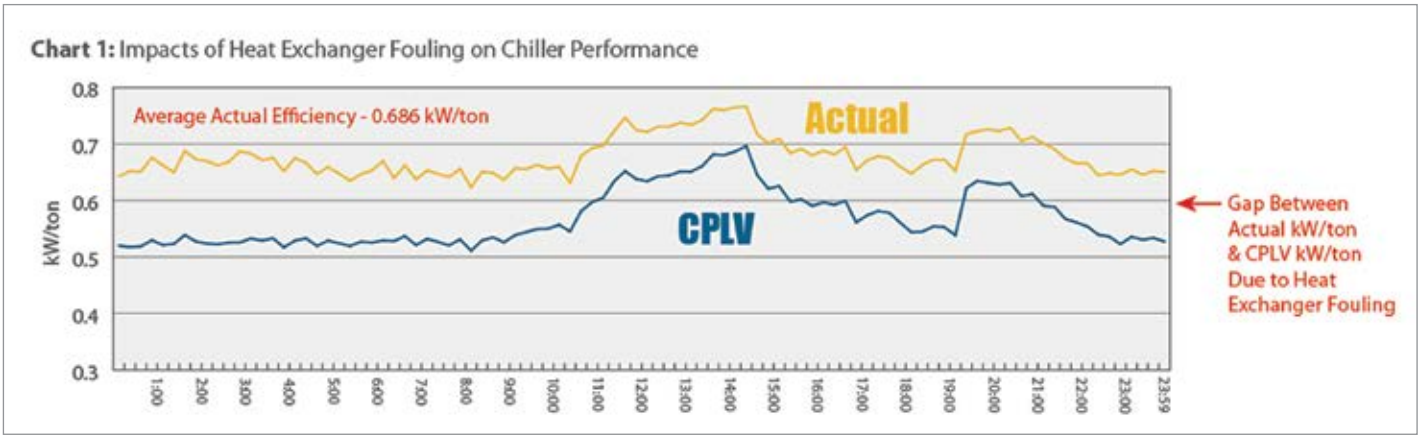
Hudson Technologies recommended a plan of action to improve chiller efficiency at all times of operation including peak loads – while also avoiding the potential to alarm or shut down any chillers should performance fall too far outside established operating parameters.

In addition to adjusting water flows and changing a variety of setpoints, Hudson Technologies advised the university to brush the tubes of heat exchangers on the three chillers that were operating inefficiently. TU staff subsequently rotated the chillers out of operation to perform the needed proactive maintenance. Brushing the heat exchangers eliminated fouling inside the evaporator of each chiller and increased the overall heat transfer co-efficient, which allowed for a higher refrigerant temperature – and in turn – reduced compressor lift to achieve energy savings.

After the heat exchanger cleaning, the average efficiency of each chiller improved from 0.686 kW/ton to 0.497 kW/ton as shown in Figure 2. This translates into cost and energy savings of almost 27% per chiller.

By the third year of operation, the kW/ton of cooling capacity of the three inefficient chillers improved by 25% for a savings of $51,000 per year in energy costs. Addressing fouled heat exchangers also prevented the need to shut down the chillers for an extended period of time and spend an estimated $300,000 to restore them to their design condition. The cost for restoration would have included re-tubing/replacement of the heat exchanger bundles, full refrigerant recovery and reclamation possibly due to water leakage, etc. TU also improved the performance of the chillers by:

- Adjusting chiller sequencing: Higher efficiency chillers are given priority to run always to meet the load rather



A gap between the actual kW/ton and the kW/ton of a CPLV curve points to inefficient operation of a chiller due to a fouled heat exchanger.

Shown is improved chiller performance following the cleaning of the chiller's heat exchanger.

than running all chillers equalizing operating run time on each of them.

- Reducing Entering Condenser Water Temperature: This allows the system to take advantage of cooler ambient temperatures. Doing so lets the cooling tower provide a lower water temperature to the condenser, thereby allowing for lower compressor lift and energy savings.
- Load balancing: Running the chillers as close to their optimal operating conditions provides the highest efficiency. This requires the total load be divided (balanced) among the running chillers for optimal chiller plant efficiency. BP

About the Authors

Riyaz Papar is Director, Global Energy Services, Hudson Technologies. Papar, with more than 20 years of experience in industrial energy systems and best practices, is a U.S. Department of Energy (DOE) Steam Best Practices Senior Instructor and a U.S. DOE Steam Energy Expert. Additionally, he is a steam, waste heat recovery and refrigeration/chiller system expert. A registered Professional Mechanical Engineer and a Certified Energy Manager, Papar has completed Ph.D. level coursework with a research emphasis on optimization of operation of energy assets (boilers, turbines, chillers, etc.) in industrial plants. His graduate-level education specialized in the area of thermal engineering (heat transfer, energy conversion, refrigeration, etc.).

Senthil Kumar is Product Lead for SMARTenergy OPS in Hudson Technology's Global Energy Services division, tel: 845 512 6000 ext. 6073, email: skumar@hudsontech.com. Kumar is a Certified Energy Manager (CEM) and is also a U.S. DOE Best Practices Qualified Steam System and Process Heating Specialist. He has more than 10 years of experience in industrial energy assessment and auditing, data collection, development of energy efficiency measures and energy efficiency calculations. He is also highly skilled in data trending, building custom system models, performance monitoring and optimization of steam and chilled water system.

Derrick Shoemake is the IT Lead for SMARTenergy OPS, Hudson Technologies. He has over 35 years computer programming experience. He also has more than 15 years of experience in chiller efficiency, data collection, energy efficiency measures, energy efficiency calculations, and technical report writing. Additionally, Shoemake has more than 10+ years in building automation programming.

Hudson Technologies extends it appreciation to Michael Bolien, Manager of Central Plant Operations, University of Tulsa, for his contributions to this article.

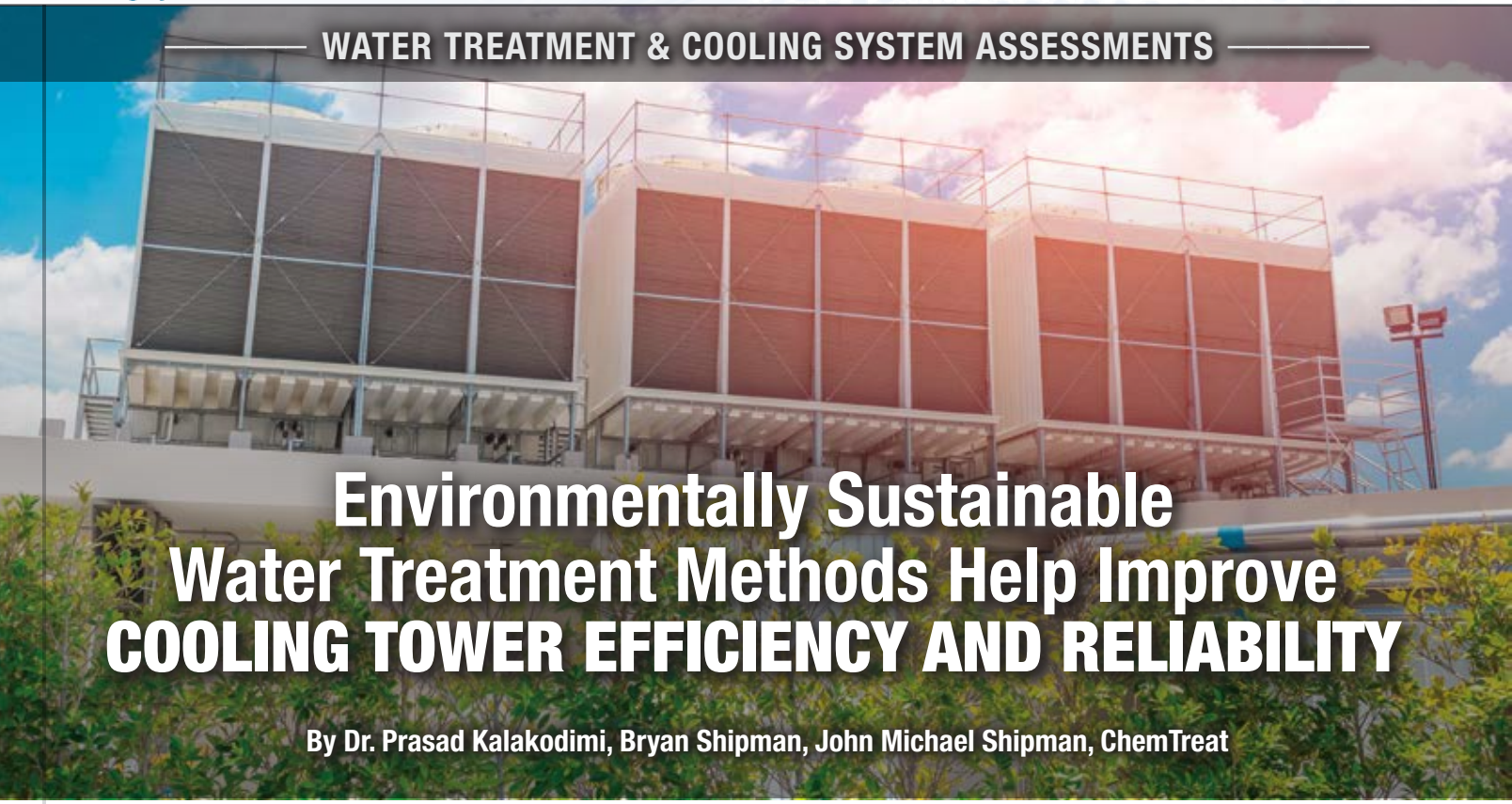
About Hudson Technologies

Hudson Technologies, Inc. is a refrigerant services company providing innovative solutions to recurring problems within the refrigeration industry. Its products and services are primarily used in commercial air conditioning, industrial processing and refrigeration systems, and include refrigerant and industrial gas sales, refrigerant management services, consisting primarily of reclamation of refrigerants and RefrigerantSide® services, consisting of system decontamination to remove moisture, oils and other contaminants. In addition, the company's SMARTenergy OPS® service is a web-based real time continuous monitoring service applicable to a facility's refrigeration systems and other energy systems. Its Chiller Chemistry® and Chill Smart® services are also predictive and diagnostic service offerings. It also participates in the generation of carbon-offset projects. The company operates principally through its wholly owned subsidiaries, Hudson Technologies Company and Aspen Refrigerants, Inc., formerly known as Airgas-Refrigerants, Inc. For more information, visit www.hudsontech.com.

All charts courtesy of Hudson Technologies, Inc.

To read similar ***Chiller Control Technology*** articles, visit www.coolingbestpractices.com/technology.

WATER TREATMENT & COOLING SYSTEM ASSESSMENTS



Environmentally Sustainable Water Treatment Methods Help Improve COOLING TOWER EFFICIENCY AND RELIABILITY

By Dr. Prasad Kalakodimi, Bryan Shipman, John Michael Shipman, ChemTreat

For decades, the most common cooling water treatment programs for large industrial cooling tower-based systems have relied on a combination of inorganic and organic phosphate (PO_4) chemistry to maintain the quality of cooling water to ensure system efficiencies. However, important factors are driving an evolution away from phosphate-based chemistry towards non-phosphate/non-zinc treatment methods to improve cooling system reliability and efficiency at many plants.

This article examines challenges with phosphorous-based programs, key factors to controlling cooling water chemistry and the advantages of phosphorous- and zinc-free cooling water treatment technology.

Interest in Phosphorus and Zinc-free Water Treatment Methods Grows

Inorganic and organic phosphate programs, such as those that relied on phosphonates, phosphinates, and polyphosphates, etc., emerged as the technology of choice when chromate and zinc-based corrosion inhibitors were phased out due to environmental concerns. However, this transition did not come without difficulties, including the issue of precisely controlling the chemistry to avoid scale formation in heat exchangers. In addition, phosphate-based treatments promote algae growth on cooling tower wetted locations exposed to sunlight and in holding ponds, resulting in increased biocide feed.

Two additional factors has also driven an evolution away from phosphate-based chemistry toward non-phosphate treatment methods. One is the increasingly problematic issue of phosphorus discharge and its effects on the generation of toxic algae blooms in receiving bodies of water. The second is growing evidence that well-formulated non-phosphate programs are more effective, from both a technical and economic standpoint, than phosphate/phosphonate chemistry for scale prevention and corrosion protection.

"Since implementing the technology, the chemical plant began moving from a from a yearly plant turnaround cycle to a two-year cycle, improving profitability."

— Dr. Prasad Kalakodimi, Bryan Shipman, John Michael Shipman, ChemTreat

Influence of Phosphate in the Natural Environment

Phosphorus, along with nitrogen and carbon, is a macronutrient that is essential for all life forms. In fact, it is often the limiting nutrient for growth in aquatic systems because it is present in very low concentrations relative to that required by plants and microorganisms. Yet it in high concentrations it can be problematic.

Algae derive their carbon requirements from inorganic bicarbonate and carbonate, utilizing energy from sunlight to convert the inorganic carbon into organic carbon for cellular tissue growth. Some species of algae are also capable of "fixing" atmospheric nitrogen gas, using the nitrogenase enzyme to convert N_2 into ammonia and other compounds required for the biosynthesis of nucleic acids and proteins. Common among the photosynthetic nitrogen fixing species are cyanobacteria, commonly referred to as "blue-green algae." Cyanobacteria are known for their extensive and highly visible green blooms. An example is a cyanobacteria bloom in the shallow western basin of Lake Erie that occurred in 2011. The unpleasant and unsightly algae growth resulted in fouled beaches, sharply reduced tourism, and a decline in fish populations. Apart from their noxious sensory impact, cyanobacteria also produce microcystins and other cyanotoxins that are toxic to fish, birds, and mammals.

The presence of phosphorus in aquatic systems is also problematic because it ultimately leads to a reduction in dissolved oxygen, which is required by fish and other aquatic life forms.

A blue-green algae bloom in Lake Erie in 2011.

Dissolved oxygen is consumed rapidly by bacteria associated with the decay of algae, resulting in hypoxic conditions (< 2 mg/l (dissolved oxygen) that do not support aquatic life. Environmental scientists are aware of these

FREE SUBSCRIPTION

DIGITAL EDITION FREE WORLDWIDE | PRINT EDITION FREE TO U.S. SUBSCRIBERS

CHILLER & COOLING BEST PRACTICES

coolingbestpractices.com

Learn How To Save Energy & Improve Productivity In YOUR Industry!

EVERY ISSUE CONTAINS BEST PRACTICES FOR

Cooling Towers • Central Plant Chillers

Cooling System Components

Subscribe at **coolingbestpractices.com**

Subscribe Now!

ENVIRONMENTALLY SUSTAINABLE WATER TREATMENT METHODS HELP IMPROVE COOLING TOWER EFFICIENCY AND RELIABILITY

issues, and industrial phosphorus discharge is becoming increasingly regulated.

Eliminating Phosphate from Cooling Systems

The growing evolution in treatment chemistry to eliminate phosphorus discharge in order to protect the environment has impacted water treatment programs designed to prevent fouling and scaling in cooling systems, which is essential for sustainable operation.

Factors critical to cooling water chemistry control are corrosion, deposition (scaling and fouling) and biofouling (both micro- and macro-fouling). In this era of heightened environmental awareness, the classical cooling water triangle could be expanded to a four- or five-sided figure to include control of discharge chemistry, and increasingly, issues related to makeup water conservation.

A brief review of the most common cooling water corrosion mechanism is appropriate to understand the evolution of cooling water chemistry. All corrosion mechanisms are electrochemical in nature, although some, such as erosion corrosion, are also influenced by mechanical factors.

Iron is oxidized at the anode and enters solution as the ferrous ion (Fe^{+2}). The process releases electrons that flow through the metal to the cathode, where the electrons reduce dissolved oxygen to hydroxyl ions (OH^-). Hydroxyl ions then react with the iron ions to complete the electrical circuit and form an initial product of $Fe(OH)_2$, which continues to oxidize to eventually form rust, with a basic formula of $Fe_2O_3 \cdot xH_2O$. Uncontrolled oxygen attack can cause severe damage in piping networks and generate deposits that may partially or completely restrict flow.

Corrosion inhibitors function by slowing down reactions at either the anode, the cathode, or sometimes both. Treatment evolved to phosphate-based chemistry for both scale and corrosion prevention. The programs typically function at a mildly alkaline pH, which minimizes general corrosion. The chemistry also provides additional corrosion protection, as phosphate will react with Fe^{+2} produced at anodic sites to form a reaction-limiting deposit, while $Ca_3(PO_4)^2$ precipitates in the local alkaline environment at cathodic sites to inhibit electron transfer. However, even small upsets in phosphate programs can cause severe calcium phosphate fouling, and at one-time excess $Ca_3(PO_4)^2$ deposition became almost as great a problem as calcium carbonate scaling had been before. $Ca_3(PO_4)^2$ has inverse solubility (solubility decreases with increase in temperature and pH) and tend to lay down as thick scales on the heat exchangers.

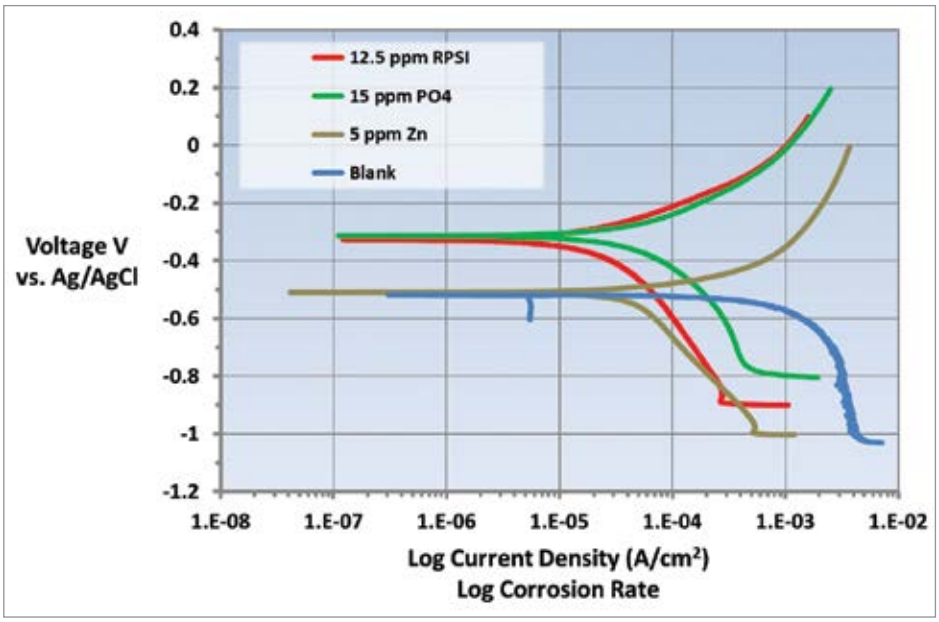


Figure 1. Shown is a current vs. voltage graph with various chemistries. The curve in green (PO_4) shows increase in anodic current and the shift in corrosion potential to more positive values. This indicates that PO_4 is an anodic inhibitor. The curve in brown (Zn) shows an order magnitude decrease in cathodic current, indicating that Zn is cathodic corrosion inhibitor. Whereas, the curve in red (RPSI) shows reduction in corrosion current in anodic and cathodic directions and shift in corrosion potentials to more positive values. This indicates that RPSI chemistry is a combination of anodic and cathodic corrosion inhibitor.

Though every type of industry suffers with scaling issues due to improper operating, this scaling problem is especially prevalent in "heavy" industries such as refineries, petrochemical plants, steels, etc., which commonly have very hot heat exchangers and low water velocities.

Water treatment professionals use combinations of several chemical additives to control deposition in cooling systems. Most common deposit control agents (dispersants) for controlling calcium phosphate scales are polymeric compounds (homo polymers, co-polymers, ter-polymers, oligomers, etc.) containing various functional groups, principally carboxylic, sulfonate, amide, and hydroxide. Accordingly, treatment methods evolved to more forgiving methodologies, where in many cases the backbone of these programs are organic phosphates (phosphonates) with a supplemental polymer to control calcium phosphate deposition. Phosphonates attach to deposits as they are forming and disrupt crystal growth and lattice strength.

ENVIRONMENTALLY SUSTAINABLE WATER TREATMENT METHODS HELP IMPROVE COOLING TOWER EFFICIENCY AND RELIABILITY

The Emergence of Non-phosphorus Chemistry

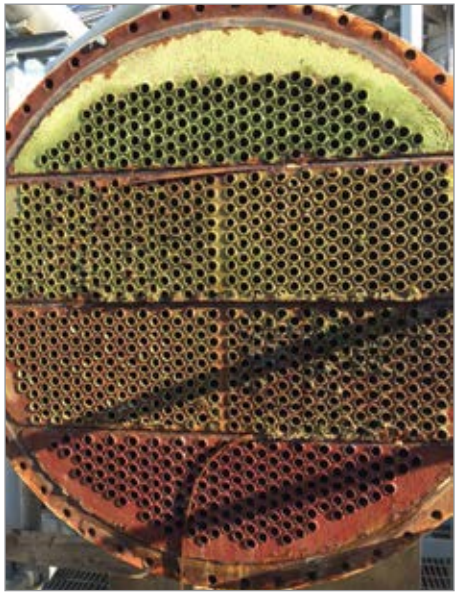
Due to emerging environmental restrictions on phosphorus discharge and the many shortcomings of phosphorus-based cooling water treatment technologies, ChemTreat implemented a multi-year research effort to develop a phosphorus- and zinc-free cooling water treatment technology.

The effort led to the introduction of ChemTreat's FlexPro® technology, which contains Reactive Polyhydroxy Starch Inhibitor (RPSI) chemistry. The development and application of this corrosion inhibitor chemistry for use in cooling towers under normal flowing conditions has been described in earlier publications[i]. Since then, several products containing RPSI chemistry have been formulated and applied in several industries including power, refinery, chemical, steel, power, and light industrial.

RPSI is very effective in inhibiting both anodic and cathodic corrosion reactions. As shown in Figure 1, the anodic corrosion potential of the metal is shifted to more positive values, indicating strong passivation. Also, the corrosion current values decrease in both the anodic and cathodic sweeps in the presence of the RPSI corrosion inhibitor. This means the RPSI corrosion inhibitor will provide complete corrosion protection of the metal. Shift in the corrosion potential to more positive values also means the RPSI corrosion inhibitor will form a persistent passive film and provide better corrosion inhibition under upset conditions such as pH, process leaks etc.

RPSI chemistry has also shown to be effective in field applications in forming a passive film under stagnant conditions and during preoperational cleanings conducted at pH_3[ii]. One study also reported the ability of RPSI chemistry to passivate during preoperational cleaning[iii]. In the study, efficacy of RPSI chemistry was compared to the traditional passivation chemistries such as polyphosphates and organic phosphates. It demonstrated non-phosphorous chemistry forms a passive film which persists for several days in untreated blank water. Formation of persistent passive film is very essential in cooling systems since this will protect the system under upset conditions such as pH excursions, process leaks, copper throw, etc.

More recently, RPSI chemistry was shown to be capable of passivating lightly rusted surfaces to a degree comparable to that obtained on a fresh steel surface[iv]. The data indicated RPSI chemistry enables passivation of new equipment on-line without a separate precleaning step for lightly corroded metal surfaces. It also allows water systems that have experienced moderate corrosion resulting from upset conditions to be effectively re-passivated and treated without removing them from service. It also showed RPSI chemistry to be superior to traditional polyphosphate, organic phosphate, ortho phosphate, molybdate, and nitrite-based treatments in terms of forming a passive film on the rusted mild steel surface.



A phosphate-based water treatment program at the chemical plant resulted in a heat exchanger with severe calcium phosphate deposition and possible biofouling.

Shown is another heat exchanger at the same chemical plant, which is free of corrosion and scaling when cooling water was treated using FlexPro technology.

Heat Exchanger Performance Improves at Chemical Plant

A large chemical plant in the Gulf Coast was using phosphate-based corrosion inhibitors to protect its heat exchangers with skin temperatures in excess of 160 ˚F. Due to drawbacks of the technologies, the plant either suffered with excess corrosion due to underfeed of phosphate, or severe deposition on the heat exchangers due to over feed of phosphate.

Both scenarios hindered reliable operation of cooling systems and thereby adversely impacted the operating performance of the plant. The plant had to regularly clean the heat exchangers, which resulted in loss of production due to downtime. It also adds costs for cleaning.

In late 2015, the plant began using FlexPro technology with RPSI corrosion inhibitor chemistry to mitigate corrosion and scaling issues. An inspection in 2017 showed much

cleaner heat exchangers. The level of iron and copper in the tower also declined, which indicated the technology was providing adequate corrosion/scale inhibition. Also observed were improvements in heat exchanger heat transfer efficiency.

ChemTreat added a proprietary halogen stable triazole technology to the water treatment program at the same plant later in 2017, which improved the yellow metal corrosion rate. In addition, iron and copper levels were maintained at historically low levels.

Since implementing the technology, the chemical plant began moving from a from a yearly plant turnaround cycle to a two-year cycle, improving profitability. Additionally, the program resulted in improved process cooling system efficiency and reliability. BP

About the Authors

Dr. Prasad Kalakodimi is Director of Applied Technology for ChemTreat, tel: 804-935-2130; email: prasadk@chemtreat.com. Bryan Shipman is a ChemTreat Area Manager, email: BryanS@chemtreat.com; and John Michael Shipman is an Account Manager for ChemTreat, email: jshipman@chemtreat.com.

About ChemTreat

Headquartered in Richmond, Virginia, ChemTreat is one of the largest and fastest-growing industrial water treatment companies in the world. Continued expansion has allowed us to evolve into one of the world's largest providers of water treatment products and services. ChemTreat has grown to become a leader in the water treatment industry and is committed to continued growth. We retain the flexibility of the smaller companies to meet specialized needs through a rapid and thorough response in all areas of the business, and we have the significant resources of a larger company to ensure superior customer support. Our proprietary solutions allow our customers to reduce water, chemical, and energy costs, extend asset life, improve process operations, and reduce downtime. For more information, visit www.chemtreat.com.

All photos courtesy of ChemTreat

References

i Post, R.M., Kalakodimi, R.P., Tribble, R.H., Development and Application of Phosphorus Free Cooling Water Treatment, Cooling Technology Institute, Houston, February, 2014.

ii Post, R.M, Kalakodimi, R.P., Tribble, R.H., Lamm, J, Nelson, J.L., Advances in Pretreatment, Passivation, and Layup of Cooling Systems, International Water Conference, IWC 15-75, Orlando, November 2015.

iii Post, R.M., Kalakodimi, R.P., Tribble, R.H., Advancements in Cleaning and Passivation of Cooling Systems, Cooling Technology Institute, Houston, February, 2016.

iv Kalakodimi, R.P., Tribble, R.H., and Post, R.M., Advancements in Cleaning and Passivation of Cooling Water Systems, Cooling Technology Institute, New Orleans, February, 2017.

To read similar ***Heat Exchanger Optimization*** articles please visit www.coolingbestpractices.com/technology/heat-exchangers

COOLING TOWERS & CHILLERS

Advancing Standards and Compressor Technologies Can CAPTURE MORE PART-LOAD ENERGY SAVINGS

By Ben Majerus, Danfoss

➤ In recent years, the HVAC industry has enlarged its vision from focusing on equipment efficiency measured in terms of ratings points at specific conditions to include a whole building perspective that uses models of year-long, real-world conditions. Accordingly, energy standards have adopted new rating methods to evaluate equipment efficiency during part-load operation.

In Part 1 of this two-part article series we examined how these standards are evolving. The article can be found at https://coolingbestpractices.com/technology/refrigeration-compressors/advancing-standards-and-equipment-improve-building-energy. This article looks at how technologies are advancing to deliver more part-load energy savings.

Improving Part-load Performance

The continuing push for more efficient HVAC systems is challenging OEMs, designers, and specifiers to find new ways to improve part-load efficiency.

In the past, the HVAC industry had it relatively easy when it came to achieving high energy efficiencies at full load. Selecting the optimum heat exchangers and compressors usually sufficed in designing equipment to meet the required load. When it was necessary to run the system at less than full load, various low-cost techniques were applied to turn down capacity, such as hot gas bypass and compressor step modulation. But with systems optimized for full-load efficiency, this technique and others are inefficient, because the high compressor efficiency cannot be maintained at part load without capacity modulation to better match the load.

Designing systems to operate efficiently at part load, therefore, requires new thinking and a new set of technologies. The main idea is to apply technologies that can modulate capacity when encountering varying loads.

Advances in Compressor Configuration

Substantial advances have been made in compressors, which are the primary energy users in chiller systems.

Driven by cost, designers typically use two approaches for the majority of residential and commercial systems in the U.S. market. The first is to employ a single fixed-speed compressor on a single circuit. The second

is to use multiple circuits, each with a single fixed-speed compressor.

The first design approach was to be phased out by ASHRAE 90.1 in 2016 for systems above 65,000 Btu/hr., as regulators have recognized this design is an inefficient way to meet the building load throughout the year. It also reduces the lifetime of the compressor by constantly short cycling on and off.

The second design improves the system's capacity modulation by essentially creating two systems that are half the size of the total system. This approach allows the use of two uneven circuits, which enable the system to better match varying loads. Also, this configuration improves uptime, because one circuit can function independently while the other is down.

In such a system, technology that can assist fixed-speed compressors to handle varying load and pressure conditions – such as Intermediate Discharge Valves (IDVs) – can further improve efficiency. Nevertheless, there are system designs that offer better capacity modulation and can capture more benefits from IDV technology, as well as other technology like variable speed fans.

A more efficient configuration employs multiple compressors in one circuit to further improve system part-load performance. Multiple compressors may be configured in tandem or in so-called parallel configurations. When several are installed in parallel, one or more compressors can be turned off and kept off for a longer period of time. Further capacity modulation can be achieved by using unequally sized fixed-speed compressors in parallel or three compressors in parallel to turn down capacity from 100 to 66 to 33 percent.

Danfoss VLT® HVAC Drives are designed to improve part-load performance of fixed-speed scroll compressors.

ADVANCING STANDARDS AND COMPRESSOR TECHNOLOGIES CAN CAPTURE MORE PART-LOAD ENERGY SAVINGS

Finally, variable speed compressors take the industry to the energy efficiency limit of what today's compression technology can provide. The majority of these applications are single compressors on a single circuit, but they can also be applied in parallel with fixed-speed compressors to further increase the turndown ratio or achieve a specific capacity. Studies show this latter configuration provides superior capacity modulation while maximizing efficiency at partial loads.

Parallel configurations and variable speed compressors are further enhanced by technologies that improve part-load efficiency, such as fixed-speed compressors with IDV and variable speed fans. In fact, these technologies do more to enhance efficiency the more capacity modulation is utilized.

Advances in Compressors

Today, advancements in nearly every type of compressor – scroll, reciprocating, screw, and centrifugal – provide efficient methods of handling varying loads.

New technologies have been developed to improve the part-load performance of fixed-speed scroll compressors. For example, the IDV helps the compressor respond to varying system load and pressure conditions, although the compressor itself doesn't change speed as conditions change. IDV broadens the pressure ratio to allow a compressor to be optimized for an increased number of applications. The ability of IDV to respond quickly to part-load conditions helps limit compression overshoot, which improves efficiency and also reduces mechanical stress on the scroll components.

For variable speed compressors, an inverter, also known as a variable frequency drive (VFD), runs the motor at different speeds, thereby modulating refrigerant flow and cooling output.

Speed reductions that precisely match the load help reduce energy consumption – as much as 50% or more depending on the application. Less energy is wasted since the variable speed compressor delivers precisely the capacity required by speeding the motor up and down.

There are operational benefits as well. A VFD uses an inverter switching circuit to change incoming alternating current (AC) power to direct current (DC), which is then output as an AC-like sine wave that can modulate in a controlled fashion. Consequently, a VFD eliminates the big inrush of line voltage AC at startup. The resulting "soft start" reduces amperage draw, which extends motor life and reduces costly peak electric usage.

Variable speed compressors require sophisticated engineering, however. The compressor itself must be rugged enough to handle repeated acceleration and deceleration from 110% to as low as 10% of its full speed rating.

A Danfoss DSH scroll compressor with IDVs helps the compressor respond to varying system load and pressure conditions.

A major challenge in designing a variable speed compressor is maintaining proper oil circulation. With scroll compressors operating at low RPMs, for example, oil circulation is poor because the mass of refrigerant and oil flow is reduced at slower speeds. Consequently, compressor designers use dedicated internal systems to ensure adequate oil circulation as compressor capacity turns down. High RPMs present other challenges, including the higher speeds that put more stress on internal parts. To withstand the added stress, careful selection of the materials and the oil and wear is required to ensure compressor reliability.

For advanced centrifugal compressors, however, other techniques are used to handle changing refrigerant gas pressures and flows at part load. Variable geometry inlet guide vanes and/or variable geometry diffusers are used to maintain compressor stability when refrigerant flow is reduced. As far as lubrication is concerned, magnetic bearings have been developed that allow the entire oil system to be jettisoned. With magnetic bearings, the compressor shaft rotates in a magnetic field without physically contacting the bearing in normal operation. This eliminates the need for an oil system and all its side effects – oil films on heat exchanger surfaces and oil stacking in the evaporator at low loads.

Advances in Fan Motors

Technological advances have also boosted the efficiency of another major energy consumer – fan motors. As with compressors, the main energy-saving strategy has been to use conditioned DC instead of the incoming line voltage of AC to modulate motor speed.

Reducing motor speed at partial loads produces immense energy savings. Fan motors obey Affinity Laws for turbomachinery, in that reducing speed exponentially reduces energy use. For example, cutting speed by 20% decreases power consumption by 50%.

BLOWER & VACUUM BEST PRACTICES blowervacuumbestpractices.com

COMPRESSED AIR BEST PRACTICES airbestpractices.com

CHILLER & COOLING BEST PRACTICES coolingbestpractices.com

PROUDLY PRESENTING THE 2020 EXPERT WEBINAR SERIES

Ron Marshall
Chief Auditor, Marshall Compressed Air Consulting

Tim Dugan, P.E.
President and Principal Engineer, Compression Engineering Corp.

Loran Circle
Senior Consultant, Circle Training & Consulting

Tom Jenkins, P.E.
President, JenTech Inc.

Tom Taranto
Owner, Data Power Services

Chris Gordon
President & CEO, Blackhawk Equipment

JAN 24 — **How to Conduct a Compressed Air Leak Audit**
Presenter Ron Marshall, Chief Auditor, Marshall Compressed Air Consulting
January 23, 2020 – 2:00PM EST

FEB 28 — **Verifying Blower System Energy with PTC 13**
Presenter Tom Jenkins, P.E., President, JenTech Inc.
February 20, 2020 – 2:00PM EST

MAR 14 — **Designing Piping Systems for Low Pressure Drop**
Presenter Tom Taranto, Owner, Data Power Services
March 19, 2020 – 2:00PM EST

APR 04 — **How to Correctly Size Vacuum Pumps**
Presenter Chris Gordon, President & CEO, Blackhawk Equipment
April 16, 2020 – 2:00PM EST

APR 25 — **Air Compressor Master Controls to Prevent Control Gap**
Presenter Tim Dugan, P.E., President and Principal Engineer, Compression Engineering Corporation
May 21, 2020 – 2:00PM EST

JUN 06 — **VSD Air Compressor Installation Guidelines**
Presenter Loran Circle, Senior Consultant, Compressed Air System Training & Consulting
June 18, 2020 – 2:00PM EST

JUN 27 — **Where Does Blower Air Go? Process Fundamentals**
Presenter Tom Jenkins, P.E., President, JenTech Inc.
July 16, 2020 – 2:00PM EST

JUL 18 — **Calculating Storage for Demand Events**
Presenter Tom Taranto, Owner, Data Power Services
August 20, 2020 – 2:00PM EST

AUG 22 — **Vacuum System Efficiency Projects**
Presenter Chris Gordon, President & CEO, Blackhawk Equipment
October 15, 2020 – 2:00PM EST

DEC 12 — **Measuring KPI's: kW, Flow, Pressure, Dewpoint**
Presenter Tim Dugan, P.E., President and Principal Engineer, Compression Engineering Corporation
November 12, 2020 – 2:00PM EST

Register for Free Today at airbestpractices.com/magazine/webinars

SPONSORED BY

VP INSTRUMENTS · KAHN · BEKO · TRACE Analytics · inovair · KAESER COMPRESSORS · BUSCH · UE SYSTEMS INC

ADVANCING STANDARDS AND COMPRESSOR TECHNOLOGIES CAN CAPTURE MORE PART-LOAD ENERGY SAVINGS

In HVAC applications, significant fan-speed reduction is obtained with two types of motor technologies: electronically commutated motors (ECM) and VFDs applied to AC induction motors.

ECM motors, also known as brushless DC motors, have been used for decades. They employ permanent magnets rather than brushes and electricity to create a magnetic field in copper windings. That feature alone makes them about 30% more efficient than "squirrel cage" AC induction motors.

To control ECM fan motor speed, however, integrated electronics must be used to continuously adjust RPMs based on control input. ECM motors operate at relatively lower power (below 750 kW) and are often used as external-rotor fan and blower motors.

Three-phase AC induction motors, however, remain the workhorse for HVAC applications. They are found in applications below 750 kW, as well as huge 1,500 kW motors for cooling tower fans. While AC motors are available with optional external speed controllers, they don't always operate at optimum efficiency at slower RPMs.

VFDs must be employed to efficiently control three-phase AC motors at various speeds. Reducing the frequency of the conditioned sine signal reduces motor speed. Varying the applied voltage reduces torque.

For users, it is important to examine each application carefully to see what type of motor is most efficient – and what type of control delivers that efficiency in real-world conditions.

Advances in Controls

According to a major motor-manufacturer association, approximately 10% of the potential savings in drive systems can be achieved by using motors with higher efficiency. By applying variable speed technology, however, potential savings of approximately 30% can be obtained. The best means of attaining maximum savings (approximately 60%) is by optimizing the overall system. Using components that improve overall system efficiency makes major energy reductions possible.

For example, capacity modulation of variable speed compressors can only be obtained with an electronic expansion valve (EXV). An EXV allows condensing temperatures to be reduced to the lowest possible minimum, enabling capacity to be turned down. In contrast, thermostatic expansion valves (TXV) do not offer a wide enough dynamic range to allow the system to remain stable at low pressures. As a result, higher condenser temperatures must be maintained, which wastes energy.

For fans, efficient operation of ECM motors requires an optimal combination of frequency converter, motor, and fan impeller. Similarly, the algorithms in a VFD need to be tuned to match the individual application and motor to achieve optimum performance. Today, advanced frequency converters and VFDs are available with automatic tuning capabilities, programmable setpoints, and compressor/fan motor cycling to make system optimization at part-load conditions easy to achieve.

Bottom-line Benefits

Today, contractors, consulting engineers, and building owners – in addition to HVAC OEMs and equipment designers – have a vested interest in technology optimized for part-load efficiency. Technologies that can turn down capacity to maximize energy savings at part load are financially attractive when energy costs are high. In addition, they provide further energy savings in milder climates, because these areas spend up to 99% of the year at part-load conditions. In those circumstances, when part-load technology is properly deployed, the actual energy efficiency obtained at real-world conditions exceeds the Integrated Energy Efficiency Ratio (IEER) or Integrated Part Load Value (IPLV) energy-efficiency rating printed on the equipment label. Regardless of energy prices, improvements in part-load efficiency reduce a utility CO_2 emission, which addresses concerns about climate change.

New technologies are also being developed to improve whole building efficiency. These trends include connectivity and electronic devices, more precise system control and monitoring, and peak-load management tools. These developments will, in turn, drive further development and adoption of variable speed and other innovative technologies.

Advancing part-load efficiency in standards and equipment will significantly contribute to building performance, as well as nurture an energy-efficiency ecosystem of technology, standards, and policies that will grow energy savings and reduce CO_2 emissions for years to come. BP

About the Author

Ben Majerus is Manager, Application Engineering, at Danfoss.

About Danfoss

Danfoss engineers advanced technologies that enable us to build a better, smarter and more efficient tomorrow. In the world's growing cities, we ensure the supply of fresh food and optimal comfort in our homes and offices, while meeting the need for energy-efficient infrastructure, connected systems and integrated renewable energy. Our solutions are used in areas such as refrigeration, air conditioning, heating, motor control and mobile machinery. Our innovative engineering dates back to 1933 and today Danfoss holds market-leading positions, employing 27,000 and serving customers in more than 100 countries. We are privately held by the founding family. Read more about us at www.danfoss.com.

All images courtesy of Danfoss.

To read similar ***Refrigeration Compressor Technology*** articles, visit www.coolingbestpractices.com/technology/refrigeration-compressors.

April 21-22, 2020

Duke Energy Convention Center

Cincinnati, OH

aee ENERGY CONFERENCE & EXPO

East

2020 Keynote Speakers

Bill Kent, CEM
Executive Director
Association of Energy Engineers

Dennis Deters
Public Utilities Commissioner of Ohio
PUCO

Amy B Spiller
State President, Ohio & Kentucky
Duke Energy

Business, Learning & Innovation for **A Sustainable Energy Future**

Join commercial, industrial, Institutional and governmental energy efficiency professionals from across the region for AEE's 2020 energy conference and expo.

Save the Date & Register Today...
east.aeecenter.org

Host Sponsor

TOYOTA

Utility Energy Leader

DUKE ENERGY®

Red Star Energy Leader

AMERESCO

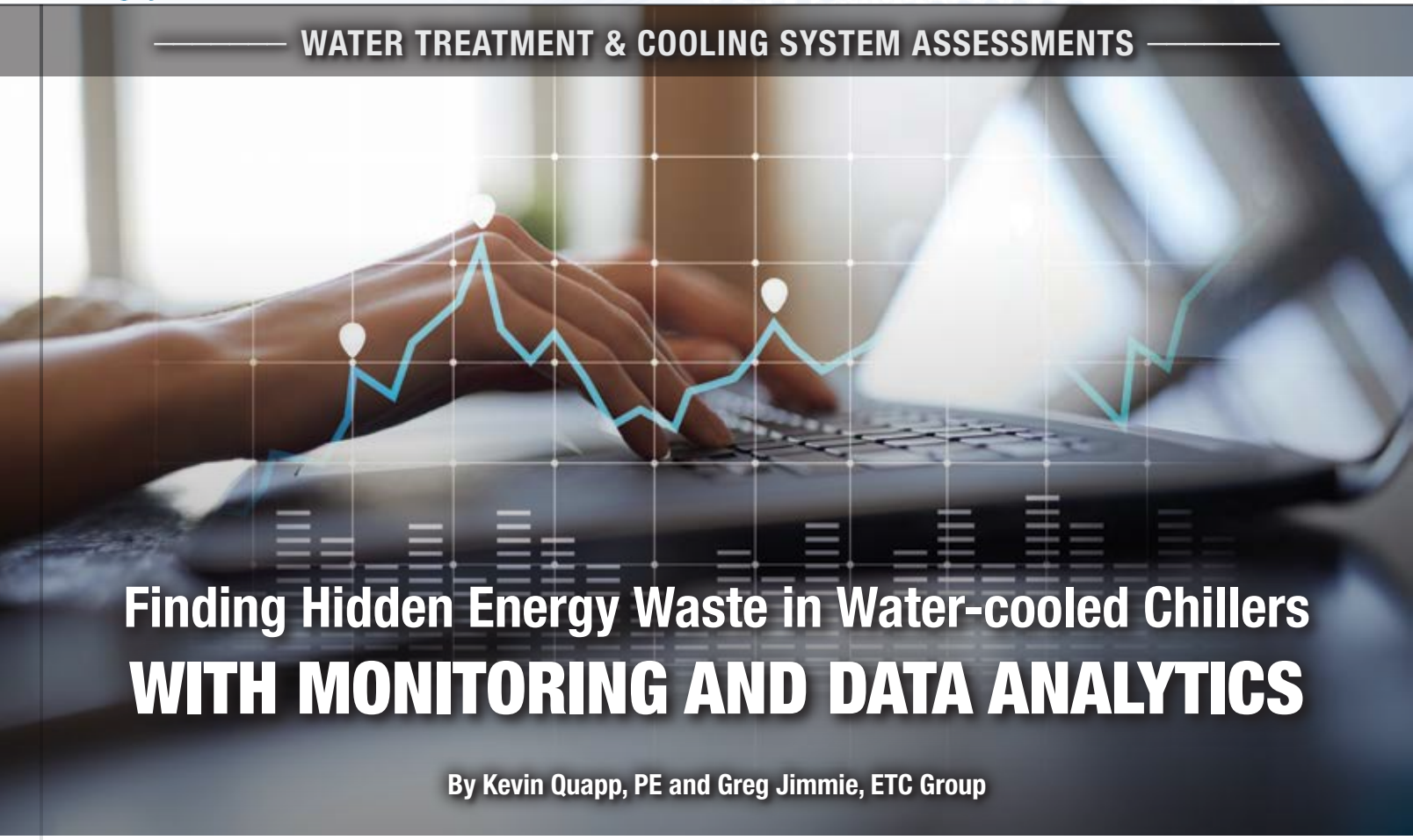
White Star Energy Leader

E4E SOLUTIONS
ENGINEERED FOR EFFICIENCY

Supporting Partner

NALMCO

WATER TREATMENT & COOLING SYSTEM ASSESSMENTS



Finding Hidden Energy Waste in Water-cooled Chillers WITH MONITORING AND DATA ANALYTICS

By Kevin Quapp, PE and Greg Jimmie, ETC Group

Chillers are an essential component in many building Heating, Ventilation and Air Conditioning (HVAC) systems. They provide cooling to the building by working in tandem with pumps and cooling towers in a water-cooled chiller plant. Because of the chiller's complexity and its role in cooling facilities, it is arguably the most important piece of equipment to maintain.

Chillers are big energy users and are often not running at peak efficiency. Missed chiller energy savings opportunities can be as high as 40% and typically range between 10 to 20 percent. The U.S. Department of Energy (DOE) also estimates chillers consume more than 50% of a building's electric energy use during seasonal periods. Unfortunately, the DOE also estimates chillers are wasting up to 30% of their energy use because of inefficiencies.

This article examines often overlooked or undiscovered energy waste with water-cooled chillers and the benefits of chiller monitoring and data analytics.

Multiple Reasons for Chiller Plant Inefficiencies

Energy (and money) is often wasted due to chiller inefficiency and underlying operational problems. There seems to be a general thinking that if a chiller is delivering chilled water at its setpoint, everything is fine and annual maintenance takes care of the rest. This thought process can lead to problems since annual maintenance is generally scheduled when the chilled water plant is not running anywhere near maximum capacity. This means

> "Missed chiller energy savings opportunities can be as high as 40% and typically range between 10 to 20 percent."
>
> — Kevin Quapp, PE and Greg Jimmie, ETC Group

issues can go unseen by the service technician. Frequently, issues remain hidden until chillers operate near their design capacity.

In many instances a chiller has poor operating efficiency – or worse – the chiller's capacity is reduced. Reduced capacity doesn't show itself until the plant can't deliver on the hottest week of the year and chillers can fail at that time because they are pushed to or beyond their design limits. With such a critical piece of equipment, it's better to know there is a:

- Performance issue before you've spent money operating under the pretense that everything is fine,
- a capacity problem before the chiller plant can't deliver enough chilled water, and
- a reliability problem before a chiller fails at the least opportune time.

When we initially hook up chiller plants to a monitoring and analytics solution, we commonly find efficiency losses from 10 to 20 percent, and sometimes up to 40% on about half of the chillers we evaluate. It's not that service contractors are doing something wrong; they just don't have all the information served up in a way to help pinpoint problems. Service technicians know more about their machines than anyone. They just don't have the same tools and are not specifically looking for energy waste and underlying problems.

Typical chiller issues we encounter include low refrigerant, which is more prevalent on high-pressure machines; fouled condenser and evaporator tubes; or issues with Variable Geometry Diffusers (VGDs), Inlet Guide Vanes (IGVs), sensors, and Variable Frequency Drives (VFDs). We also occasionally see liquid carryover and excessive compressor oil. We've even run across an older chiller control board causing reduced chiller performance. It all points to the need for chiller plant monitoring and analyses of analytics.

Implementing Chiller Plant Monitoring Solutions

The value of a monitoring and analytics solution will depend on the quality of the analytics and ultimately who is evaluating the data and delivering findings. All solutions we are familiar with collect data locally at the chiller and then

CHILLER & COOLING

BEST PRACTICES

coolingbestpractices.com

FREE SUBSCRIPTION

DIGITAL EDITION FREE WORLDWIDE | PRINT EDITION FREE TO U.S. SUBSCRIBERS

2020 FOCUS INDUSTRIES!

Chemicals & Oil Refining • Maintenance & Refrigerants • Quality, Pressure & Flow Measurement • Metal Fabrication & Machining

Optimize Onsite Utilities Powering Automation

Chiller & Cooling Best Practices is a technical magazine dedicated to discovering Energy and Water Savings in industrial and commercial HVAC and process cooling systems. Our editorial focus is on case studies and technical articles focused on optimizing cooling towers, central plant chillers and process chillers. We also focus on building knowledge on refrigeration compressors and circuits.

How Can Mechanical Contractors and Owners Design Systems Using Reduced Cooling Water and kW?

Our goal is to share the "Best Practices" already available and used in the field today. Our readers embrace Sustainability as a profitable business opportunity-and the right thing to do. We believe the industrial process cooling and HVAC installed base to be at a tipping point – one where "energy and water retrofits" will fuel a new era of market growth. Our case study editorial focus teaches Mechanical Contractors and Owners how to use less kW and cooling water by understanding "the constituents of demand" and exploring alternative cooling options.

- Retrofit cooling towers to reduce water consumption
- Improve water treatment strategy to reduce water consumption
- Deploy VSD compressor technology to reduce chiller kW consumption
- Reduce demand by replacing water-cooled air compressors with air-cooled
- Identify waste heat sources
- Measure and challenge flow and temperature specifications

"The new chiller has multiple cycling scroll compressors providing 30% energy savings, zero down-time in production and remote monitoring for all KPI's."

— Derrick Gough, Coppertail Brewing Co. (feature article in March 2019 Issue)

"We have invested heavily in water treatment. Our Water Saver technology can save clients an immense amount of water and decrease the amount of treatment chemicals."

— Dustin Cohick and Josh Boehner, EVAPCO (feature article in May 2019 Issue)

"Adsorption chillers use water as the refrigerant for zero ODP/ GWP and are driven by waste heat or low-cost natural gas."

— Rajesh Dixit, Johnson Controls
(feature article in August 2019 Issue)

Subscribe Now!

To subscribe visit **coolingbestpractices.com**

FINDING HIDDEN ENERGY WASTE IN WATER-COOLED CHILLERS WITH MONITORING AND DATA ANALYTICS

send it to the cloud for analytics. Some good rules of thumb to follow to ensure the system is operating efficiently, include:

- Condenser approach should be less than 3 °F (1.7 °C) and evaporator approach should be less than 2 °F (1.1 °C) at full load.
- Discharge superheat should not exceed a differential of 25 °F (13.9 °C).
- Subcooling should be in the range of 8 °F to 10 °F (4.45 °C to 6 °C).
- Compare efficiency (kW/ton), differential pressure (dP), water and refrigerant temperatures of like chillers.

When vetting solutions, it's essential to gauge the level of diagnostics needed to find out what is happening with your chiller. A detailed monitoring and analytics solution provides the full picture of what is happening with any given chiller. Hardware and cloud-hosted software solutions for data refrigeration analytics, such as ClimaCheck (www.climacheck.com), can provide insight to help optimize water-cooled chillers.

A thorough monitoring and analytics solution typically incorporates existing data points from the existing chiller, such as water entering/leaving temperatures, and condenser/evaporator saturation temperatures and pressures, along with a few external temperature and pressure sensors to complete the data collection package.

Having as much data available as possible from the chiller does three things. First, it keeps installation cost down because many of the sensor readings are available from the chiller BACnet cards. Secondly, by collecting data directly from the chiller, the quality of these explicit data points can't come into question during investigative troubleshooting with the chiller technician. Finally, only one set of sensors must be maintained.

With any monitoring and analytics solution, proper commissioning is critical to obtain reliable results. It's also vital for a person knowledgeable about chillers and the refrigeration cycle to review the data in order to unlock the power of the analytics. It's best to perform ongoing data reviews on a monthly basis.

It's also important to realize there can be resistance or pushback about the findings of data reviews, which is natural since chiller performance monitoring is not yet common and it's natural to be skeptical of something new. It may even go as deep as questioning the validity of the data.

The key to success with monitoring and analytics is teamwork. This means bringing the monitoring engineering team's diagnostics and the mechanical service contractor onsite together to work through complicated performance issues.

It may also be necessary to strip away analytics and get to the basics of the refrigeration cycle: Discharge superheat, sub-cool, power input and refrigerant/water approach temperatures. When you have the benefit of two identical chillers, get them loaded evenly so a comparison of two machines can occur. Trust your data and keep digging. Chiller diagnostics are critical for knowing there is a problem, but when the problem is more obscure, we must look beyond the tool and get to a common ground.

Monitoring and Data Analytics at Work

What follows are case studies at three different facilities to illustrate how a detailed monitoring and analytics solution pinpointed issues that might've gone unnoticed with water-cooled chillers. While the case studies don't paint a complete picture of the typical findings and how all of the issues were resolved, they illustrate the value of continuously monitoring to identify issues that can prevent a critical failure from occurring and from energy waste

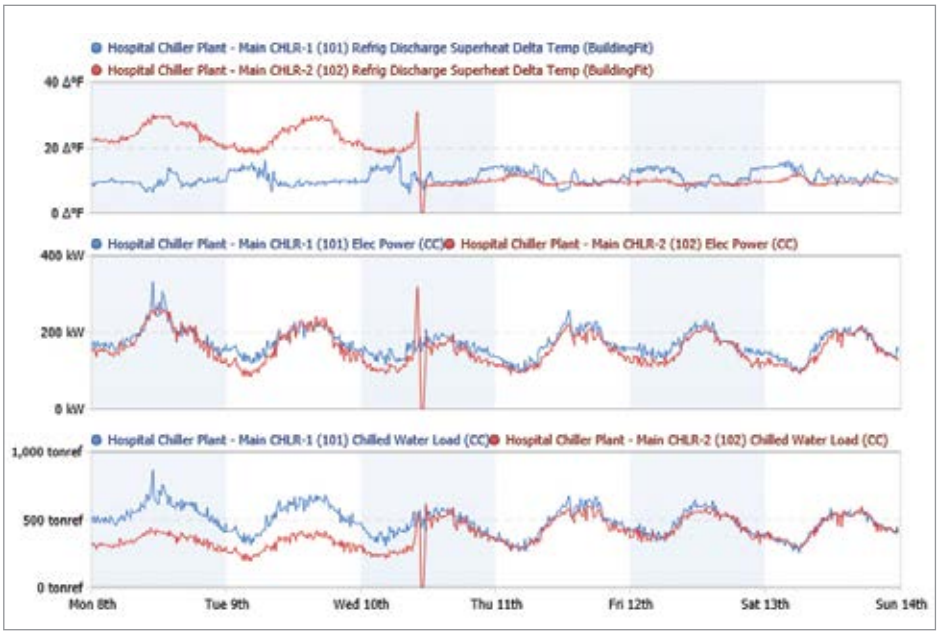


Figure 1: The top graph in this diagram shows Chiller No. 2 (red line) with a discharge superheat in excess of 20 °F, which kept it from increasing capacity throughout the day. Once the VGD actuator was corrected, the discharge superheat reduced significantly, and Chiller No. 2 was able to match the load and efficiency of the equivalent Chiller No. 1 (blue line) as shown in the bottom two graphs.

FINDING HIDDEN ENERGY WASTE IN WATER-COOLED CHILLERS WITH MONITORING AND DATA ANALYTICS

going unchecked. All three examples share common themes in that:

- Operators have observed a chiller running poorly.
- Available data helps the team pinpoint the problem.
- It can take a team to resolve the root cause of some problems.

Case Study No. 1

The facility historically had problems with the performance of one of its two chillers. While looking at the analytics data, the engineering team observed a 40% difference in operation in terms of power and efficiency for the identical chillers. The data pointed to something wrong with Chiller No. 2, including higher power draw, very high discharge superheat and low refrigeration compressor efficiency.

In follow-up discussions, plant operators said they observed differences in these two chillers and opted to only operate the questionable chiller if necessary. Additionally, the chiller service provider investigated the concerns and concluded the issue was caused by different flow rates through the chillers.

Data analytics helped to more clearly identify the problem, while also moving toward a resolution. In this complicated example, it took the monitoring engineering team and chiller service technicians working together to identify the root cause of poor compressor performance – an improperly installed VGD. As a result, the VGD was adding pressure drop at the outlet of the refrigeration compressor. The chiller had been running this way for five years and without analytics all that existed was a hunch from operators that something was wrong. Fortunately, data analytics provided enough information to confidently move beyond a conversation and accurately pinpointed the problem.

Case Study No. 2

A monitoring and analytics solution was used on six of the facility's chillers. When comparing two identical chillers, the team saw a clear difference in performance between Chiller No. 5 and Chiller No. 6. During a short-term test, it was clear Chiller No. 6 operated 20% less efficiently than Chiller No. 5. Again, the solution involved the data monitoring engineer working onsite with the contracted chiller service technician to find the root cause which ended up being bad chiller trigger control board. Shortly after testing and before the facility could investigate the findings, Chiller No. 6 experienced a VFD-single phase failure. The chiller manufacturer subsequently replaced the malfunctioning trigger board. With the repair all problems were resolved, allowing Chiller No. 6 to operate at the same level of efficiency as chiller No. 5.

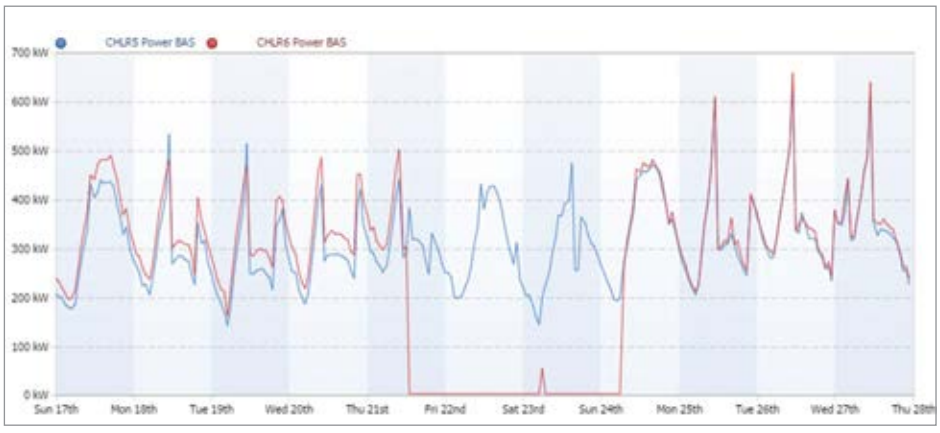


Figure 2: Shown are Chillers No. 5 (blue line) and No. 6 (red line) operating at the same level of efficiency before a trigger board malfunctioned on Chiller No. 6 on Friday and how a repair on the same chiller on Sunday corrected the issue.

Case Study No. 3

A routine review of data revealed a problem with low-refrigerant charge, which is a common issue in water-cooled chillers and especially with high-pressure chillers.

Data obtained on one of several chillers indicated there was a significantly degraded evaporator approach temperature over several months. The chiller indicated poor approach in January but since the chiller was operating at low load (less than 50%) and relatively close to the other chillers in the plant, it was not an urgent concern. There were signs something might be wrong since evaporator approach was above the "rule of thumb" of 2 °F. However, part load on the chiller made it difficult to call out a refrigerant charge issue at that time.

When the chiller next operated in April, the evaporator approach jumped from 2.5 °F (1.4 °C) and was consistently above 8 °F (4.4 °C). Additionally, it's operating efficiency was 10 to 15 percent worse (kW/ton) than the other chillers. The chiller illustrated consistently poor performance at all load conditions with the evaporator approach well beyond the acceptable range for this type of chiller.

The problem was revealed when a chiller technician identified the chiller had a failed O-ring that allowed refrigerant to leak. A low refrigerant situation happens more often than some might think. Additionally, the right way to add refrigerant is to fully evacuate the chiller, weigh the refrigerant, and add the missing amount to take the chiller up to the

manufacturer's recommended amount. Too often, shortcuts are taken, and refrigerant is simply added with spot checks by a chiller technician. This can lead to either an overcharge of refrigerant, or simply not providing enough of it. We have seen scenarios of chillers being at 50% of design refrigerant charge, or several hundred pounds over factory spec.

After the problem was identified, the contracted chiller technician repaired the chiller and filled the refrigerant to design specification. Chiller performance increased significantly post-refrigerant charge. At about 300 tons, efficiency improved from 0.5 kW/ton to 0.4 kW/ton for an improvement of approximately 20%.

Detailed Chiller Monitoring and Analytics Well Worthwhile

Chillers are the largest energy user in the heating and cooling system and many of them waste a considerable amount of energy, i.e., dollars. It's even more of a reason for having detailed chiller monitoring and analytics solutions in place. BP

About the Authors

Kevin Quapp, PE, is ETC Group Director of Engineering. He has 21 years of experience including eleven as an energy efficiency specialist at ETC Group. Quapp earned a Bachelor of Science in Mechanical Engineering from the University of Idaho.

Gregory Jimmie is a project engineer with expertise in chiller and chiller plant optimization. He also focuses on using analytics to identify energy efficiency opportunities. Jimmie earned a Bachelor of Science in Mechanical Engineering from the University of California, San Diego.

About ETC Group

ETC Group is a leader in energy efficiency, commissioning and an engineering firm that provides services to reduce building energy waste, reduce operational costs, and creates healthy and comfortable environments to patients and tenants. The company's people are experienced, trusted and proven. The company prides itself on being an industry innovator in its approach to problem-solving, and implementation of leading-edge data analytics technologies. For more information, visit https://etcgrp.com/.

All charts courtesy of ETC Group.

To read similar ***Chiller System Assessment*** articles, visit
www.coolingbestpractices.com/index.php/system-assessments/chillers

THE MARKETPLACE

CHILLER & COOLING BEST PRACTICES
www.coolingbestpractices.com

ADVERTISER INDEX

TECHNOLOGY & JOBS

Job & Product Marketplace Advertising Information

Reach 13,000+ readers of Compressed Air Best Practices® Magazine with Marketplace Ads every month!

Prices are $300.00 per Job Marketplace Ad and $350.00 per Product Marketplace Ad ($300 if 6 or more ads are placed).

Contact Rod Smith at rod@airbestpractices.com to schedule your Marketplace Ads.

Contact Rod Smith for ad rates: **rod@airbestpractices.com, Tel: 412-980-9901**

CHILLER & COOLING BEST PRACTICES
www.coolingbestpractices.com

Advertising & Editorial: Rod Smith
rod@airbestpractices.com
Tel: 412-980-9901

Subscriptions & Administration: Patricia Smith
patricia@airbestpractices.com
Tel: 412-980-9902

A Publication of: Smith Onandia Communications LLC
37 McMurray Rd. Suite 106
Pittsburgh, PA 15241

Chiller & Cooling Best Practices is published quarterly and mailed together with Compressed Air Best Practices®. Compressed Air Best Practices is published monthly except January-February combined by Smith Onandia Communications LLC, 37 McMurray Rd. Suite 106, Pittsburgh, PA 15241. Periodicals postage paid at Pittsburgh, PA and additional mailing offices. POSTMASTER: Send address changes to: Compressed Air Best Practices, 37 McMurray Rd., suite 106, Pittsburgh, PA 15241.

BEST PRACTICES

2020 EXPO SEPTEMBER 20-23 CHICAGO, IL

COMPRESSED AIR / VACUUM / COOLING

OPTIMIZE ON-SITE UTILITIES

Powering Automation

Research and Identify Innovations

to Enhance the Efficiency and Reliability of Your Systems

Compressed Air

Air Compressors
Air Compressor Controls
Air Purification & Piping
Condensate Management
Pneumatics

Blower & Vacuum

Aeration Blowers
Industrial Blowers
Vacuum Pump Systems
Inlet Filtration/Oil Separators

HVAC & Process Cooling/Steam

Chillers
Heat Exchangers
Cooling Systems
Cooling Towers
Water Treatment
Boilers
Steam Traps

Motors & Drives • Lubricants • Measurement Instruments • IoT Automation & Monitoring

EXPO HOURS

Monday, September 21 12:00-6:00pm

Tuesday, September 22 12:00-6:00pm

SAVE THE DATES ON YOUR CALENDAR!

Located at the modern Schaumburg Convention Center just 10 minutes from Chicago O'Hare International Airport.

www.cabpexpo.com

Sponsored by CAGI Compressed Air & Gas Institute

Carrier

Turn to the experts

When You're the Leading Efficiency Screw Chiller,[1] Keeping Your Cool Is All in a Day's Work.

When measured across a broad range of operating conditions, Variable Speed Screw technology, as used in the Carrier 23XRV chiller, was 11% more efficient than mag bearing technology.[4]

Heat waves? Bring 'em on. Storms? Piece of cake. Tower fan failure? No problem. The AquaEdge® screw chiller with Greenspeed® intelligence from Carrier is engineered to thrive in situations other chillers can't survive. With surge-free performance, variable-speed range twice that of other chillers[3] and a unique compressor design that minimizes the need for scheduled maintenance. Oh, and it's remarkably quiet next to comparable centrifugal chillers.

Day in, day out, no chiller keeps its cool quite like the AquaEdge chiller.

AquaEdge® 23XRV
Water-Cooled Chiller

For more information about the AquaEdge 23XRV and the GPG Study, visit carrier.com/proof.

[1] Among electric-driven, water-cooled screw chillers as measured at IPLV conditions reported by the DOE/FEMP Energy-Efficiency Study. [2] Integrated Part Load Value conditions based on ASHRAE 90.1 2016 minimum requirement on select models. [3] Validated by performance testing. [4] Source: www.gsa.gov/gpg, GPG Program Summary, GPG-031, Aug. 2017, Variable-Speed Direct-Drive Screw Chiller. The GSA study referenced herein does not constitute a product endorsement, recommendation, or preference by the U.S. Government or any agency thereof, or the Pacific Northwest National Laboratory/Oak Ridge National Laboratory. [5] 0.299 kW/ton on select models.