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July 2023



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FROM THE EDITOR



Reliable Compressed Air and Cooling Systems

We were recently kindly invited, by a team of subscribers and regular visitors to Best Practices EXPO & Conference, to visit the compressed air, cooling tower and chiller, and vacuum systems supporting their plant. For confidentiality reasons, we will just say this was a modern plant employing a few thousand people.

Visiting was very motivating and inspiring! I've been in the compressed air industry, since 1992, and this plant set a new standard (for me) relating to compressed air system low pressure drop, low dew point and monitoring/control. The massive evaporative cooling tower "buildings" and the rows of centrifugal chillers provided both precision process cooling and the lowest air compressor inlet water temperatures I remember seeing. My biggest takeaway was, however, a reminder that if the compressed air, vacuum, or cooling systems go down or deviate from the dew point, pressure or temperature requirements, the entire plant stops production. Reliability and quality are everything to this plant – what we do really is important!

Hitachi Industrial Equipment Systems recently announced Sullair, Hitachi, and Champion Compressors (Australia) would come together under the umbrella of Hitachi Global Air Power (HGAP). We asked to visit their growing manufacturing campus in Michigan City, Indiana to learn more. I hope you enjoy Mike Grennier's article resulting from our visit and interviews with HGAP leadership.

How well does your plant evaluate and understand air- and water-cooling alternatives for air compressors? What about the related heat recovery options? Our feedback, from even sophisticated companies, is that within these topics there is still "low hanging fruit" in most plants. Veteran auditor, Hank Van Ormer, has sent us "Part 1" of a two-part series on this subject.

How well do you understand adiabatic cooling? I personally have arrived, after some work, at the infamous, "knows enough to be dangerous", level engineers use to describe those still learning. To help us all on our journey, we'd like to sincerely thank EVAPCO's Mihir Kalyani for sending his article titled, "Adiabatic Cooling, the New Happy Medium."

Thanks also go to Neal Walsh and Robert Downey, from the Baltimore Aircoil Company, for their insightful article titled, "The Paths to Leadership in Energy and Environmental Design Water Conservation Credits for Evaporative Cooling Towers." This is a must read for engineering firm personnel!

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

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Compressed Air Technology & Industry News

Schulz Compressors Celebrates 60th Anniversary

Schulz celebrated its 60th anniversary on June 12, 2023. The firm is proud to achieve this milestone as the largest manufacturer of air compressors in Latin America exporting their innovation and technology to more than 70 countries. Schulz would like to thank their customers and partners who, in many diverse segments, have placed their trust in the Schulz brand and helped the firm get to where it is today. Schulz will continue to grow and evolve, responding to the ever-changing needs of their customers.

Schulz is a genuine Brazilian company located in Santa Catarina, with headquarters in Joinville. Like other large organizations which began as family businesses, Schulz started its history 60 years ago with only 26 co-workers and limited resources. On June 12th, 1963, Heinz Schulz invited a group of friends and entrepreneurs to found Metalúrgica Schulz.

Schulz S.A. is today a world-class company formed by two business divisions: Schulz Automotiva and Schulz Compressores. Headquarters is in a modern industrial park, covering 3,460 million square feet with more than 325,000 square feet of buildings. Here it develops and manufactures a large line-up of products such as reciprocating piston and rotary screw air compressors. The company also maintains a branch in the USA and two in Shanghai, China as well as distribution centers for automotive products in Europe and the USA.

Today, Schulz is acknowledged as one of the most complete factories of air compressors in the world, offering the market a full line in the generation, treatment and storage of compressed air. Besides the reciprocating piston, diaphragm, and screw air compressors, ranging from 5 to 250 horsepower, it has refrigerated and adsorption air dryers, in-line filters, coalescing filters, condensate separators, pneumatic tools, electrical tools and accessories for residential, professional and industrial applications.

About Schulz of America

Schulz Compressors is the largest manufacturer of air compressors in Latin America with one of the most comprehensive air compressor plants in the world. The company has operated in the North American market since 1980 and offers the residential, professional and industrial segments a full product line of air compressors. Reliability, safety, durability and efficiency have been trademarks for decades, since its foundation in Brazil in 1963. For more information, visit www.schulzamerica.com.

Atlas Copco Sponsors Military Workforce Training Program

The Manufacturing Institute, the workforce development and education partner of the National Association of Manufacturers, has announced Atlas Copco as a silver sponsor of its Heroes MAKE America initiative. The investment will support the growth and expansion of the Heroes program. Heroes MAKE America is a Department of Defense-approved SkillBridge program dedicated to promoting manufacturing careers in the United States, building connections between the military and veteran communities and the manufacturing industry, and providing exposure to a reliable stream of skilled military talent.

“Atlas Copco is incredibly grateful for the sacrifices made by U.S. military service members and their families,” said Atlas Copco North America Vice President Aaron Prato. “Just as Atlas Copco has been committed to driving development and delivering breakthrough innovations to customers around the world in countless industries for 150 years, we are committed to investing in resources that



The Schulz global headquarters is located in Joinville, Santa Catarina, Brazil.

improve the lives of veterans and their families. With the Heroes MAKE America program, we combine our strong, qualified workforce values with our commitment to serving American veterans and military members."

Manufacturers highly value the core elements of military training that allow America's service members to be the best in the world. The teamwork, commitment to mission, communication, and critical thinking skills essential to mission success are also essential to manufacturing success. Heroes MAKE America launched in January 2018 at Fort Riley in Kansas and has since expanded to Fort Hood in Texas, Fort Bragg in North Carolina, and Fort Stewart in Georgia as well as a 100% virtual training program.

Since 2018, Heroes MAKE America has issued over 5,100 industry-recognized certifications and achieved a 90% placement rate among graduates in more than 350 companies in 47 states. The program has introduced more than 12 million individuals from the greater military community to information about manufacturing careers through in-person events, social media, VA newsletters, and industry-related events.

Serving over 180 countries, Atlas Copco develops industrial ideas that empower customers to grow and drive society forward. Every day, across the United States and around the world, products are manufactured, facilities are constructed, critical fasteners are secured, processes are pressurized and cleaned, and all types of gasses are compressed and turned into energy. This may seem like a collection

of unrelated processes, but Atlas Copco unites them, working with customers from every industry to create a better tomorrow, by maximizing efficiency today. In 2023, Atlas Copco celebrated their 150th anniversary.

"Manufacturing has averaged over 800,000 job openings per month over the past year. Nearly 200,000 service members exit the military every year, and there are an additional 2.9 million under-employed veterans with the skills and experience that are uniquely aligned for manufacturing careers," said MI President and Executive Director Carolyn Lee. "Modern manufacturing careers are great opportunities for veterans to find their next



The investment will support the Manufacturing Institute's Heroes MAKE America Program.
calling and join a new mission. Thanks to today's generous investment by Atlas Copco, the Manufacturing Institute's Heroes MAKE America program can continue working towards closing the manufacturing skills gap

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Compressed Air Technology & Industry News

by training our transitioning service members, veterans, military spouses, National Guard, and Reservists with critical skills and placing them on a path toward a rewarding manufacturing career. We are incredibly grateful to Atlas Copco for making an impactful investment in such an important program."

Sponsors of Heroes MAKE America include Atlas Copco, Amazon, Johnson & Johnson, Union Pacific, Howmet Aerospace, Saint-Gobain, WestRock, Cargill, Honeywell, Niagara Bottling LLC, SK Battery America, SEMI, Plastics Pipe Institute, FUCHS Lubricants Company, and NAFEM.

About Atlas Copco Compressors

Atlas Copco Compressors LLC is part of the Compressor Technique Business Area, headquartered in Rock Hill, South Carolina. Atlas Copco Compressors provides innovative solutions, including world-class compressors, air blowers, industrial coolers, vacuum pumps, quality air products, and gas generation systems, all backed with full service, remote monitoring, and auditing services. With a nationwide service and distribution network, Atlas Copco Compressors is your local, national, and global partner for all your compressed air needs. For more information, visit www.atlascopco.com/air-usa.

ELGi Launches AR Premium Series

Cycling Refrigerated Dryers

ELGi North America (ELGi), a subsidiary of ELGi Equipments Limited, one of the world's leading air compressor manufacturers, has announced the introduction of the AR Premium Series Energy Saving Cyclic Refrigerated Air Dryer. The new ELGi's AR P Series Energy Saving Refrigerated Air Dryers, ranging from 100 cfm to 5,000 cfm, improve the efficiency and reliability of compressed air systems.

"We are excited to introduce our AR Premium Series air dryers at the AICD show. Our new energy-saving dryers align with our commitment to providing innovative solutions that enhance the efficiency and reliability of compressed air systems," said Malcolm Lindsay, SVP of ELGi Industrials

During the compression process, cooling compressed air causes water vapor to precipitate as condensation. To prevent damage to downstream equipment, it is crucial to remove this condensation from the system. The AR P Series air dryer effectively eliminates moisture and condensation, making it an ideal accessory for a wide array of applications.

Any compressed air installation is subject to variation in compressed air demand depending on the manufacturing plant operation. AR P Series Energy Saving Cyclic Refrigerated Air Dryer has a refrigeration system specifically designed to attune itself to this varied compressed air demands, this results in significant saving in power consumption of dryer. This range also gives significant saving by adopting to ambient temperature



The new refrigerated dryers from ELGi can replace non-cyclic dryers in all applications requiring CLASS 4 air, offering highly efficient thermal mass control for better energy savings.

varyations during day and night, also ambient temperature variations during different seasons of the year.

The ELGi AR Premium Series Energy-Saving Cycling Refrigerated dryer's features include:

- **High Energy Efficiency:** The hermetically sealed refrigeration compressor in the dryer enables superior energy efficiency with minimal noise and vibration.
- **Automatic Condensate Drain:** Features a mechanical level-sensing drain for efficient condensate removal, ensuring no air loss and low maintenance.
- **Smart Controller:** Displays crucial metrics such as pressure dew point temperature, ECO mode status, operation hours, fan operation, air temperatures, and maintenance intervals.

➤ **Integrated Filters:** Enhances performance with reduced pressure drop and less piping needs. The inlet pre-filter and outlet fine filter efficiently remove dust and oil particles.

*Applicable for sizes up to AR 2350P

➤ **Heat Exchanger:** An aluminum plate and stainless steel, copper brazing heat exchanger ensures maximum thermal exchange efficiency and longevity.

For more information on the ELGi AR Premium Series dryers, please visit: <https://www.elgi.com/us/ar-premium-series-air-dryers>.

About ELGi North America

ELGi North America, headquartered in Charlotte, NC, is a subsidiary of ELGi Equipments Limited, a leader in compressed air solutions for over 60 years. Established in 2012, ELGi North America, in conjunction with its subsidiaries, Pattons, Pattons Medical, and Michigan Air Solutions, offers a comprehensive range of compressed air products and services. Our product offering includes oil-lubricated and oil-free rotary screw and reciprocating compressors, dryers, filters, and ancillary accessories. ELGi and its subsidiaries serve multiple industry verticals spanning medical applications, pharmaceuticals, food & beverage, construction, manufacturing, and infrastructure. For further information, please visit <https://www.elgi.com/us/>.

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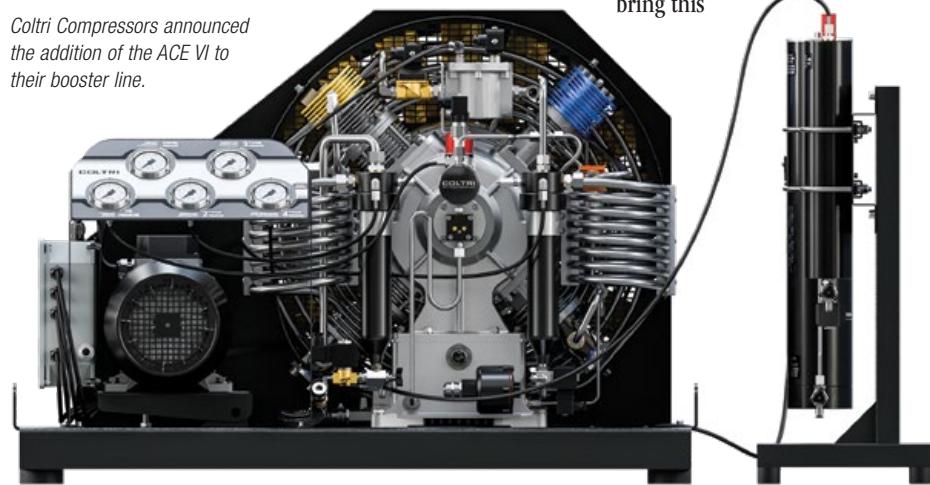
COLTRI Adds the ACE VI Industrial Compressor

Coltri Compressors, a leading manufacturer of high-quality industrial compressed air solutions, is excited to announce the ACE VI industrial compressor, the latest addition to their top-rated booster line. The ACE VI is designed to meet the needs of industrial customers that require reliable and efficient compressed gas solutions. It is a powerful compressor built to withstand the most demanding operating conditions, making it perfect for a wide range of applications.

The ACE VI boasts impressive features that make it stand out. At the heart of this compressor is a powerful four-stage block delivering a maximum output driven by a 15-kW motor with an inlet pressure of 2 and 5 bar / 29 and 72 psi.

To ensure optimal performance, the ACE VI uses a unique five-stage filtration system to deliver the cleanest gas for every application. This helps protect the equipment and extend the machine's life while reducing maintenance requirements and costs. Other features of the ACE VI include an automatic condensation

Coltri Compressors announced the addition of the ACE VI to their booster line.



drain and a user-friendly control panel for operators to adjust settings and monitor performance easily.

"Our team of experienced engineers and designers have worked tirelessly to develop a compressor that meets the needs of our industrial customers. The ACE VI is a testament to our innovation, and we are confident that this compressor will exceed our customers' expectations," said Claudio Coltri, CEO of Coltri Compressors.

One of the key benefits of the ACE VI is its versatility. It can be easily adapted to meet the specific requirements of different customers, with many options and the ability to add dryers, aftercoolers, and additional filters. The ACE VI also comes with a comprehensive warranty, ensuring that customers can rely on the performance and durability of the compressor for years to come.

"With the introduction of the ACE VI, we are confident that we have raised the bar for quality and performance in the industrial compressor market. We are excited to

compressor to our customers, and we look forward to working with them to find the perfect solution for their needs," said Coltri.

The Coltri ACE VI industrial compressor is a high-performing, reliable, and versatile solution perfect for various industrial applications. Built with the latest technology and designed with the needs of our customers in mind, the ACE VI is the ultimate choice for those who demand nothing but the best.

About Coltri Compressors

Coltri Compressors is an Italian company that has been producing high-quality compressors for over 60 years. Founded in 1963, Coltri began as a small manufacturing workshop specializing in the production of high-pressure compressors for the diving industry. Since then, the company has grown to become a world leader in the design and manufacture of compressors for a wide range of applications, including industrial gas compression. Thanks to its focus on innovation, quality, and customer service, Coltri Compressors has become a trusted brand in the global market. For more information, visit www.coltri.com.

Ingersoll Rand Announces HD Compression as Distributor

Ingersoll Rand, a global provider of mission-critical flow creation and industrial solutions, announced that it is partnering with HD Compression, headquartered in Montreal, Canada. HD Compression will offer reciprocating, rotary and centrifugal compressors along with a full suite of Ingersoll Rand's air treatment equipment, replacement parts and CARE offerings in the province of Quebec, Canada. HD Compression is led by

long-time Ingersoll Rand employee, Al Giffen, who is now president of HD Compression.

The partnership will allow customers in Quebec access to a compressed air products and services provider that will ensure that their compressed air systems operate reliably and as efficiently as possible. Customers will also have the full support of Ingersoll Rand, its products and resources.

"Al Giffen has a proven track record in the compressed air industry in Quebec and shares Ingersoll Rand's values," said Ben Ward, director of distribution, Ingersoll Rand. "We are pleased to have Al leading this initiative



HD Compression will offer reciprocating, rotary and centrifugal compressors along with a full suite of Ingersoll Rand's air treatment equipment, replacement parts and CARE offerings.



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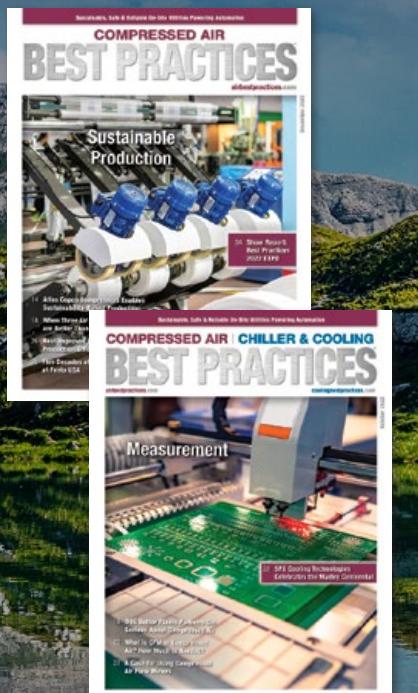
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and are confident that HD Compression will provide spectacular customer service to our existing and new customers. Al's knowledge, expertise and 25 years in the industry make him the ideal leader for the success of HD Compression."

Backed by Ingersoll Rand's first-in-class compressor product portfolio and certified parts and service, the HD Compression and Ingersoll Rand partnership creates a seamless conduit of local support with OEM quality and excellence direct to the end user. HD Compression is one of 21 Ingersoll Rand distributors in North America.

"The mission of HD Compression is to deliver number-one systems, service, and support of compressed air systems in the market to our customers. To do this, we require the support and partnership of the number-one compressor brand in North America, Ingersoll Rand," said Al Giffen, president, HD Compression.

HD Compression was built from the ground up to serve and support customers' compressed air needs. The leadership of HD Compression brings over 100 years of compressed air system experience from Ingersoll Rand and other brands in centrifugal, reciprocating, and rotary technologies.

About HD Air Compression

HD Compression is the official distributor of Ingersoll Rand in Quebec. The company provides a complete range of services to meet the needs of its customers, including sales, planning, installation, and maintenance of equipment to maintain operations at their facilities. For more information, visit www.hdcompression.com.

About Ingersoll Rand Inc.

Ingersoll Rand Inc., driven by an entrepreneurial spirit and ownership mindset, is dedicated to helping make life better for its employees, customers and communities. Customers lean on the company for its technology-driven excellence in mission-critical flow creation and industrial solutions across 40+ respected brands where its products and services excel in the most complex and harsh conditions. Employees develop customers for life through their daily commitment to expertise, productivity and efficiency. For more information, visit www.ingersollrand.com.

ABB Invests Nearly \$100 Million in New Berlin Greenfield Campus

ABB, a global leader in technology innovation, is celebrating the "floor pour" of its newest U.S. flagship campus at 18250 W. Lincoln Avenue. The greenfield location in New Berlin will serve as the U.S. headquarters, manufacturing facility and distribution center for the Drives and Motion Services businesses. The new facility is anticipated to open in late 2024 and will accommodate 720 ABB employees. Approximately \$100 million is being invested in the project and is expected to create 100 new jobs over the next three years.

"The U.S. is a significant and crucial market for our drives and the services that support them," said Tuomo Hoysniemi, President of ABB's US Motion Business Area and Global Drives Products Division. "We are committed to local engineering, product design, and manufacturing as well as increased capacity and innovative production and warehousing processes. Our new campus will help us better serve our local customers by increasing the



ABB is investing nearly \$100 million in a new campus in New Berlin to increase US production capacity of industrial electric drives.

availability of market-specific solutions and decreasing the time it takes to serve our customers."

The business manufactures a wide range of AC variable frequency drives and controls that reduce energy consumption in buildings and industrial applications in the U.S. market. Currently, the business is divided between two smaller, separate campuses in New Berlin and Wauwatosa. The new campus will include 220,000 square feet of manufacturing space and support offices in addition to a connected 315,000-square-foot distribution center. The consolidation of all operations to one campus will add additional efficiencies and reduce overall time to deliver.

"While we make products that help our customers improve their energy efficiency, we are pleased to incorporate features into our campus that will help us reduce our own carbon footprint," said Kelly Kling, Site Leader and Vice President of Finance for the U.S. ABB Drives and Motion Services businesses.

"Geothermal heat pumps and modern HVAC systems will allow us to recycle wasted heat and reduce our energy usage by more than 45%. Improved insulation, rooftop solar panels and ABB advanced building controls will also ensure that our campus operates efficiently and sustainably over the long term."

ABB has more than 20,000 employees across more than 40 sites in the U.S. and has invested more than \$14 billion in the country since 2010.

About ABB

ABB is a leading global technology company that energizes the transformation of society and industry to achieve a more productive, sustainable future. By connecting software to its electrification, robotics, automation and motion portfolio, ABB pushes the boundaries of technology to drive performance to new levels. With a history of excellence stretching back more than 130 years, ABB's success is driven by about 105,000 talented employees in over 100 countries.

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Good Things in Store as Hitachi Global Air Power Takes Shape

By Mike Grennier, Compressed Air Best Practices® Magazine

Hitachi has invested \$45 million in Hitachi Global Air Power's Michigan City, Indiana, manufacturing facility since 2017.

When Hitachi Industrial Equipment Systems Co., Ltd. (HIES) announced Sullair, Hitachi, and Champion Compressors (Australia) have come together under the umbrella of Hitachi Global Air Power (HGAP), many wondered what it would all mean.

It means good things are in store for HGAP and its customers, said Yasuhiro (Charlie) Takeuchi, President & Director of HIES, and John Randall, President & CEO of HGAP. Both shared insights into the establishment of HGAP as a unified global compressed air business. David Andrews, HGAP Vice President of Global Marketing & Communications, also provided views on the company announcement.

Company leaders said the formation of HGAP puts the organization in a strong position to deliver compressed air solutions that meet the demands of customers with diverse applications throughout the world. Customers can also expect to see a range of innovations introduced in the months and years ahead that will help them improve sustainability, growth, and profitability, thanks to HGAP's heavy emphasis on idea sharing and strategic

planning – all of which builds on more than 100 years of technological advancements.

Broader Resources Support Established Brands

While the creation of HGAP makes for a strong global company, Takeuchi and Randall said the organization remains unchanged in terms of ownership, leadership, and staff. HGAP will also continue to market and support products and solutions as distinct Sullair, Hitachi and Champion Compressors brands.

The company will be managed globally by Randall as before when he served as President & CEO of Sullair, located in Michigan City, Indiana. Sullair became a wholly owned subsidiary of Hitachi, Ltd. in 2017. Randall was named Sullair's leader in 2021. Takeuchi, who joined Hitachi in 1991, was instrumental in the creation of HGAP. His years of leadership experience with Hitachi's compressed air side of the business includes serving as CEO of Sullair in 2020.



Yasuhiro (Charlie) Takeuchi, President & Director, Hitachi Industrial Equipment Systems Co., Ltd.



John Randall, President and CEO of Hitachi Global Air Power.

Takeuchi said HGAP represents a mixture of the entire company's best manufacturing technology, product technology and talent.

"We need to support our customers globally. It made sense to form Hitachi Global Air Power to bring our best strengths together and bring that to the customer," he said. "Distributors will also continue to be very important for us as we continue to take care of our customers' assets."

Since acquiring Sullair in 2017, Hitachi has invested \$45 million in the Michigan City operation to bolster its manufacturing capabilities. The investment, Takeuchi said, exemplifies HGAP's commitment to deliver the best possible product and services to customers where they do business.

"We want to have a local presence and local capability to support our customers," said Takeuchi. "It's important we do what the customer wants us to do."

The formation of HGAP, Randall said, is part of a strategic plan established long ago as HIES set out to integrate corporate resources over time.

"The brands will continue to remain strong," he said, adding that HGAP is working through how best to integrate and utilize capabilities of the business at an organizational level.

"An example is the consolidation of global engineering under one leader to help our regionally based product management teams with a roadmap for satisfying customers' needs in each market," Randall said. "We'll also look

at how we manage operations globally to best utilize the strength of the total organization to satisfy customer needs around the world."

Randall said sales team will also continue to evolve in terms of compressed air products and beyond.

"We're already working with the global sales team at the Hitachi, Ltd. level to make sure we can serve customers from multiple different perspectives, not just at the air compressor level. If we can help other parts of Hitachi and vice versa we can not only satisfy the customer but grow with them as well," he said.

Product Strategies Taking Shape

There are a variety of examples of how HGAP will capitalize on the concept of idea sharing and planning to strengthen its service offering. The process has already begun, said company leaders.

A prime example, Randall said, is the adaptation of a 50 Hertz (Hz), CE-compliant DS Series oil-free rotary screw air compressor manufactured in China and engineered for the European market. The machine, which was recently introduced at the Hanover Fair, Hanover, Germany, is currently being adapted for the United States as a Sullair air compressor.



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Good Things in Store as Hitachi Global Air Power Takes Shape

"That's another strength of utilizing the entire engineering organization within Global Air Power," Randall said. "We've basically taken that rock solid airend that Hitachi developed for that product range and did some things differently with things like serviceability, airflow, and size to make it more applicable in other markets."

The big-picture idea, Randall said, is to develop a regional manufacturing strategy. The DS oil-free 50-Hz product is only one example.

"We launched that product in one location. As we start to see the volume build, we will localize it here in the United States to be closer in-market to the customer. We want to

provide a complete solution with everything from the product to the technical support and service where our customers are," he said, noting how plans call for manufacturing a full range of Sullair-branded oil free air compressors from 30 horsepower (hp) to 600 hp. Sullair currently offers stationary rotary screw air compressors from five hp to 600 hp and portable air compressors that generate from 185 to 3,000 cfm each.

HGAP will continue to invest in technologies that help customers improve efficiencies and achieve sustainability goals, Takeuchi said, adding Hitachi has a strong corporate commitment to sustainability. He said HGAP will continue to invest in key technologies such as motors, drives and airenads.

"We want to support our customers and that means providing them with green products and solutions," Takeuchi said.

Voice of Customer a Driving Force

While engineering and operational synergies are a major focus, the driving force in HGAP's go-to-market strategy will continue to be the voice of the customer, said David Andrews, who previously served as Vice President, Global Marketing and Communications at Sullair.

An example is how HGAP took to heart the need for serviceability in the design of its LS Series rotary screw air compressors. Distributor and customer input led to improved lift-off panels for the lubricated air compressor line as an important feature, which will also be incorporated into the oil-free air compressors.



John Randall next to new airenads from the new machining centers.



The newly expanded Sullair LS Series industrial air compressors highlight the company's focus on efficiency and ease of use.

"Distributors and end users want easy to access serviceable components," Andrews said, noting how understanding the customer contributes to overall product performance and reliability. "An efficient air compressor only runs efficiently if it's being serviced."

The oil-free line will also see the introduction of the Sullair touch-screen controller that has gained popularity with the LS Series product line. The controller can manage as many as 16 air compressors as part of a compressed air system.

"We've put a lot of thought into how we move forward with compatibility to be able to make it easier not only for technicians but users to manage their assets," Randall said.

Another core element of HGAP's strategy is to go beyond supplying customers with air compressors and related solutions based on specifications alone. The goal is to dig deeper into issues customers want to address and the problems they want to solve, Andrew said.

"The key here is really understanding the customer and what they need. No customer needs an air compressor. They need what an air compressor provides," he said. "When you start to have that discussion, it's not about design. It's about here's what works best for the customer," he said.

"Then the question gets back to, 'How do we have the right regional customer requirements satisfied?'" said Randall. "To David's point, sometimes it's asking the extra question and maybe providing a solution or an opportunity customers weren't even thinking about."

More insight often leads to options, the team pointed out, citing Sullair's Spiral Valve Technology as an example. Introduced in 1984 and refined since then, the technology is an alternative to Variable Speed Drives (VSD) as a capacity control method to efficiently manage changes in air compressor demand, in turn, reducing the amount of air compressed. The energy-saving solution is ideally suited for hot climates and dusty environments, as well as high altitude applications.

Reliability Remains Top Priority

Reliability, the HGAP team noted, is what most HGAP customers have said they want more than anything out of a compressed air

system. As such, the company will continue to incorporate proven design features into products as a way to enhance air compressor reliability and longevity.

Randall cited the company's recent initiative to enhance the reliability and performance of its 23 Series, 26 Series, and 32 Series airends.

"We went through and looked at where we were seeing problems," he said. "We eliminated all of the external oil piping and tubing to make them internal galleries. We eliminated as many as 30 potential leak points to where you now only have two or three oil points going in and a single discharge going out. We also looked

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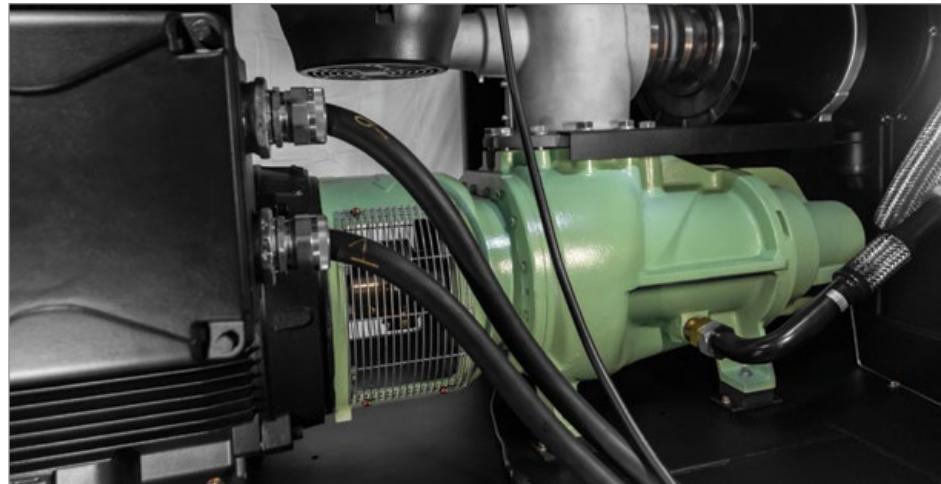
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Good Things in Store as Hitachi Global Air Power Takes Shape

at bearing loading and bearing life and put lot of science into things and really amped up the efficiency side of it."

Randall said HGAP is incorporating the same enhancements into its Certified REMAN Airend Program.

"The cast for our airends is so durable that we can now use some of our learnings to make older airends more efficient as remanufactured airends," he said, adding how remanufactured components on an air compressor equates to sustainability. "We're now on the second and third life for some cast components. We're eliminating the use of virgin material but still satisfying the customer need."



Sullair 23 Series, 26 Series, and 32 Series airends have been re-engineered for even greater efficiency and reliability.

Values of Hitachi Help Mold the Future

Randall said he appreciates the opportunity to lead a company with roots in the industry that dates to 1911 when Hitachi began manufacturing air compressors, which is in addition to Sullair's rich history in rotary

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screw technology. He said HGAP fully embraces Hitachi's values of pioneering spirit, harmony, and sincerity as it looks to mold its future.

"When we work with our colleagues in Japan, we think about having a pioneering spirit and how we can continue to bring new products and services to market that not only satisfy the customer need but also a societal need," he said.

"The concept of harmony," Randall said, "is about how we work together so we can get products and services to markets faster. Embracing harmony allows us to use the combined strength of 200-plus engineers as an example. Whether they're in China, Japan, or

the United States, we're able to work together on solutions that satisfy the customers' needs."

Sincerity, Randall said, will be nothing less than essential to the overall success of HGAP and its partners.

"Let's make sure we're open and honest about our challenges. Let's continue

to make sure we're putting together plans and resources so we can continue to deliver those things that our customers can count on," he said. **BP**

For more information on Hitachi Global Air Power visit <https://www.hitachiglobalairpower.com/>

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Adiabatic Cooling, the New Happy Medium

By Mihir Kalyani, Global Product Manager
of Dry and Adiabatic Fluid Coolers, EVAPCO



► The need for cooling capacity is increasing globally. An expanding population and an ever-growing dependence on data increases the need for process cooling, centralized space cooling, and data center cooling. Meanwhile, in many places, water scarcity is a massive issue.

In conventional, industrial cooling applications, the use of water for heat rejection is critical. Cooling towers and most evaporative fluid coolers depend heavily on water to reject waste heat to the atmosphere.

Taking blowdown and drift losses into account, evaporative cooling systems use approximately three GPM per 100 tons of cooling capacity. A 1,000-ton industrial cooling application running around the clock consumes approximately 15.7 million gallons of water annually, assuming a constant year-round load. As ambient air temperatures rise globally and the climate becomes more severe, the demand for water increases.

Many facility managers – when they first learn of the volume of water used for an evaporative cooling system – look to dry cooling systems as the answer. This is often an idealistic response, before they're aware of the obstacles that dry cooling systems pose for large facilities.

Eliminating the use of water from the cooling process entirely dramatically increases one or more of the following: total connected fan horsepower (and energy consumption), initial

investment, and mechanical footprint, often to the point of being impractical or impossible.

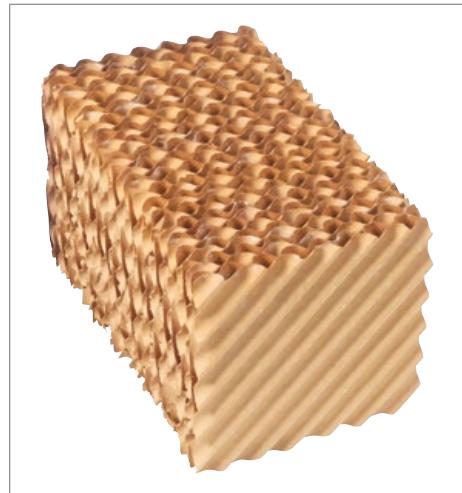
So, is there a happy medium?

Adiabatic Cooling

Adiabatic coolers are closed-circuit coolers that primarily operate dry. However, these coolers have the unique ability to supplement the cooling capacity of the equipment through the use of pre-cooling pads, which require



Adiabatic units are immediately distinguished from dry coolers by the presence of adiabatic pads installed in front of the heat transfer coils.



Adiabatic pad material is constructed of an impregnated cellulose material that resembles extremely dense cardboard, and is engineered to withstand wetting and drying cycles.

small quantities of water for a finite period in the year. Typically used in the hottest summer months, these pads lower the dry bulb temperature of the incoming air, providing greater heat rejection from the heat exchanger coils. This allows the unit to provide sensible (dry) heat transfer for as long as possible, while capitalizing on the latent (evaporative) heat transfer provided by the adiabatic pads once the unit's dry cooling capacity has been exceeded.

These adiabatic pads, made of absorbent material, are dampened when the ambient conditions exceed the unit's ability to satisfy the cooling load. Water never comes in contact with the coil itself, greatly reducing unit maintenance and extending its lifecycle. As incoming air passes through the damp pad, the dry bulb temperature of the air is depressed before coming in contact with the unit's coil. This increases what's called the "approach," or

the difference between entering air temperature and leaving fluid temperature, increasing the cooling capacity of the unit with very minimal water consumption.

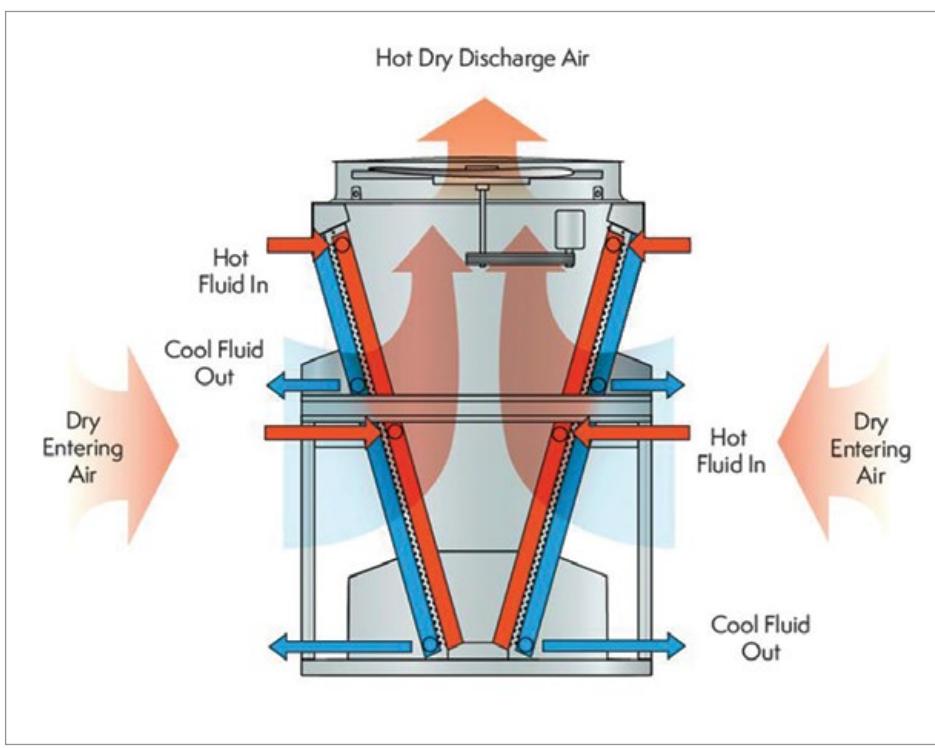
There are benefits to dry and adiabatic cooling systems beyond water savings, when compared to conventional evaporative heat rejection systems. Water treatment chemicals are eliminated, maintenance is significantly reduced, and water utility tap fees are often reduced.

It's also worth noting that there are areas in North America where the use of evaporative cooling systems has come under heavy scrutiny. For example, the Las Vegas Valley Water District Board of Directors recently approved a water conservation measure stating that, after Sept. 1, 2023, no new permits in the

Water District's service area will be approved for commercial and industrial buildings that plan to use evaporative cooling. Replacing evaporative cooling systems with alternative technologies is also being incentivized by the Southern Nevada Water Authority.

The downside of installing an adiabatic cooling system in place of a conventional design is that, to meet the same capacity, adiabatic systems use more power and cover a larger footprint, in addition to carrying a higher per-ton initial equipment cost.

For these reasons, facility managers, owners and engineers must carefully examine a number of site-specific considerations during the early design phase of any cooling application – whether new, or replacement.



Adiabatic Cooling, the New Happy Medium



A large installation of dry coolers serving a power generation process.



EVAPCO's eco-Air Double Stack Coolers have coils stacked in the vertical direction to maximize surface area while reducing the footprint required for the equipment. These systems occupy roughly half the footprint of the shorter, conventional dry coolers.

Site-Specific

Facilities that gain the greatest advantage from adiabatic cooling systems are those that wish to remain in dry cooling operation as long as possible while supplementing their cooling capacity with small amounts of water. This may be the result of a maximum utility tap size, local restriction on water consumption, high cost of water, leaving fluid temperature requirements, high ambient conditions or simply an environmental stance taken by the company.

This approach allows the dry portion of the system to be undersized for the total cooling load. The adiabatic portion of the system is then used to supplement capacity during peak ambient conditions, reducing the physical size and initial cost of the dry cooler(s).

Many cooling systems that serve processing or data center applications are designed for high return water temperatures; 100–110°F, instead

of the 85–95°F required by most air conditioning applications. Dry coolers do not transfer heat as effectively as evaporative coolers and can't cost-effectively provide leaving fluid temperatures as low as evaporative systems. Because of this, dry coolers provide a sound solution for high-temperature cooling applications. Supplementing the dry system with an adiabatic component trims the peaks from the cooling load during the warmest days of the year.

Of course, there needs to be physical space sufficient for dry and adiabatic heat rejection. These units require more space per ton of cooling capacity than evaporative units.

Even that challenge, however, can be reduced to a degree. To mitigate the space challenge that dry and adiabatic systems can pose, EVAPCO recently released a line of high capacity dry and adiabatic coolers, the eco-Air Double Stack Coolers, which are essentially two coolers stacked vertically. The largest model in the product line provides 703 tons of nominal heat rejection capacity while occupying roughly half the space of a conventional model.

In addition to saving mechanical space, the stacked configuration reduces wiring and consumes slightly less water than a single stack unit of the same capacity.

Real-world Application

"If cooling capacity is needed during the winter, we typically specify closed circuit coolers," said Craig Huston, principal of Huston Engineering, in Troy, NY. "If there's no need for cooling capacity in the winter, we use open loop cooling towers and a heat exchanger."

That sounds simple, but it's the leading consideration in Huston's decision-making process when selecting between a fluid cooler or cooling tower.

"Running a hybrid fluid cooler – like an adiabatic system – in dry mode allows us to reject heat during the winter in dry mode, eliminating the risk of ice formation in and around the unit. Then, in the summer, the cooling load can be met with the adiabatic element."

Aside from selecting the appropriate type of cooler; there's a crucial design parameter called the "dry bulb switchover temperature"

that must be specified to ensure the cooler can operate 100 percent dry during the cold months. The cooler will run in dry mode when the ambient outdoor temperature drops below the dry bulb switchover point for that specific cooler.

The dry bulb switchover temperature is determined by the surface area of the heat transfer coil, and the airflow volume across the coil.

Huston and members of his engineering team calculate, then specify, a dry bulb switchover temperature. This results in the end-user operating a fluid cooler that does not consume

water in the winter, completely eliminating the risk of icing.

"Dry and adiabatic fluid coolers are becoming more attractive to end users in our area," Huston explained. "Our clients can save time and money by not having to register the unit or test the recirculating water for Legionella as they would with an evaporative unit. Water treatment and the cost of associated chemicals are also eliminated."

Some Maintenance

While adiabatic systems require a great deal less maintenance than evaporative cooling units, it is still a consideration. Adiabatic pads



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Adiabatic Cooling, the New Happy Medium



Adiabatic fluid cooler installation.



An EVAPCO eco-Air series V-configuration dry cooler was installed at the USU central energy plant to provide winter cooling capacity, allowing the campus to shut down its much larger evaporative cooling tower when the cooling load is low.

are constructed of an impregnated cellulose material that resembles robust cardboard. The media is engineered to withstand wetting and drying cycles.

Adiabatic pad life expectancy is largely determined by the quality of water being used and the frequency with which the adiabatic component is energized. Site maintenance can take steps to extend pad life expectancy, like softening, descaling, washing, etc. But, pads are a degradable component of the system and have an average lifecycle of five years. It's worth noting that adiabatic systems do not require a sanitary drain, and some facilities opt to recirculate the water.

Cooling Technology Institute Certification

It's critical that business owners and mechanical engineers understand the importance of Cooling Technology Institute

(CTI) certification, and that not all fluid coolers are CTI certified.

CTI certification provides independent, third-party validation of thermal performance claims made by heat rejection equipment manufacturers. Cooling tower test codes have been in place for decades, but only recently have dry coolers been added to CTI's certification process. In 2018, CTI published an acceptance test code, ATC 105-DS to test the thermal performance of dry coolers. In September of 2022, CTI included dry coolers in Standard 201, the prevalent thermal performance certification standard which includes open cooling towers and evaporative fluid coolers.

Currently, the base, dry performance of dry and adiabatic coolers is being certified by CTI, but the performance of adiabatic pad systems is not currently included in the test code. This is expected to change in 2023, as CTI is currently in the process of developing a test code for the adiabatic pad systems.

Specifying CTI-certified equipment relieves liability from the mechanical engineer and eliminates the need to build margin of error into the specification.

Rapid Growth

The dry and adiabatic cooling market is exploding globally. This is due to the rise in data center construction, the need for more process cooling, and accelerating demand to conserve water. In the US, the government is incentivizing domestic manufacturing, which increases the need for cooling domestically.

Demand for dry and adiabatic coolers certainly has not usurped the market for evaporative coolers because there's more demand for cooling equipment than manufacturers can produce. That said, the increase in demand for water-sensitive cooling systems is rising at a staggering pace.

Many professionals in the cooling industry expect sweeping water use code changes within the next few decades. If this occurs – and current trends

already allude to it – dry and adiabatic heat rejection is potentially future-proof. **BP**

About the Author

Mihir Kalyani is Global Product Manager for Dry & Adiabatic Coolers at EVAPCO. His role involves driving the growth and development of EVAPCO's dry & adiabatic product line, in addition to educating consulting engineers, end users and sales representatives on the applications and benefits of the products he manages. Kalyani

holds a Mechanical Engineering degree from the University of Maryland, College Park.

About EVAPCO

Founded in 1976, EVAPCO, Inc. is an industry leading manufacturing company with global resources and solutions for worldwide heat transfer applications. EVAPCO is dedicated to designing and manufacturing the highest quality products for the evaporative cooling and industrial refrigeration markets around the globe. Headquartered in Taneytown, MD, EVAPCO products are engineered and manufactured in 26 locations across 10 countries and supplied through a sales network of more than 170 offices. For more information, please visit www.evapco.com.

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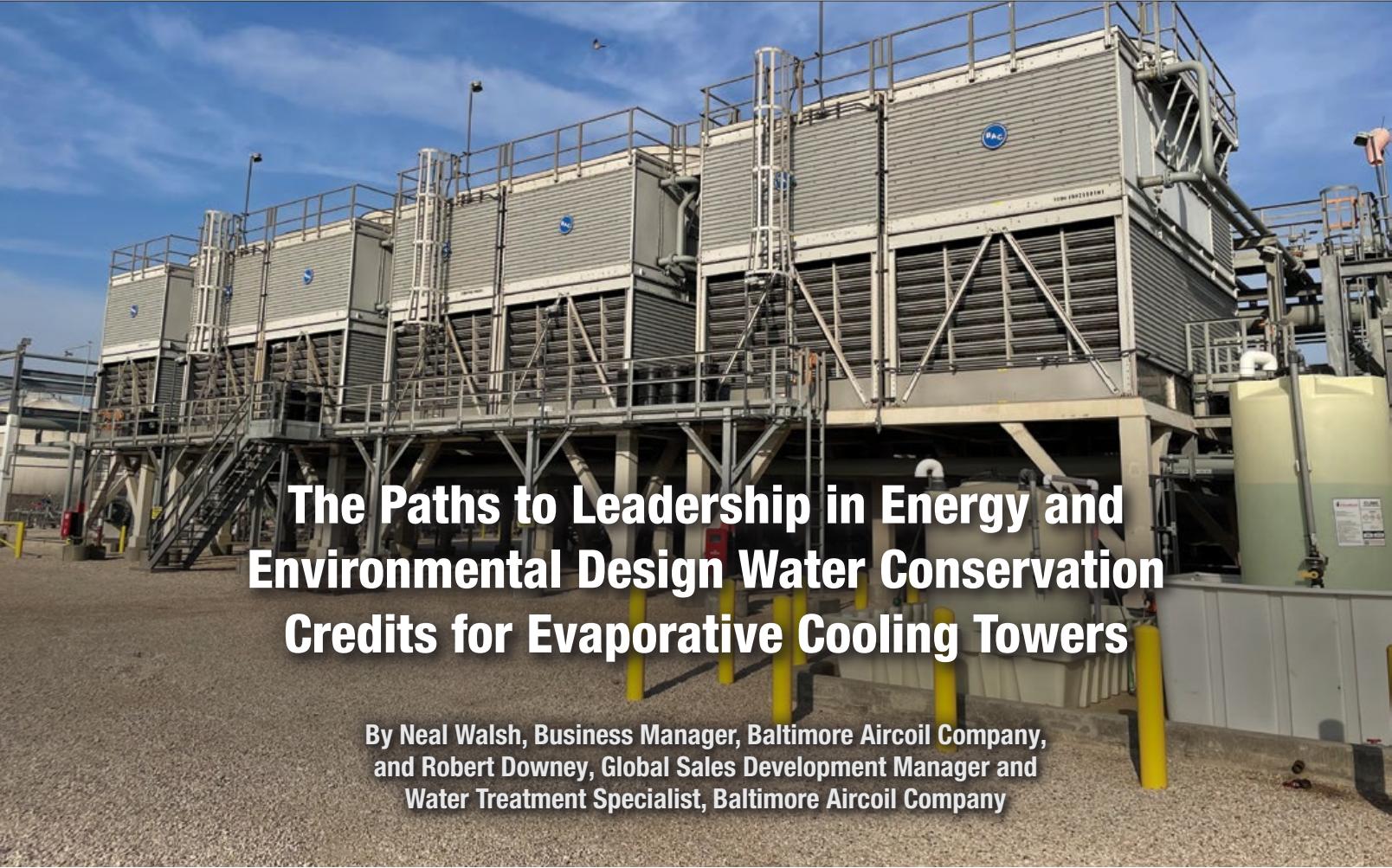
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The Paths to Leadership in Energy and Environmental Design Water Conservation Credits for Evaporative Cooling Towers

By Neal Walsh, Business Manager, Baltimore Aircoil Company,
and Robert Downey, Global Sales Development Manager and
Water Treatment Specialist, Baltimore Aircoil Company

► Evaporative cooling towers play an important role in green buildings by significantly reducing energy consumption when they supplement or replace traditional air conditioning systems, thereby reducing carbon footprint and operating costs. Although evaporative cooling is great at saving energy, it does consume some water but the benefits on energy savings outweigh the water usage, which in some places is a scarce resource.

Water conservation is therefore a high priority in designing and operating water-cooled equipment and plays an important role in USGBC's Leadership in Energy and Environmental Design (LEED) certification and other sustainability programs. LEED assigns credit points to reduce water usage.

Two Design Paths

The LEED options for reducing potable water consumption in cooling towers can be separated into two strategies:

Get more use from the potable water. The first strategy is directed at maximizing the use and value of each gallon of potable water used in evaporative cooling by optimizing the cooling tower's cycles of concentration (COC). The success of this strategy and the ease or difficulty of implementing it is highly dependent on the quality of the available potable water.

Substitution of non-potable water. The second LEED recommended strategy – which can be combined with the first – is to substitute non-potable water, such as HVAC condensate or rainwater, for some portion of the total water

consumed. Analogous to the use of solar and wind as "alternative energy" sources to replace or supplement fossil fuel consumption, the use of non-potable water acts as an "alternative water" source, replacing potentially scarce drinking water. Obviously, the viability of this approach depends on the types of available non-potable water sources.

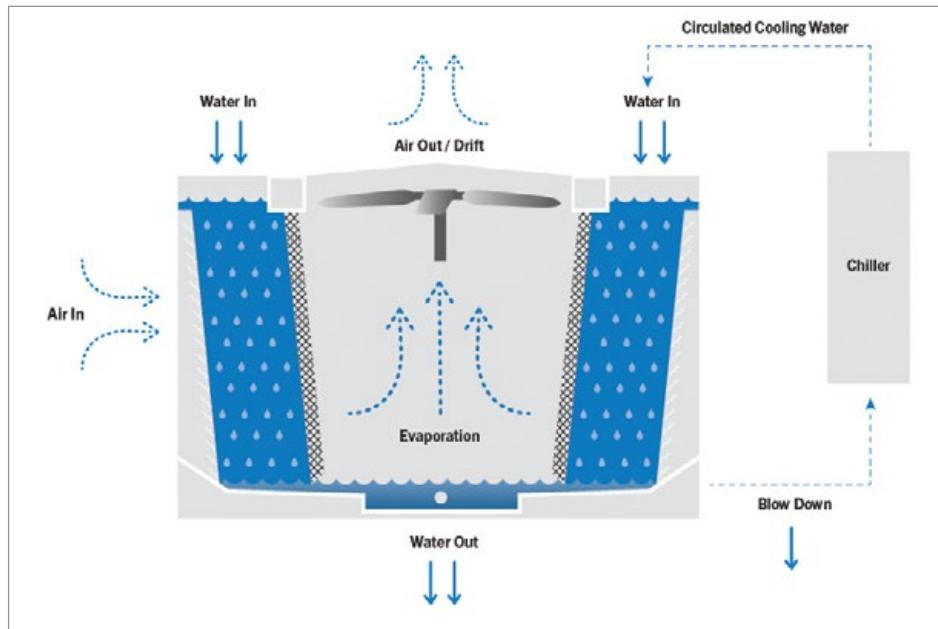
For some of these design paths, achieving the desired reduction of potable water use comes with some potential side effects and new challenges that must be evaluated and addressed. For instance, increasing the COC is more difficult when the local water has high hardness. Another example is HVAC condensate and rainwater that are often great naturally-soft options for non-potable water. It should be noted that these introduce the potential

problems of airborne particulates that foster biological growth and of corrosiveness to the cooling equipment.

Water Consumption in a Cooling Tower

To understand the principle of COC, we must step back and understand the causes of water loss in a cooling tower.

Evaporation. Water vapor is a major byproduct of evaporative cooling, and the Environmental Protection Agency (EPA) estimates that about 1.8 gallons of water are evaporated for every ton-hour of cooling. According to the EPA, "evaporation is the primary function of a cooling tower and is the method that

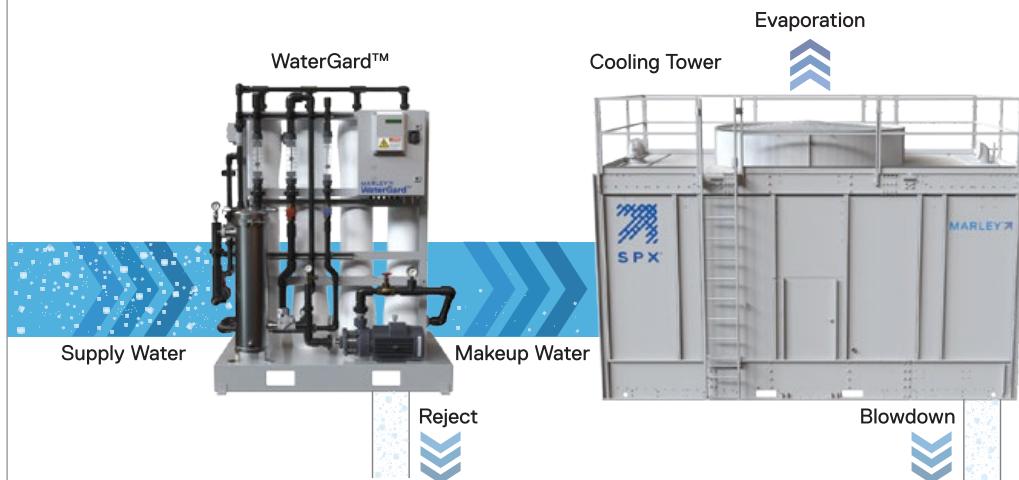


Source - EPA: Water Efficiency Management Guide - Mechanical Systems, Nov. 2017.

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The Paths to Leadership in Energy and Environmental Design Water Conservation Credits for Evaporative Cooling Towers

removes heat from the cooling tower system. The quantity of evaporation is not typically targeted for water efficiency, as it is responsible for the cooling effect."

Drift, leaks and overflow. While evaporation is considered a necessary and acceptable cause of water loss, other means of water loss must be carefully controlled.

Drift is the small quantity of water in the form of mist or water droplets that is blown off the cooling tower with little or no beneficial cooling effect. Equipment manufacturers address this by including drift eliminators, which control drift loss between 0.05-0.2%

of the water flow rate through the cooling tower. For a 500 nominal ton application with 1500 gpm flow, drift loss could be up to 3 gpm, which is typical for crossflow units and represents around 1% of the total water usage.

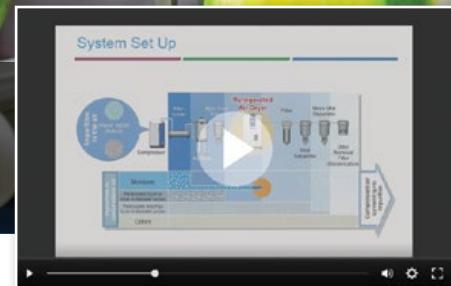
Leaks or overflow should not regularly occur in a properly operated and maintained cooling tower. Overflow alarms should be installed at the overflow drain, as is typically required by plumbing and building codes, in order to quickly correct any leak or overflow issues.

Blowdown. This leaves one remaining cause of water loss. Blowdown, also known as bleed, is the water that is bled from the system to

keep the concentration of dissolved solids in the circulating cooling water within acceptable limits. As water evaporates, the water escapes but most of the other molecules are left behind. This process elevates the concentration of total dissolved solids (TDS) remaining in the system water, including calcium, magnesium, chloride, and silica. High concentrations can cause scale to form or lead to corrosion, resulting in system inefficiencies, failures and maintenance headaches. The concentration of suspended solids from airborne particulates and other sources also increases, facilitating biological fouling and risking bacterial growth.

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Simply put, the concentration of TDS and suspended solids is controlled by the removal of blowdown water. To maintain the optimal volume of water in the system, the total volume of water that is lost through this blowdown and through evaporation is replaced by “make-up water” (assuming no loss from drift, leaks, and overflow).

Maximizing Cycles of Concentration

A fundamental measure of cooling tower efficiency is cycles of concentration, also known as concentration ratio. Cycles of concentration (COC) is defined as the ratio of the dissolved solids (conductivity) in the tower water to the dissolved solids (conductivity) in the makeup. This is easily and commonly determined by taking the specific conductance of the cooling water and dividing it by the conductance of the makeup. The calculation can also be done using minerals that are not affected by the chemical treatment regime, such as chloride or silica.

An alternate, equally accurate method, of calculating COC is to take the make-up water volume and divide it by the bleed volume. This is easily done if the tower is equipped with water meters on the make-up and bleed lines, a practice that is highly recommended.

The better the quality of the make-up water – in other words, the lower the TDS, suspended solids, and corrosiveness – the higher the COC that can be achieved and less blowdown is required to maintain the desired COC to keep the system water quality within acceptable limits. Next, we look at various methods for improving the quality of the make-up water.

LEED v4.0: credits for reducing water use

Cooling tower cycles	New Construction	Existing Building	Existing Data Center
<10 cycles of concentration	1	2	2
>10 cycles of concentration OR <10 cycles of concentration AND > 20% recycled non-potable water	2	3	4

Figure 1. LEED version 4.0.

LEED v4.1: credits for reducing water use

Cooling tower cycles	BD+C	CS
Maximize cycles of concentration	1	1
Exceed cycles of concentration by 25% OR Maximize cycles of concentration AND > 20% recycled non-potable water	2	2
Exceed cycles of concentration by 30% OR Maximize cycles of concentration AND > 30% recycled non-potable water	n/a	3

Figure 2. LEED version 4.1.

TDS, and specifically water hardness, is by far the most significant factor affecting strategies to conserve water by increasing the COC. Increasing COC is much easier to implement in locations where water is naturally soft, such as portions of the Northeast, Southeast, and Northwest of the United States.

In LEED version 4.0 (Figure 1), achieving at least 10 COC earns 2-4 credits, depending on whether the system is for new construction, an existing building, or a data center. Water reduction programs achieving less than 10 COC will earn only 1-2 credits (unless at least 20% of the make-up water is recycled non-potable water, in which case 2-4 credits can be earned).

LEED version 4.1 (Figure 2) is somewhat different. It removes the 10 COC threshold and instead awards credits based upon exceeding COC by a percentage. The percentage compares the COC before and after measures are taken to improve the quality of the make-up water. For BD+C and core and shell projects, exceeding the baseline COC by 25% earns 2 credits, and for core and shell an additional point can be gained if the baseline COC is exceeded by 30%.

Non-Potable Water as an Alternative Source

Where available, non-potable water sources can be a great way to conserve potable water, and a path to earning 2 LEED credits. Let's look at four common categories of non-potable water:

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The Paths to Leadership in Energy and Environmental Design Water Conservation Credits for Evaporative Cooling Towers

HVAC condensate, rainwater and stormwater, recycled municipal water, and gray water.

HVAC Condensate. Especially in the Southeastern U.S., high humidity and high cooling loads during most of the year affords a high potential for condensate capture. In Washington, D.C., for example, the condensate capture could be as much as 10 gal/cfm of OA each year and in Miami as much as 31gal/cfm of OA each year, according to a 2021 ASHRAE Journal article.

HVAC condensate is an ideal source of make-up water for cooling towers for two reasons. First, the timing of the generation of condensate from air conditioning systems aligns well with the timing of need for make-up water for the cooling towers. This alignment means that a storage tank may not be necessary. Second, condensate water is pure with a very low dissolved mineral content. However, a potential downside of HVAC condensate is that it sometimes contains heavy metals, such as copper or lead, which may require treatment prior to use as make-up water.

Rainwater. Rainwater and stormwater are commonly harvested from roofs and hard surfaces, such as roadbeds or parking lots. Regulations vary by state on the use of such water. The Federal Energy Management Program's Rainwater Harvesting Regulations Map¹ provides an initial assessment of the feasibility of implementing rainwater and stormwater capture. A 2012 study published by the University of Tennessee concluded that a high number of COC can be achieved with rainwater because dissolved solids are significantly lower than in tap water.

However, rainwater pH frequently is around or below 6 and therefore needs to be mitigated before use in a cooling tower to minimize the risk of corrosion and contamination. Also, control of microbiological growth must be included in any water treatment plan where harvested rainwater is being used. The level of treatment required for harvested rainwater depends on the source. Two common issues are bird droppings if the rain is harvested from a roof and oil if harvested from roadbeds and parking lots.

Recycled Municipal Water. Local municipalities are increasingly developing the capability to reclaim and sell treated wastewater (at a significantly lower price than potable water) rather than discharging it into a lake or river. "Purple pipe," along with appropriate signage, is used to distinguish such distribution systems from potable water lines.

This water is often good quality, although the concentration of minerals is usually higher than potable water. An advantage is that the increased silica, alkalinity, hardness, and phosphate content in reclaimed water are often less corrosive than tap water. When using recycled municipal water, water quality management teams need to evaluate how corrosion inhibitors from the municipal process may impact water treatment strategies for cooling tower make-up water.

Gray Water. Unfortunately, typical commercial sources of gray water – e.g., urinals and laundry – are not appropriate for use as a direct non-potable water source without significant further treatment. Soaps found in

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laundry can be problematic because they act as a food source for microbiological growth.

Addressing Water Quality Challenges

Depending on the quality of the water available, and based upon testing and recommendations of water treatment professionals, the strategy for conserving water may require the implementation of one or more mitigation methods. These methods divide into two basic categories: (a) improving the water with chemical treatment and filtration, and (b) protecting the system with materials of construction that offer high protection from corrosion.

Dissolved Minerals. Water with high mineral content can be particularly challenging because high levels of calcium, magnesium, alkalinity, and silica increase the risk of scale on heat transfer surfaces, which can rapidly degrade system performance. On the other hand, high levels of chlorides and sulfates increase the risk of corrosion on various metals used in cooling water systems, which could lead to increased maintenance costs and reduced asset life. Limiting dissolved solids is critical to achieving increases in the number of cycles of concentration. Three mitigation methods are commonly used:

Chemical treatment. Scale inhibitor chemicals cause a process called crystal modification to occur, which softens the hard edges of the crystalline precipitate into rounder material that stays in solution longer and is less likely to form scale. Chemical treatments also include dispersant polymers that coalesce and agglomerate these softer

particles, and by hydrophilic and hydrophobic forces make these particles less likely to bond to the heat transfer surfaces. These chemical treatments work, but they have limits based on modern chemistry, and are often insufficient to address water with high mineral content.

Mechanical Pretreatment. Most facilities need to consider mechanical pretreatment, either water softener systems or partial reverse osmosis systems or a combination of the two. Water softeners use an ion exchange resin, which collects calcium and magnesium, along with a brine tank, which uses salt as a regenerant. These systems are relatively simple and have a low total cost of ownership, but they only remove calcium and magnesium and not other dissolved solids like chlorides; and they do not reduce alkalinity. Water softeners can increase cycles of concentration from approximately 2 to 4, but rarely allow for the large leaps necessary to reach 10 COC.

Partial reverse osmosis (RO) is more effective. Water is pushed through a membrane, removing 95-98% of all minerals. Normally RO is used to produce pure water, but that would be too corrosive for cooling tower applications. Therefore partial RO is used, which blends the RO water with municipal make-up water. For water with very high mineral content, the most cost-effective design is to use a water softener to remove the hardness minerals prior to the RO process.

Suspended Solids. The concentration of suspended solids from various water sources and from airborne particulates collecting on the cooling tower facilitates biological fouling

The Paths to Leadership in Energy and Environmental Design Water Conservation Credits for Evaporative Cooling Towers

and risks dangerous bacterial growth. For this application, cyclonic filtration is more effective and easier to maintain than sand filtration.

The most cost-effective solution is to design and install a side stream filtration system with basin sweeper piping. The system should be factory assembled and delivered with the new cooling tower. Aftermarket systems require removing the fill pack which increases the risk of damage to the fill.

Corrosion. Water conservation strategies often involve elevated corrosiveness of the system water, especially when using partial RO or high purity non-potable water such as HVAC condensate and rainwater.

Alternative Materials of Construction

Another mitigation strategy is to select a material of construction for the cooling tower that offers some protection from corrosion, such as stainless steel. For the highest level of corrosion protection, polyurethane basin coatings can be applied. The TriArmor Corrosion Protection System from Baltimore Aircoil Company offers a factory applied polyurethane coating.

Multiple Design Paths

Owners and operators that address scale, bacteria, and corrosion will maintain peak system efficiency and extend the life of the evaporative cooling equipment. Figure 4 summarizes design considerations to meet these objectives.

These various design paths afford many options for earning LEED points in existing

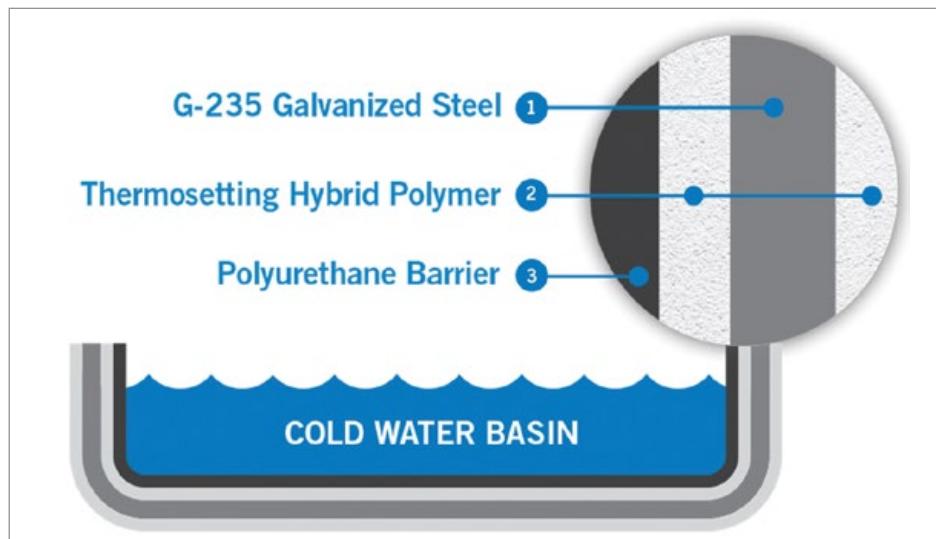


Figure 3. Alternative materials of construction.

Design Paths for Reducing Potable Water Consumption in Cooling Towers		Limiting Factors		
Maximizing Cycles of Concentration		Dissolved Minerals Scale	Suspended Solids Bacteria	Chlorides, Low pH Corrosion
	Naturally Soft		x	x
Non-Potable Water as an Alternative Source	Hard Water	x	x	x
	HVAC Condensate		x	x
	Rainwater		x	x
	Recycled Municipal Wastewater		x	x
Mitigation Methods		Corrosion		
• Chemical Treatment • Softener System • Partial Reverse Osmosis		• Filtration • Sweeper Piping		
316 Stainless Steel 304 Stainless Steel Polyurethane Coating				

Figure 4. Design considerations summary.

buildings and new construction. By reducing the consumption of energy and potable water, well-designed and well-maintained cooling tower systems conserve scarce natural resources and save money. **BP**

For more information, visit www.baltimoreaircoil.com.

1 Rainwater Harvesting Regulations Map | Federal Energy Management Program: <https://www.energy.gov/femp/rainwater-harvesting-regulations-map>

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Evaluating Air Compressor Cooling and Heat Recovery Part 1

By Hank Van Ormer, Technical Director, APenergy

► This is a two-part article looking at factors impacting decisions on whether to use air or water-cooled air compressors. It also provides heat recovery guidelines for both situations. Part 1 will provide a brief history on air compressor cooling, a review of cooling water sources and costs, and some cooling cost comparisons between air and water-cooled air compressors.

Brief Historical Background on Cooling

Before evaluating the air or water-cooling opportunities of air compressors, a little historical background is in order.

When the only primary industrial air compressor choices were reciprocating or centrifugal, the choice was, as it still is, what was best for the equipment and economical to run. The selection of the cooling media depended on several obvious factors – typical highest ambient temperature, continuous or intermittent load, total heat rejection, and most important, the type and design of the compressor.

From the 1930's through the 1960's the basic thought was heat transfers more efficiently through the cast iron cylinder and/or heads to water than air, because water is the denser

fluid. Therefore, water-cooling is not only better but necessary in larger horsepower industrial grade air compressors, generally above about 100 horsepower. Units were designed with cooling water jackets to achieve this. Cooling water, or some other appropriate fluid, was required.

Air-cooled versions of 100 horsepower air compressors, and lower, generally had finned cylinders, heads, intercoolers and after-coolers, along with a cooling air fan. The fan may have been incorporated in the flywheel, driven off the main motor/compressor shaft, or separately motor driven. When it was all said and done,

industrial air-cooled air compressors were not perceived to be continuous duty rated, meaning, they were intermittent duty rated.

Centrifugal Air Compressors Were (and Are) Water Jacket Cooled

Keeping in mind that cooling water was not very expensive in those days and often the cooling water was straight through – out of the river, through the air compressor and back to the river – well water was also available and of course city water.

As the cost of water and water treatment increased, various measures were taken to limit or control the use of cooling water such as series piping in lieu of parallel, recirculation ponds, etc.

During the late 1950's and into the 1960's, more demand developed for larger air-cooled air compressors, particularly for the portable engine driven market. These large, low rpm, water jacketed air compressors required large water-cooled, low rpm, engine drives that resulted in large, heavy units – a serious hindrance to portability.

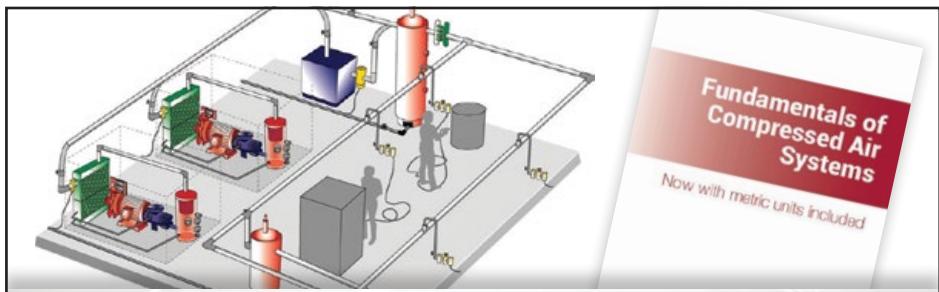
Early on, small air-cooled, engine-driven air compressors were interfaced with the frame – also acting as an air receiver. The momentum changed in the 1960's with the advent of the lubricant-cooled, rotary vanes and screws. The heat of compression generated in the compression chamber is now being controlled and absorbed by the cooling air flow. To have a successful application, the user only has to cool the oil. This can be done with an oil-to-air heat exchanger or an oil-to-water heat exchanger.

The heat of compression generated in this air compressor does not have to go through cylinder walls. To be removed, it is captured and controlled right inside the compression chamber as it is being generated. The result is a base air compressor design that is continuous duty rated (from a thermodynamic standpoint) with air or water-cooling.

The oil (or lubricant)-cooled rotary screw air compressors gained first acceptance as engine driven portables. As the products continued to develop through the 1970's until today, they became more and more efficient and were accepted as an appropriate industrial compressed air supply. This also left the air-

cooled or water-cooled selection a much more open question.

In existing industrial plants today, for 100 psig class compressed air supply, small air-cooled reciprocating air compressors and large reciprocating water-cooled compressors are used with the increasing number of lubricant-cooled rotary vane and screw, oil-free 2-stage rotary screw, and centrifugals. For new installations, you generally see air-cooled reciprocating (< 100-hp), rotary vane, rotary screw and centrifugal air compressors. The type of air compressor and size range will help dictate the type of primary cooling required.



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Evaluating Air Compressor Cooling and Heat Recovery Part 1

A Review of Cooling Water Sources and Costs

When considering the direct operating costs of an air compressor, including energy, cooling water is often overlooked. Why?

- It may be difficult to isolate to the air compressor.
- It takes diligence to track and measure. Like anything, if you don't measure it, you cannot manage it.
- Often the decision of whether to use air-cooled or water-cooled air compressors is dictated by the

air compressor technology type, initial price, and general technical "sound bites."

Generally today, air-cooling is often less expensive in capital costs, operating costs, maintenance costs, and floor space.

Regardless of what number is used for water cost (not including energy use) it will probably not be right for each particular location. This cost is very, very, site specific and should be the first factor identified when embarking on a water cost, energy control program.

Some thoughts on the various sources of cooling water:

- **Municipal Cooling Water:** Over the last 40 years these costs have escalated rapidly reflecting the scarcity of water and particularly, the cost of water treatment. It is becoming the exception to the rule today to see a compressed air system cooling water supply coming from the municipal utility. If additional costs aren't ignored such as sewer charges (for the water out) and various surcharges, the true cost is not always evident.

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- Often, city water will still require water treatment for effective performance in industrial cooling. These costs must also be considered.

When companies react by no longer using municipal water, there are several other choices:

➲ **Well Water:** Has varying characteristics which are site specific but generally is not “Free.” After the well is drilled, in most parts of the world, the good news is that it is usually cool. The bad news is that it usually requires significant intake filtration and water treatment for industrial use. Electric energy is required to pump it out of the ground and through the equipment.

- Today, the cost of disposing of the heated cooling water has escalated as various agencies may limit the dumping of the heated water into streams, rivers and lakes due to potential thermal pollution.

- In many areas, well water supply is diminishing as the water tables may be lowering and as the well gets older, the total flow in gpm may well be falling off.

➲ **River Water / Lake Water:** River water and lake water all have the same limitations as well water with

regard to intake filtration and water treatment. In many, if not most, areas today it is no longer “free” and there often is a charge for the discharge of heated water to the local body of water. There are also EPA regulations to be met and monitored with any water being discharged to this type of water supply.

All of these escalating costs, along with the man hours required to measure and manage the process, created great incentive for industrial plants to supply all their own plant water utility or supply.

The net result of these cost factors for cooling water has resulted today with most design engineers using a “default cost” of **\$3.00 (USD) per 1000 gallons** of cooling water when the actual site situation is unknown. The accompanying water treatment cost is about specific situations and can be much higher depending on site conditions and maintenance diligence. An example is \$1.20 per 1000 gallons based on 40 grains of hardness, alkalinity 10 and biocide treatment included.

Plants have had several options in light of escalating costs and regulations:

➲ Decrease the cooling water requirements. To avoid the escalating cooling water costs, compressed air systems have become prime targets for continuous duty, air-cooled, air compressors. The lubricant-cooled rotary screw and vane compressors

offered good selections for greater than 100-hp unit market and over the years became the design of choice. The larger horsepower units being supplied, to a heretofore water cooled market, often developed issues in applications when installed such as lack of room ventilation, installation in too high of ambient temperature for proper compressor after-cooler and dryer performance, and maintenance personnel being unprepared for large air-cooled units.

Today, many of these problems are behind us due to effective training. During the last decade, however, many operations have laid off utilities maintenance personnel and either outsourced or ignored much of the routine maintenance. This has resulted in significant productivity improvements and showed no immediate adverse effects. After some time, however, negative effects have begun to show as trained local personnel were no longer on site or available. Budgets for overhauls were forgotten, cooling issues, particularly in air-cooled units, where lack of proper and timely action will have significant adverse effects became a problem. Often these problems were blamed on the cooling media – air. The truth is, water-cooled units, not maintained in a timely manner with regard to cooler condition (water treatment) will take longer to reveal and have generally larger problems more expensive to correct. What remains are operating units that are:

➲ Air-cooled air compressors, small and large, that perform well

Evaluating Air Compressor Cooling and Heat Recovery Part 1

- Larger air-cooled units with selection or application issues causing poor performance
- Water-cooled units that cannot be converted to direct air cooling

How Much Cooling Water is Required?

The stated rating for cooling water requirements is how many gallons of water per 1000 btu/hr is rejected into the cooling water flow.

Air compressors generate a high rejection load due to their very basic inefficiency – i.e. it takes 7 to 8 input horsepower to supply 1-hp

of work in compressed air. This creates heat-of-compression, generated during the process reflecting this inefficiency. Energy input not converted to work shows up as heat. This heat has to be removed for the equipment to run and for the plant to be able to use the air. Particularly today where dry air is often critical, it must be reliably and effectively after-cooled and dried.

Comments to Tables 1–4

- All data is general in nature and should not be used to select equipment. It is necessary to look at the specific engineering data for all equipment being used.

- The required gpm is very dependent on several critical specifications:
 - Intake cooling water temperature to the compressor or dryer
 - The allowable air compressor discharge temperature – i.e. reciprocating, oil-free rotary screw and centrifugals easily handle 350°F to 400°F discharge. Lubricant-cooled units are limited by the cooling lubricant fluid but are usually a maximum of about 200°F.
 - Do not use nominal horsepower class for evaluation rather the exact OEM rated flow (acf m) at full load operating pressure (psig) at what bhp (compressor shaft) and, **most important**, motor input hp or kW which includes motor and drive losses. Examine the differences in flow and horsepower between the standard factory packaged two-stage, lubricant-cooled rotary screw and the oil-free (air or water jacket cooled) rotary screw.

Table 1. Cooling water requirements for single-stage rotary screw air compressors

Typical Lubricant-cooled Rotary Vane or Screw Cooling Estimated Heat Reduction to Cooling Water (btu/hr)*				Typical Values for Air Cooled Oil Coolers Estimated Heat Rejection to Cooling Air (btu/hr)*		
Air Compressor Capacity CFM/HP**	Water-cooled, Oil-Cooler and After-cooler btu/hr	Approx. gpm at 70°F	Approx. gpm at 85°F	Air Compressor Capacity CFM/HP**	Water-cooled, Oil-Cooler and After-cooler btu/hr	Approx. cfm Cooling Air
250/62	150,900	6	10	250/62	156,300	8400
350/83	200,300	7	12	350/83	208,500	8400
500/120	276,700	11	18	500/120	287,700	12000
800/215	445,500	16	27	800/215	463,100	17500
1000/250	550,400	23	39	1000/250	572,400	28700
1200/300	668,200	33	56	1200/300	694,700	28700
1500/350	889,709	33	56	1500/350	920,000	36000
2500/500	1,543,000	49	79	2500/500	1,543,000	45000

* This data is general in nature and should not be used to select equipment. It is necessary to look at the specific engineering data for all equipment being used.

** System at 100 psig

Table 2. Two-stage compressor data – Reciprocating nominal reference

Bhp Class	Discharge pressure psig	Cap acfm	Inlet Air 60°F, Water 75°F		Inlet Air 100°F, Water 95°F	
			Air discharge °F	Gpm water required	Air discharge °F	Gpm water required
150	125	772	335	16	370	16
200	125	1050	335	21	370	21
250	125	1300	335	26	370	26
300	125	1560	335	32	370	32
350	125	1840	335	37	370	37
400	125	2035	335	41	370	41
450	125	2340	335	52	370	52

All this considered, looking at the differences in 100 hp and 200 hp cooling cost for municipal “once through” or city, compared to the operating cost of air-cooling at \$.06 kWh / 8,600 hrs/yr, is at least 5 to 6 times greater using \$3.00 per 1000 gallons for the water cost. It is obvious why plants are looking for air-cooled units whenever possible and seeking how

to minimize water-cooling costs when air is not viable. These numbers do not include water treatment or pumping circulation costs.

Heat Recovery Guidelines for Air-Cooled Air Compressors

Air-cooling offers many opportunities, especially heat recovery. Lubricant-cooled rotary screw air compressors, factory packaged, particularly lend themselves to effective energy recovery in the form of heated air with up to 90+% of the motor horsepower in btu/hr available in the cooling air stream. If ducting heated air out for heat recovery, a few guidelines are in order:

- Be cautious of the allowable back-pressure in the ducting. Depending on the brand and model, the allowable back-pressure varies from 1/32 inch of H₂O to 1/2 inch of H₂O. Be sure the ducting has proper configuration and large enough cross sectional (Figure 1).
- If air is ducted in and perhaps filtered, design and maintenance are critical not to impair performance.
- Normally ducting air to the air compressor and out will not be enough ventilation to control temperature buildup in the room. The heat radiated to the room by the compressed air equipment and piping (30-35% potential) must also be considered, which will vary depending on the machinery design and other equipment in the room such as pumps, controls, electric boxes, etc.

**Table 4. Comparing Costs of water and air-cooled systems:
Two-stage, oil-free, 200-hp rotary screw air compressors**

856 acfm /193 bhp @ 100 psig – Discharge 350 to 400°F	Water	Air
Gpm at 50°F Electric \$.06 kWh at 8600 hours/yr	22	11 fan hp / 10 kW / \$5,160 yr
Gpm at 70°F	29	N/A
Gpm at 80°F	48	N/A
Total H ₂ O pressure loss (psid)	–	N/A
Vent fan Input Horsepower	1.75 kW / 3500 cfm	–
Cooling Cost at 70°F H ₂ O (H ₂ O costs at \$3.00 per 1000 gallons)	\$44,892/yr	–
Vent fan cost	\$387/yr	N/A
Water & Electrical Energy Cost at \$.06 kWh / 8600 hrs/yr	\$45,279/yr	\$5,160/yr
Total Heat Remaining		599,000 btu/hr

**Table 3. Comparing costs of water and air-cooled systems:
Two-stage, lubricant-cooled, 100-hp rotary screw air compressors**

547 acfm /111 bhp @ 100 psig – Discharge 180-200°F	Water	Air
Gpm at 50°F Electric \$.06 kWh at 8,600 hours/yr	8	5.5 fan hp / 5 kW / \$2,580 yr
Gpm at 70°F	11	N/A
Gpm at 80°F	18	N/A
Total H ₂ O pressure loss (psid)	21	N/A
Vent fan Input Power	1.1 kW	N/A
Cooling Cost at 70°F H ₂ O (H ₂ O costs at \$3.00 per 1000 gallons)	\$17,028/yr	–
Vent fan cost	\$568/yr	N/A
Water & Electrical Energy Cost at \$.06 kWh / 8600 hrs/yr	\$17,596/yr	\$2,580/yr
Total Heat Remaining		303,000 btu/hr

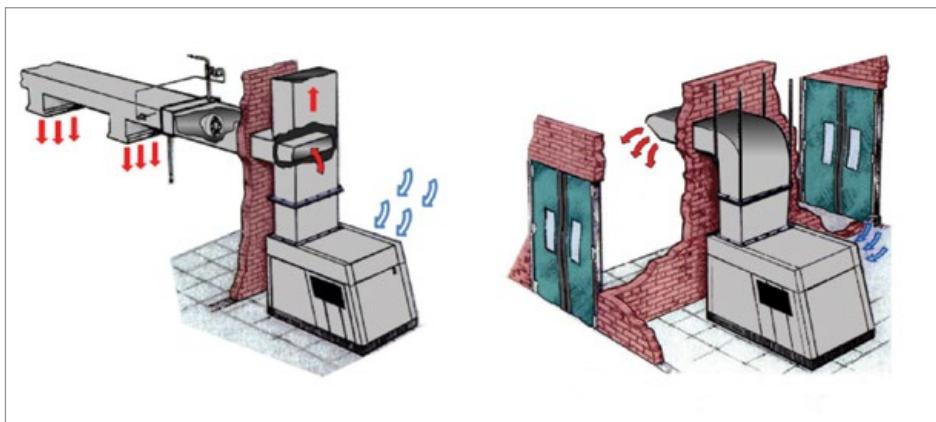


Figure 1

Evaluating Air Compressor Cooling and Heat Recovery Part 1

Figures 2 and 3 illustrate a well-sized duct system to remove the heated air from the room and on to another location. Note, when the duct wall

- Room 95°F
- **Inlet air temp 104°F**
- Air/Oil 210°F at FL at 100 psig
- Air/Oil 215°F at FL at 120 psig

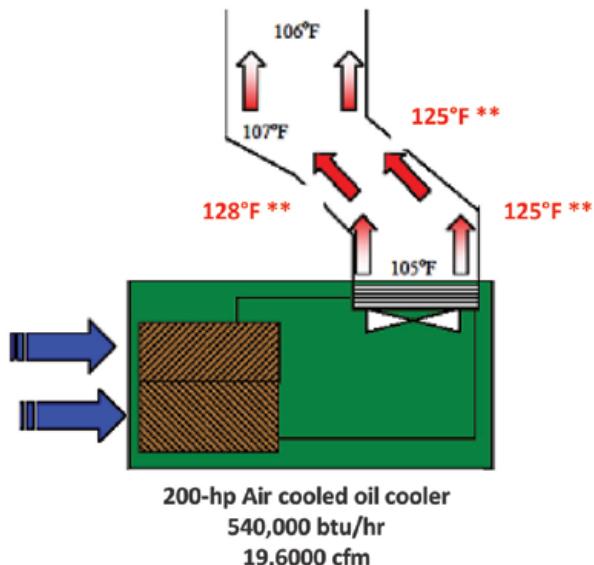


Figure 2. Cooling air ducting not working correctly

temperature is checked, the cooling air moves further from the cooler and the temperature continuously drops. The air compressor is at full load and operating at normal temperature.

Estimating Ventilation Required – Estimating Only, Not Designing

Heat Rejection for 100 hp Air Compressor Consuming 110 bhp

$$\begin{aligned}\text{Total heat rejection} &= 110 \text{ bhp} \times 2,546 \text{ btu/hr} \\ &= 280,060 \text{ btu/hr}\end{aligned}$$

Air-cooled unit – rejection into ambient air: 280,060 btu/hr (100% of total)
Water-cooled unit – rejection into ambient air: 13% of total minimum / 30% of total maximum

Calculate Ventilation Air CFM (cubic feet per minute) from Heat Rejection

$$\text{Cfm cooling air} = \frac{(\text{Sensible heat btu/hr})}{(1.08)(T_1 - T_2) \text{ Temp Rise}}$$

$$\text{Cfm} = \frac{(110\text{-hp})(2,546 \text{ btu/hr})}{(1.08)(20^\circ\text{F})}$$

$$\text{Cfm} = \frac{280,060}{21.60}$$

Cfm = 12,966 cfm ventilation air to allow a 20°F temperature rise in the room. Consider all heat sources in the room! **BP**

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Figure 3. Cooling air ducting working correctly

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 Presenter Tie Duan, Solutions Engineer, E.W. Klein & Co. – Sponsored by Kaishan
 Thursday, June 8, 2023 – 2:00PM EST

JUN 22 **Greener Compressed Air Systems- Reducing the Environmental Impact**
 Presenter Paul Edwards, Principal, Compressed Air Consultants – Sponsored by VPInstruments and Kaeser Compressors
 Thursday, June 22, 2023 – 2:00PM EST

JUL 13 **Design Considerations When Transitioning to Oil-Free Compressed Air Systems**
 Presenter Tim Dugan, P.E., President and Principal Engineer, Compression Engineering Corporation – Sponsored by Rogers Machinery and FS-Curtis/FS-Elliott
 Thursday, July 13, 2023 – 2:00PM EST

JUL 23 **Engineering Rooms for Aeration Blowers**
 Presenter Tom Jenkins, P.E., President, JenTech Inc. – Sponsored by APG-Neuros
 Thursday, July 23, 2023 – 2:00PM EST

JUL 27 **From Fresh to Soggy – Quality Monitoring: How Compressed Air Condensate Affects Food Quality**
 Presenter Francisco Lara, Manager, Airtec Global LLC – Sponsored by SUTO IITEC
 Thursday, July 27, 2023 – 2:00PM EST

AUG 17 **Compressed Air as a Food Ingredient**
 Presenter Roderick Smith, Publisher, Compressed Air Best Practices Magazine – Sponsored by Trace Analytics and BEKO Technologies
 Thursday, August 17, 2023 – 2:00PM EST

AUG 24 **ASME PTC 13: Efficient Blower, Sustainable Systems**
 Presenter Tom Jenkins, P.E., President, JenTech Inc. and John Conover, Business Development Manager, Air Clean USA – Sponsored by Lontra
 Thursday, August 24, 2023 – 2:00PM EST

SEP 21 **Information Required to Specify an Air Compressor**
 Presenter Loran Circle, Senior Consultant, Circle Training & Consulting – Sponsored by Vaisala
 Thursday, September 21, 2023 – 2:00PM EST

OCT 05 **Compressed Air Systems for Cheese Manufacturing**
 Presenter Frank Melch, Vice President, Zorn Compressor & Equipment – Sponsored by Quincy Compressor
 Thursday, October 5, 2023 – 2:00PM EST

NOV 09 **Chiller Selections for Central Plants: Lowest Overall Costs for Process Cooling**
 Presenter Clayton Penhallegon, Jr., P.E., Integrated Services Group – Sponsored by Carrier
 Thursday, November 9, 2023 – 2:00PM EST

NOV 30 **Vacuum System Efficiency**
 Presenter Andy Smitneek, President, Growth Solutions Consultants – Sponsored by Rogers Machinery
 Thursday, November 30, 2023 – 2:00PM EST

DEC 07 **Compressed Air Dryer Maintenance and Monitoring**
 Presenter Loran Circle, Senior Consultant, Circle Training & Consulting – Sponsored by BEKO Technologies
 Thursday, December 7, 2023 – 2:00PM EST

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Chiller & Cooling System Technology & Industry News

CTI Sound Performance Certification Program Under Development

The Cooling Technology Institute is currently exploring the development of a sound performance certification program for both evaporative and air-cooled heat exchanger rejection equipment. A new certification standard, once approved and released, would set forth a program whereby the CTI certifies that a line of heat rejection equipment conforms to the Manufacturer's published sound pressure level data. As the program is currently envisioned, a prerequisite to participate in the new sound performance certification program is that the Manufacturer's product line be thermally certified under CTI Standard 201. Thus a product line could have Thermal Certification only, or Thermal plus sound certification, but never sound certification only without Thermal Certification.



Product types and configurations already addressed in CTI Standard 201 are potential candidates for such a future sound performance certification. The program would apply to mechanical draft (both forced and induced) heat rejection equipment and encompass open-circuit cooling-towers, closed-circuit cooling towers, evaporative refrigerant condensers, and dry fluid coolers. Under such a program, by purchasing a CTI sound certified model, an Owner/Operator would have the assurance that the heat rejection device will achieve the published 1.5- and 15-meter sound pressure levels.

The new sound performance certification program is currently under development within several CTI Committees. The documents being worked on are CTI STD 204 OM (Operations Manual) and STD 204 RS (Ratings Standard) for the sound certification program. The Test Code for Measurement of Sound from Heat Rejection Equipment, ATC 128, is currently being updated to include air-cooled heat rejection devices. Note that the Thermal Certification Standards are currently available for a nominal change on the CTI Marketplace – STD 201 RS and STD 201 OM as are the associated thermal test codes – ATC-105, ATC-105S, ATC-105DS and ATC-106 (open-circuit and closed-circuit cooling towers, dry coolers, and evaporative refrigerant condensers, respectively).

The CTI would also like to gauge interest in which firms would like to participate in a sound certification program as currently envisioned.

For more information, visit www.cti.org.

Johnson Controls Introduces YORK YVAM Magnetic Bearing Chiller

Johnson Controls, the global leader for smart, healthy and sustainable buildings, announced the launch of the YORK YVAM air-cooled magnetic bearing centrifugal chiller operating with the ultra-low global warming potential (GWP) refrigerant, R-1234ze, for hyperscale and colocation data center cooling.

The YORK YVAM chiller is one of the most efficient options for data center applications, because its magnetic-bearing technology

allows the system to operate very efficiently at low lift conditions. This means the chiller doesn't need free cooling coils to deliver performance comparable to air-cooled chillers with integral water-side economizers. Compared to traditional air-cooled screw chillers, the YVAM can improve efficiency by 49% in non-standard part load value (NPLV) in typical data center conditions.

"The pioneering design of the YORK YVAM chiller was specified for the unique needs of mission critical applications, featuring industry-leading efficiency, simplified design and low harmonics," said Chris Paraskevakos, vice president of product management, chillers and applied equipment, Johnson Controls. "Johnson Controls and the YORK brand have a long history of serving the mission critical industry since 1998, and as such, owners and operators can have confidence in our equipment improving their operations, reducing the total cost of ownership and accelerating payback."

The YORK YVAM chiller uses a variable-speed drive with active front-end to lower energy consumption and total harmonic distortion. This means the magnetic driveline is significantly quieter than traditional air-cooled chiller drivelines that use screw compressors. Full-load sound is only 65 dBA at a distance of 10 meters. The machine's lubrication-free design also eliminates the complexity of subsystems and reduces the costs of routine maintenance and system checks.

Data centers and other mission critical facilities require non-stop cooling. A power



The YORK YVAM air-cooled magnetic bearing centrifugal chiller is one of the most efficient options for data center applications.

failure could jeopardize operations and lead to costly downtime and performance penalties. To maximize uptime, the YORK YVAM features Quick Start technology with integral uninterruptible power supply (UPS) backup, allowing the chiller to return to full load in as little as three minutes after power is restored.

About Johnson Controls

At Johnson Controls, we transform the environments where people live, work, learn and play. As the global leader in smart, healthy and sustainable buildings, our mission is to reimagine the performance of buildings to serve people, places and the planet. Building on a proud history of nearly 140 years of innovation, we deliver the blueprint of the future for industries such as healthcare, schools, data centers, airports, stadiums, manufacturing and beyond through OpenBlue, our comprehensive digital offering. Today, with a global team of 100,000 experts in more than 150 countries, Johnson Controls offers the world's largest portfolio of building technology and software as well as

service solutions from some of the most trusted names in the industry. For more information, visit www.johnsoncontrols.com.

Daikin Applied Introduces Trailblazer Heat Pump Chiller

Daikin Applied Americas announced the launch of the Trailblazer HP, an air-cooled scroll chiller that uses heat pump technology to deliver electricity-powered heating and cooling for commercial buildings and industrial processes. The Trailblazer HP is built on a product platform that Daikin Applied has successfully leveraged in Europe, a region where heat pumps are prevalent – hitting a record high in sales in 2022. This marks a significant, cross-region collaboration between Daikin experts to bring the most innovative, effective solutions to U.S. customers.

“As a global brand, Daikin is uniquely positioned to combine the best in technology and talent to deliver innovative solutions across markets,” said Jim Macosko, VP of Product

Marketing for Daikin Applied. “Given the climate impact of heating and cooling commercial and industrial facilities, decarbonizing buildings is key to meeting carbon-reduction goals. That includes moving from fossil fuel-powered to all-electric equipment. And heat pumps are one of the primary technologies driving the electrification and increased efficiency of HVAC. They help create a better climate both inside and outside buildings.”

The Trailblazer HP is an air-to-water heat pump chiller that provides a reversing function that allows the chiller to switch between cooling and heating modes based on the temperature requirements of the space or process being conditioned. In a cooling application, the refrigeration cycle allows for heat removal from the internal space, dissipating excess heat into the external air. In heating mode, the refrigeration cycle reverses and transfers heat absorbed from the outside air into the internal space or process.

In terms of efficiency, heat pumps reign supreme. Traditional heating systems that rely on fossil fuels or electric resistance heat operate with efficiencies in the range of 80 to 99%. With Trailblazer’s advanced technology, however, the chiller is up to 300% efficient at typical operating conditions, which means it can transfer three times more heat than the energy used by the equipment. That leads to a significant reduction in energy use and direct greenhouse gas emissions, as well as day-to-day operating costs.

Available as a stock unit, Trailblazer HP’s design allows for easy installation in new and

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retrofit applications, making it ideal for office buildings, schools, commercial retail spaces and a range of other facilities.

As an industry leader in inverter heat pump technology, Daikin continues to expand its commercial and residential offerings with products engineered to provide a highly efficient source for all-electric, non-fossil fuel burning heating, even in cold climates. Along with Trailblazer HP, the company also recently introduced VRV EMERION for commercial applications, providing either heat pump or heat recovery inverter technology.

About Daikin Applied Americas

Daikin Applied, a member of Daikin Industries, Ltd., designs and manufactures advanced commercial and industrial HVAC systems for customers around the world. The company's technology and services play a vital role in creating comfortable, efficient and sustainable spaces to work and live – and in delivering quality air to workers, tenants and building owners.

Daikin Applied solutions are sold through a global network of dedicated sales, service and parts offices. For more information, visit www.daikinapplied.com.

Danfoss to Power All North America Facilities with Solar Energy by 2025

With an eye toward achieving their global decarbonization goals, Danfoss North America recently signed a power purchase agreement with CIG Capital, a U.S.-based project financing firm, to purchase about 75 MW of solar power from a solar farm in Texas, starting in 2025. The initial agreement term is 12 years, allowing Danfoss to fully replace its annual electricity

usage in North America with green energy through at least 2037.

The new agreement will provide Danfoss with green certificates, signifying that they are supplying the North American electrical grid with the full amount of green electricity needed to power all 24 factories and 36 locations in North America, and will reduce Danfoss' carbon footprint in the region by 75%.

"As part of our ESG goals, Danfoss has committed to achieving carbon neutrality across our global operations by 2030. This agreement to secure green energy for our North America operations will reduce our global emissions by 21%," said Soren Revsbech Dam, Head of ESG and Decarbonization, Global Services Real Estate, at Danfoss. "This is not only a significant step in our journey to becoming carbon neutral, but it also demonstrates that we are serious about putting sustainability at the heart of our business."

CIG Capital will be building the six square mile farm in the panhandle region of Texas. Groundbreaking is scheduled for November of 2023, with the farm becoming fully operational by the spring of 2025. The solar farm capacity is projected to be 509 MW of solar power, of which Danfoss will utilize 15%.

The next focus for Danfoss in its decarbonization journey will be on reducing and reusing energy across its North America locations, employing various Danfoss technologies, such as oil-free, variable-speed compressors and other heating and cooling solutions that support heat recovery and energy efficiency.

"Danfoss is committed to playing a leading role in the energy transition. Meeting our ESG goals and living up to our commitment to combat climate change means developing innovative solutions," said Rick Sporrer, President of Danfoss North America.

As part of the Science Based Targets initiative (SBTi), Danfoss is committed to become carbon neutral in its global operations (scope 1 & 2) by 2030 and says it will reduce its value chain emissions (scope 3) with 15% by 2030. This commitment is included in the targets of Danfoss' three step-change initiatives on Decarbonization, Circularity, and Diversity, Equity & Inclusion.

Already Danfoss has seen progress in decoupling environmental impact from business growth by delivering 7% decrease in scope 1 and 2 emissions while growing 15% organically in 2022.

Additionally, the 250,000 sqm Danfoss headquarters campus site in Denmark became carbon neutral in 2022. Carbon neutrality was achieved through energy saving projects, utilization of excess heat from processes and data centers, sourcing of green energy, and offsetting residual emissions.

About Danfoss

Danfoss engineers solutions that increase machine productivity, reduce emissions, lower energy consumption, and enable electrification. Our solutions are used in such areas as refrigeration, air conditioning, heating, power conversion, motor control, industrial machinery, automotive, marine, and off- and on-highway equipment. We also



Danfoss Solar project: Rodney Mumm, head of Danfoss Global Services in North America; Soren Revsbech Dam, Head of ESG, Global Services Real Estate; and Leart Berisa, Category Manager, Global Services (left to right) are excited to announce the solar power purchase agreement for Danfoss' North America facilities as part of the company's ESG commitment.

provide solutions for renewable energy, such as solar and wind power, as well as district-energy infrastructure for cities. Our innovative engineering dates back to 1933. Danfoss is family-owned, employing more than 40,000 people, serving customers in more than 100 countries through a global footprint of 97 factories. For more information, visit www.danfoss.com.

Trane Technologies Acquires MTA

Trane – by Trane Technologies, a global climate innovator, has acquired MTA, an Italian-based manufacturer and distributor of sustainable solutions in industrial process cooling, air conditioning and air treatment. Providing process chillers and an expanded rental and services business, MTA will strengthen Trane's Commercial HVAC ability to bring efficient sustainable solutions to pharmaceutical, food and beverage, and automotive industries in key markets.

"We're very excited to welcome our new colleagues and to begin collaborating on new ways we can serve our customers," said Jose La Loggia, president, Commercial HVAC EMEA, Trane Technologies. "MTA's reputation for quality and leading innovation will further strengthen our capabilities to help our customers further decarbonize their operations with sustainable high-performance industrial process cooling, air conditioning and air treatment."

Nearly 500 new employees, mainly in Europe, will join the Trane Technologies team. MTA's manufacturing sites in Tribano and Conselve, Italy, and its international sales offices will further expand Trane Technologies' presence.

"Trane Technologies is the perfect fit for MTA," said Marco Motton, CEO, MTA. We share a common purpose – to innovate for our customers and deliver sustainable solutions

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and superior service. I am excited for our future together."

About Trane Technologies

Trane Technologies is a global climate innovator. Through our strategic brands Trane and Thermo King, and our portfolio of environmentally responsible products and services, we bring efficient and sustainable climate solutions to buildings, homes, and transportation. For more on Trane Technologies, visit www.tranetechnologies.com.

Carrier Advances Lifecycle Solutions for Data Centers

Carrier is providing digital lifecycle solutions to support the unprecedented growth and criticality of data centers. More than 300 data center owners and operators with over one million racks, spanning enterprise, colocation and edge benefit from Carrier's optimization solutions across their portfolios. Carrier is a part of Carrier Global Corporation, global leader in intelligent climate and energy solutions.

"Data center operators have made great strides in power usage effectiveness over the past 15 years," said Michel Grabon, Data Center Solutions Director, Carrier. "Continual technology advances with higher powered server processors present power-consumption and cooling challenges requiring specialized solutions that Carrier provides."

Carrier's range of smart and connected solutions deliver upstream data from the data center ecosystem to cool, monitor, maintain, analyze and protect the facility to meet green building standards, sustainability goals and comply with local greenhouse gas emission regulations. Carrier's Nlyte DCIM tools share detailed information between the HVAC equipment, power systems and servers/workloads that run within data centers, providing unprecedented transparency and control of the infrastructure for improved uptime.

Carrier's purpose-built solutions are integrated across its solutions portfolio with efficient and high-performing HVAC equipment, data center infrastructure management (DCIM) tools and building management system to help data center operators use less power and improve operating costs and profitability for many years. Marquee projects around the world include:

- OneAsia's data center in Nantong Industrial Park. Carrier collaborated with the company to build its first China data center equipped with a water-cooled chiller system. By optimizing the energy efficiency of the entire cooling system, the high-efficiency chiller plant can reduce the annual electricity bill by approximately \$180,000 (RMB 1.27 million).
- China's Zhejiang Cloud Computing Center is an example of how Carrier's AquaEdge centrifugal chillers and integrated controls provide the required stability, reliability and efficiency for 200,000 servers. The integrated controls help reduce operating expenses and allow facility managers to monitor performance remotely and manage preventative maintenance to keep the chillers running according to operational needs.
- Iron Mountain's growing underground data center, in a former Pennsylvania limestone mine, earned the industry's top rating with the use of Carrier's retrofit solution to control



Carrier's purpose-built equipment, controls and service lifecycle solutions allow you to operate your data center with confidence at every stage.

environmental heat and humidity. AquaEdge chillers with variable speed drive respond with efficient cooling enabling the HVAC units to work under part-or full-load conditions.

Carrier's Nlyte Asset Lifecycle Management & Capacity Planning software provides automation and efficiency to asset lifecycle management, capacity planning, audit and compliance tracking. It simplifies space and energy planning, easily connecting to an IT service management system and all types of business intelligence applications, including Carrier's Abound cloud-based digital platform and BluEdge service platform to track and

predict HVAC equipment health, enabling continuous operations.

About Carrier

Founded by the inventor of modern air conditioning, Carrier is a world leader in high-technology heating, air-conditioning and refrigeration solutions. Carrier experts provide sustainable solutions, integrating energy-efficient products, building controls and energy services for residential, commercial, retail, transport and food service customers. Carrier is a part of Carrier Global Corporation, global leader in intelligent climate and energy solutions that matter for people and our planet for generations to come. For more information, visit www.carrier.com.

Daikin Applied Acquires

Carroll Air Systems

Daikin Applied announced it has acquired Carroll Air Systems, a Tampa, Fla.-based company that provides heating, ventilation and air-conditioning (HVAC) systems and services for commercial, industrial and institutional facilities. Supporting the Central and West Coast regions of Florida, Carroll Air Systems is a long-standing sales representative for Daikin and other leading HVAC equipment manufacturers, and is now part of the world's number one air-conditioning company.

The acquisition creates a sole source for comprehensive customer care, providing

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consulting engineers, contractors, and building owners and operators with the systems design support, solutions, services and parts they require for high-performing, sustainable buildings. Customers will have one destination for all HVAC needs from selecting and commissioning equipment to maintaining systems to upgrading or replacing technologies.

"Daikin Applied and Carroll Air Systems have a shared mission to deliver an unrivaled customer experience," said Jeff Drees, President and CEO of Daikin Applied. "Bringing the Carroll Air team into our organization fits our culture and structure. However, it's our customers that will ultimately benefit. They will have access to the most proven, experienced professionals in the region – specialists now backed by the innovation, resources and capabilities of a global leader."

Carroll Air Systems has been a mainstay of the construction and building management industry, involved in the development and renovation of airports, hospitals and clinics, offices, schools and other facilities across parts of Florida.

"We recently celebrated our 51-year anniversary," said Phillip Carroll, CEO of Carroll Air Systems. "With this move, we'll have the resources and roadmap to deliver quality air, efficiency and sustainability for the next half century and beyond. I'm excited about the future of this organization, and our ability to evolve with and support our customers throughout their HVAC journey."

Daikin Applied's regional service operations will combine with the Carroll Air Systems service team. Phillip Carroll will lead the merged operations, including service, sales and parts, which will now do business as Daikin Applied Central and West Coast Florida.

For more information, visit www.daikinapplied.com

Johnson Controls Releases 2023 Sustainability Report

Johnson Controls, a global leader for smart, healthy, and sustainable buildings, released its 2023 Sustainability Report, marking milestones on the path to achieving net zero in buildings around the world. Johnson Controls reports accelerated progress both in its own sustainability journey and in the reduction of customer emissions.

"Climate change is a key defining theme of this century. We have seven years to cut global emissions nearly in half to reach net zero by 2050 and limit global warming to 1.5 degrees Celsius. With almost 40% of those emissions coming from buildings, the consensus among global leaders is that there will be no net zero without decarbonizing buildings," said George Oliver, chairman and CEO of Johnson Controls. "The good news is, we have the technology, financing, partnerships, and people to turn buildings from one of the greatest challenges into one of the biggest and quickest solutions toward net zero."

A 2022 International Energy Agency (IEA) emissions report showed that 86% of emission reductions in Europe last year came from building improvements. Heat pumps played a

major role, with a 38% increase in heat pump sales. Globally, the IEA says emissions were kept to below a 1% rise, much lower than predicted, thanks in significant measure to unprecedented growth in energy-efficient equipment, heat pumps, renewable energy and electric vehicles.

Johnson Controls is creating and deploying technology – the smart building trifecta of energy-efficient equipment, clean electrification and systemic digitalization – to accelerate its own net zero journey. The company has already reduced absolute Scope 1 and 2 emissions by 42%, or more than 455,000 metric tons, on the way to its 2030 Science Based Target initiative (SBTi) target of 55%. The company is ahead, too, on reducing absolute Scope 3 customer emissions, achieving a reduction of 14%, or more than 18 million metric tons, on the way to its 2030 SBTi target of 16%.

"To help lead the way to a net zero future, we have committed to ambitious sustainability goals," said Katie McGinty, vice president and chief sustainability and external relations officer at Johnson Controls. "The numbers show that our smart building technologies and as-a-service financing and partnership models are having tremendous impact in cutting energy, emissions, and cost in our own operations and for our customers. We can accelerate climate progress and advance business objectives at the same time – just in time for the action the planet needs now!"

Driving climate progress is a significant factor in the company's growth and vitality, and Johnson Controls continues to innovate, investing 90% of R&D into new sustainability-

related technologies in fiscal year 2022. The company also is addressing hard-to-abate steel production and embodied carbon. Over 70% of Johnson Controls steel purchases in the United States and 45% globally are from recycled scrap materials, (Recycled steel has up to 80% less embodied carbon than primary steel).

In addition, the company has stepped up to mobilize financing and meet the capital constraints faced by so many companies today, by introducing “Net Zero as a Service.” This partnership model delivers on key performance objectives for customers – from energy, emissions, and cost reductions to healthy, smart workspaces – without upfront capital costs. “Net Zero as a Service” redefines risk by guaranteeing energy savings and paying project costs out of the savings. Since January 2000, Johnson Controls’ innovative financing structures have helped partners and customers avoid over 37 million metric tons of emissions, and they are set to save partners over \$7.8 billion in energy and operational costs over their project terms.

Johnson Controls attributes its global sustainability leadership to a 100,000-strong team, from the C-suite to the front line and factories. Compensation for the executive committee is tied to sustainability and diversity performance goals. Employees volunteered over 45,800 hours in 2022, 86% of which supported UN Sustainable Development Goals. The company is also investing in the rising generation of diverse, sustainable leaders through a wide range of scholarship, training, and internship programs.

For more information, visit www.johnsoncontrols.com.

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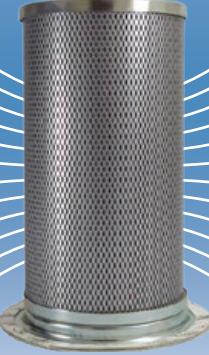
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This testing includes endurance tests, environmental tests, and functional tests, ensuring that the drain can withstand a wide range of operating conditions.

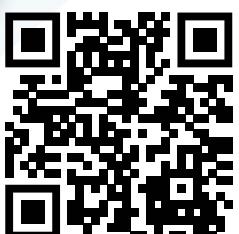
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BEKOMAT® is designed for easy maintenance, with a simple and accessible design that allows for quick and easy cleaning and servicing. This helps to minimize downtime and ensure that the drain remains in optimal condition for reliable operation.

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