CHILLER & COOLING

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5 Technology News

May 2019

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FROM THE EDITOR



This issue we've received insightful articles from some of the largest firms in the cooling technologies world. Evapco is one of the larger manufacturers of evaporative cooling technologies in the world, systems which can consume significant volumes of water. It's difficult to drive past many commercial buildings or industrial plants without seeing their cooling

towers or evaporative condensing units. I was therefore surprised at a trade show one day, when I saw them displaying a water treatment technology they call, "Water Saver". We salute manufacturers who are investing, like Evapco, in helping their clients with water conservation.

Danfoss is one of the leading refrigeration compressor manufacturers in the world. They have made significant investments in variable speed centrifugal semi-hermetic refrigeration compressors with oil-free magnetic bearings. I hope you find their article interesting discussing the impact of oil on chiller refrigeration compressors and the results of their 10-year study of two applications-one at Hershey Chocolate.

Brentwood Industries is a leading manufacturer of cooling tower fill. They have provided us with an excellent "fill fundamentals" article. I recommend it for anybody wanting to know the right questions to ask about their own cooling tower fill performance or "fouling".

SPX Cooling Technologies operates the reknown Marley brand of evaporative cooling technologies. Historically cooling towers have used belt and gear drive power transmission technologies. Today, direct drive and electronically commutated drives are getting some attention. We hope you enjoy their "pros and cons" article reviewing these drive options facing clients today.

Improving quality, reliability and efficiency, by optimizing self-generated utilities, is the focus of the 2019 Best Practices Expo & Conference, taking place October 14-16, 2019 at the Nashville Music City Center. Visit www.cabpexpo.com

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

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



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CHILLER & COOLING TOWER TECHNOLOGY PICKS

Thermal Care Launches Breakthrough Hybrid Evaporative Cooling System

Thermal Care, a leading manufacturer of process cooling equipment, has announced the commercial launch of a breakthrough hybrid film evaporator chiller that reduces energy use by 34% and uses less refrigerant than competitive flooded chillers. The company's new Accuchiller TCF model chiller uses a Hybrid Film Evaporator which provides the energy efficiency of wet (flooded) systems in a compact footprint using less refrigerant, said Bob Smith, Thermal Care's Director of Product Management.

The Accuchiller TCF is Thermal Care's first Hybrid Film Evaporator system and builds on the success of the company's industry-leading variable-speed, centrifugal compressor systems, combining the energy savings of the new TCF chiller with their other energy savings technologies like adiabatic fluid coolers and free cooling system designs.

"With this significant new advancement, Thermal Care is elevating energy-efficient process cooling to the next level," said Smith. "Industrial users can now realize the benefits of both the efficiencies of a flooded chiller and variable-speed centrifugal compressor that deliver energy efficiency, reduced refrigerant use, and a smaller physical footprint."

The new Accuchiller TCF was developed in response to market demand for improved energy efficiency and reduced refrigerant charges. Thermal Care is one of the first industrial chiller manufacturers to commercialize this breakthrough technology for process cooling market segments including plastics processing, food processing, metalworking, and other key industries.

Unlike current flooded evaporative systems, which immerse copper water tubes in liquid refrigerant, hybrid film evaporation systems use a thin film of refrigerant to achieve more energy efficiency with a reduced amount of refrigerant.

The hybrid technology boasts a compact modular design, providing a 25% smaller footprint, which maximizes floor space and helps to reduce production costs for manufacturers. The Accuchiller TCF also features Thermal Care's unique advanced PLC control system, which controls, monitors, and maintains stable and reliable operation of the pumping system. A durable color touchscreen displays operational screens

including time stamped faults or alarms and compressor and pump hours. The Accuchiller TCF is also equipped with an Ethernet port and is fully compatible with the company's CONNEX4.0 plant-wide equipment remote control and monitoring system.

About Thermal Care

Founded in 1969, Thermal Care is a developer of leading-edge process cooling technology with energy-saving and cost-efficient product designs. The company provides heat transfer equipment to more than 50 industries and specializes in meeting the specific needs of all customers by offering both standard and custom designed industrial process cooling solutions. Thermal Care's broad product line includes portable and central chillers, cooling towers, pump tanks, and temperature controllers. The company also delivers extensive experience and engineering knowledge to develop and execute plant-wide cooling solutions. For further information, visit www.thermalcare.com or call, (847) 966-2260.



Breakthrough hybrid film evaporator chiller provides energy efficiency and compact footprint.

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CHILLER & COOLING TOWER TECHNOLOGY PICKS

Frigel Introduces ModularChiller 3FX Water Cooled Central Chiller Line

Frigel, the world market leader in intelligent process cooling, has announced its ModularChiller line of central chillers now includes its new family of modular and highly energy efficient 3FX water-cooled chillers ranging from 25 to 139 tons each.

Designed for use with Frigel's internationally patented Ecodry 3DK central adiabatic dry-cooler systems and offering engineered, automatic free-cooling capability, 3FX chillers are a key component of a digitally controlled, integrated closed-loop intelligent cooling system. These units are design specifically to build "integrated systems," either in parallel configuration (Modular Refrigeration Systems) or in series arrangement (MultiStage Refrigeration Systems).

Frigel's 3FX chillers are available in 12 models to meet the demands of a wide range of process cooling applications, while providing industry leading energy efficiency ratios (EERs) in all working conditions. Seven models are engineered with high-efficiency Bitzer screw compressors offering 41 to 139 tons of cooling per chiller and allowing for step-less capacity modulation from 25 to 100%. Five models feature twin tandem scroll compressors providing 25 to 65 tons of cooling capacity per unit.

Each digitally controlled compact chiller has a minimal footprint and is engineered as a self-contained and complete package. Frigel offers the 3FX chillers as part of an integrated system engineered to cost-effectively and reliably deliver process cooling based on each customer's unique



Frigel's 3FX chillers are available in 12 models to meet the demands of a wide range of process cooling applications.

operation and process cooling needs. In addition to the 3FX chiller, an integrated system includes an Ecodry adiabatic cooler and Aquagel pumping, reservoir and filtration package - all of which are modular units designed to minimize installation costs and provide for ease of expansion.

The Frigel 3PR Intelligent Control System automatically monitors and adjusts the complete system to ensure optimum performance based on a wide range of operating parameters. The controller, in combination with a central 3-way motorized modulating valve, automatically shuts down the 3FX chillers and lets the Ecodry unit deliver process water at the proper temperature where needed via ambient air flow, achieving cooling and energy savings of up to 80 percent, conditions permitting. The controller also performs self-diagnostics and provides remote control capability to help operators monitor system performance at all times, while further ensuring peak performance and maximum uptime.

About Frigel

Frigel has been a worldwide market leader in intelligent process cooling since the 1960s. Solutions include centralized cooling systems, machine-side cooling and temperature control units, and water- and air-cooled chillers, as well as advanced control technology. Foremost among Frigel's products is Ecodry, a unique, internationally patented, closed-loop intelligent cooling system that has been proven at more than 8,000 manufacturing installations worldwide. Ecodry, an environmentally friendly cooling solution, keeps cooling water clean, delivers substantial savings on water, chemicals, energy and maintenance. Frigel also manufactures and markets the unique, cycletime improving Microgel combination chiller/temperature control units (TCUs), as well as Turbogel and Thermogel TCUs, Aquagel pumping and filtration equipment and water- and air-cooled central chillers. For more information visit: www.frigel.com.

Johnson Controls Introduces Diverse Portfolio of YORK® Absorption Chillers and Heat Pumps

Johnson Controls showcased the YORK[®] absorption offering at the 2019 AHR Expo. After successful deployment in Europe and Asian-Pacific countries, YORK is launching its absorption chillers and heat pumps in North America, expanding their portfolio of environmentally friendly heating and cooling solutions. The products use only a natural refrigerant (water) and are driven by waste or other low-cost heat sources.

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York's absorption chillers use only a natural refrigerant (water) and are driven by waste or other low-cost heat sources.

"Energy efficiency and sustainability are core elements of our vision and values," said Clay Nesler, Vice President, Global Sustainability and Regulatory Affairs, Johnson Controls. "The YORK absorption chillers and heat pumps provide energy savings by using water as the refrigerant that yields zero ozone depletion and zero global warming potential. These units can use a variety of waste heat sources, increasing cooling and heating systems efficiency while reducing operating costs."

The YORK absorption portfolio uses an innovative two-step evaporatorabsorber / parallel flow design enabling a lower salt concentration, requiring less energy input. This results in increased reliability and energy efficiency compared to conventional designs.

"With electricity costs continuing to rise and lower cost natural gas more readily available, there is a renewed interest in combined heat and power (CHP) systems," said Ian McGavisk, Vice President and General Manager, Global Chiller Products, Johnson Controls. "Our absorption portfolio is optimized to integrate with CHP systems, and comfort and industrial process cooling in a clean and resilient way. The success of these units is backed by more than 50 years of innovation and experience in absorption technology."



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- Easy installation, use and maintenance



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YORK absorption chillers are supported by an extensive service and parts network, with more than 100 locations throughout the United States. For more information on YORK absorption chillers and heat pumps, visit http://www.york.com/absorption-chillers.

About Johnson Controls

Johnson Controls is a global diversified technology and multi-industrial leader serving a wide range of customers in more than 150 countries. Our 120,000 employees create intelligent buildings, efficient energy solutions, integrated infrastructure and next generation transportation systems that work seamlessly together to deliver on the promise of smart cities and communities. Our commitment to sustainability dates back to our roots in 1885, with the invention of the first electric room thermostat. We are committed to helping our customers win and creating greater value for all of our stakeholders through strategic focus on our buildings and energy growth platforms. For additional information, visit http://www.johnsoncontrols.com.

About Johnson Controls Building Technologies & Solutions

Johnson Controls Building Technologies & Solutions is making the world safer, smarter and more sustainable – one building at a time. Our technology portfolio integrates every aspect of a building – whether security systems, energy management, fire protection or HVACR – to ensure that we exceed customer expectations at all times. We operate in more than 150 countries through our unmatched network of branches and distribution channels, helping building owners, operators, engineers and contractors enhance the full lifecycle of any facility. Our arsenal of brands includes some of the most trusted names in the industry, such as Tyco[®], YORK[®], *Metasys[®]*, *Ruskin[®]*, Titus[®], Frick[®], PENN[®], Sabroe[®], Simplex[®] and Grinnell[®]. For more information, visit www.johnsoncontrols.com.

SPX Cooling Technologies Launches Marley[®] ClearSky[®] Plume Abatement System

SPX Cooling Technologies, a global leader in evaporative cooling systems for industrial process and power plant applications, has launched the Marley[®] ClearSky[®] Plume Abatement System to help power plant operators reduce cooling tower plume and further conserve water.

The Marley ClearSky system employs a series of PVC heat exchanger modules located in the tower plenum that use external ambient air



The Marley ClearSky Plume Abatement System reduces cooling tower plume.

to condense moisture in the exhaust air prior to exiting a cooling tower. Fewer grains of moisture escaping result in reduced plume and better water conservation. SPX Cooling Technologies, reports the system has proven to reduce a cooling tower's water usage by as much as 20 percent compared to conventional cooling towers, depending on climatic conditions. It also facilitates permitting for power plant construction and improvements.

Designed for adaptability, the system can be incorporated into existing Marley field-erected counter flow cooling towers, making it an economical alternative compared to other solutions. The Marley ClearSky system requires less pump head, uses less auxiliary power compared to coil-type hybrid towers, and requires less piping than conventional systems. According to SPX Cooling Technologies, the system uses less energy than traditional dry systems for a positive impact on a power plant's carbon footprint. It has also been shown to reduce icing and fouling potential.

For more information, visit www.spxcooling.com, or call 913-664-4700.

Armstrong Unveils New IPS 4000 Controller

Armstrong Fluid Technology has announced the release of its new Integrated Pumping System (IPS 4000), an automation solution for commercial HVAC pumping stations.

HydroThrift

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The new IPS 4000:

- Automates and optimizes multi-pump installations in a range of different plant configurations.
- Provides sequences for variable-primary, secondary or tertiary pumping system applications.
- ▷ Delivers leading energy savings, with patented Parallel Sensorless[™] pump staging technology.

Pre-configured to leverage the capabilities of Design Envelope, the technology embedded in Armstrong pumps, the new IPS 4000 offers fast and simple setup for the most cost-effective and efficient pump control results. The IPS 4000 is compatible with existing building automation systems and ships pre-programmed for easy installation and set-up.

"The new IPS 4000 is a great control and automation solution. In particular, it will add value in any building that has short peak loads, or needs a hybrid solution to provide both Sensorless staging and critical zone sensors," said Peter Thomsen, Director, Building Systems Solutions.

About Armstrong Fluid Technology

With over 1,000 employees worldwide, operating seven manufacturing facilities on four continents, Armstrong Fluid Technology is known as an innovator in the design, engineering and manufacturing of intelligent fluid flow equipment. With expertise in demand-based control, digitalization, fluid flow, and heat transfer, Armstrong Fluid Technology leads the fluid systems industry, including HVAC, plumbing, and fire safety, providing the most energy-efficient and cost-effective solutions to building professionals and owners around the world.

The energy savings provided by Armstrong solutions support the company's "2 By 22" initiative – a commitment to reduce GHG among its installed customer base, targeting 2 million tons by the year 2022. The company also issued a challenge to industry participants to set similarly aggressive targets for the same fouryear timeframe. Armstrong has been working with customers to convert existing installations, and the initiative is on pace to reach the target. For more information visit, https://armstrongfluidtechnology.com.



Armstrong Fluid Technology releases the IPS 4000 Controller.



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COOLING SYSTEMS

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SUSTAINABILITY & WATER CONSERVATION

REDUCING COOLING TOWER WATER CONSUMPTION through Advanced Water Treatment Technology

By Drew Robinson, Contributing Editor

► It might cover 71% of the earth, but water is one of our most precious resources. Headlines around the world warn of water shortages, and water demand globally is projected to increase by 55% between 2000 and 2050¹. But, one innovative company is working to address a small slice of this concern.

EVAPCO's eco-ATWB is one of the company's water saving technologies, with high dry-bulb switchover temperatures

For decades now, evaporative cooling has been the principal means to regulate the temperature of buildings. And with more than 50% of total building water usage dedicated to heat transfer, there are major opportunities for water savings.

Enter EVAPCO, a manufacturing company focused on heat transfer applications and

^{ff}If the water quality at a location has a conductivity of 500, our technology lowers it to 250. That ultimately doubles the cycles of concentration and that's where water savings happen.

- Dustin Cohick, Product Manager and Josh Boehner, Marketing Applications Engineer, EVAPCO

CHILLER & COOLING BEST PRACTICES

a world leader in designing and manufacturing evaporative cooling products. I spoke with Dustin Cohick, Product Manager at EVAPCO, and Josh Boehner, Marketing Applications Engineer, to learn more about heat transfer and how EVAPCO's technology can save water. The interview that follows has been edited for clarity and length.

EVAPCO is a major name in the evaporative cooling world. Can you give us a sense of EVAPCO's scale?

We are an international company, engineering and manufacturing products in 24 locations in 10 countries, with clients all around the world. With a reputation for technological innovation and superior product quality, our products lead the way in efficiency, reliability, and sustainability.

Given EVAPCO is a manufacturer, why is the company concerned with water treatment?

Cooling towers use a great deal of water. In the past, clients acquired their cooling tower systems from a manufacturer, then were on their own to treat the water, which is crucial to operate the system at its optimal efficiency. Given we know our equipment the best and are world leaders in evaporative cooling, we saw the opportunity to overhaul this dynamic by helping our clients get the most out of our products. With sustainability at the forefront of our company's culture, we have invested heavily in water treatment. Our Water Saver technology can save clients an immense amount of water and decrease the amount of treatment chemicals.

Do most cooling tower manufacturers offer water treatment?

No, it's unique to EVAPCO. It's very abnormal for cooling tower manufacturers to focus on water treatment and invest in resources such as our own in-house water laboratory. Ultimately, the purpose of all of this is to help our customers achieve maximum water savings.



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REDUCING COOLING TOWER WATER CONSUMPTION THROUGH ADVANCED WATER TREATMENT TECHNOLOGY

Let's take a step back. How do cooling towers use water in the first place?

For any piece of evaporative equipment, such as a cooling tower or a closed-circuit cooler, the equipment transfers heat from the water into the atmosphere through evaporation. Warm water enters the cooling tower where it is exposed to ambient air passing through the tower. Some water evaporates while the rest is significantly cooled. This remaining water is then recirculated into the system.

Where does water quality fit into this?

When water evaporates through heat transfer, it leaves behind ions that are naturally occurring in the water. The quality of that water and the number of ions it contains determines the amount of water needed. A common analogy I use is boiling a pot of water. If you let all the water evaporate, the result is a whole bunch of dried minerals on the inside. Those are the ions naturally occurring in the water. In a cooling tower, you reject heat, so you need to add fresh water, or makeup water, back into the tower because a certain volume of water is required.

What is the connection between these ions that are left behind and the quantity of water used?

Generally speaking, the more ions that are in the water, the more often blowdown will occur. Blowdown is when a new cycle of makeup water enters the cooling tower. The goal of a water treatment system is to maximize the efficiency of the water being used inside the tower without scaling or corroding the system. By decreasing the concentration of ions in the makeup water before it ever enters the cooling tower, it allows you to operate at higher cycles of concentration.

What is cycles of concentration and why does it matter?

Cycles of concentration is the ratio of dissolved ions in the recirculating water divided by the



With its own water analytical service laboratory, EVAPCO is unique among cooling tower manufacturers.

concentration of dissolved ions in makeup water. The higher cycles of concentration, the less makeup water is needed. The key is identifying the cycles of concentration that maximizes the efficiency of the water used inside the tower without overburdening the system. Reducing the ions by 50%, EVAPCO's Water Saver technology can safely double the cycles of concentration. These are amazing savings for our clients.

What does it look like to overburden a system?

Usually it's one of two things. Either you're going to form scale in the system quickly, or elevate levels of corrosion. All water is corrosive to some degree as water is the universal solvent. In a cooling tower situation where you're recirculating water, the higher levels of ions and particulate matter can eventually scale or corrode the system if not maintained properly.

So how does EVAPCO's Water Saver technology work? How do you pretreat the water?

If the water quality at a location has a conductivity of 500, our technology lowers it to 250. That ultimately doubles the cycles of concentration and that's where water savings happen. Capacitors remove dissolved ions from the water, and over time the capacitors will fill up and the Water Saver will perform a flush cycle. We switch the positively and negatively charged capacitors, and when that happens, the ions come off the capacitor and get sent to drain at a lower flow, so as not to waste water.

This might sound like a silly question, but what is a capacitor?

It's a conductive piece of metal that isn't particularly special until the Water Saver sends it the electrical charge. And that electrical

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CHILLER & COOLING BEST PRACTICES

charge attracts the ions, which is the whole point of the system.

Can you provide a real-world example of this technology in practice?

At an Indiana high school we received a water sample from them and ran it through our water model, determining its maximum cycles of concentration as 2.5. They were looking to replace their cooling towers and optimize water treatment. We helped them with their chemical treatment program and they purchased our Smart Shield and Water Saver system. These modifications improved their makeup water 50%, allowing them to double the cycles of concentration to five, ultimately saving them 1.5 million gallons of water annually.

Let's say a new client is interested in incorporating your Water Saver technology. Where do you start? How do you approach evaluating an overall system?

There are three different components to assess – the chillers, the water treatment, and the evaporative equipment, meaning the cooling towers or evaporative condensers. Each of these areas requires an independent look. Take the water treatment, for example. We look at several areas within the water treatment, including how they're treating the water, how much that costs, and the quality of the water.



EVAPORATIVE COOLING WATER

Increasing the cycles of concentration is essential to reducing water use.

How do you approach evaluating the water treatment system and assessing water quality?

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The first step is understanding the quality of the makeup water. Most of the time a water treater will have an idea of the local water quality, but it's still important to evaluate.

Second, is taking a close look at the evaporative equipment system. When we're out in the field, we inspect things like what type of piping is in use, ensuring there are no dead legs, and ultimately identifying what the water is contacting. It's critical this assessment is conducted in person. There are no one-sizefits-all solutions in water treatment.

Third, is identifying the type of evaporative cooling equipment. Is it a cooling tower, an evaporative condenser, or is it a closed-circuit cooler? The type of equipment in use impacts the overall water treatment.

The fourth step is assessing the types of materials used in construction. Whatever the water will touch is important – whether it's the tower, piping, heat exchangers involved, the chiller, or anything else. The materials of construction of everything in the system influence the overall water treatment.



"It's critical to assess each system on a case-by-case, plant-by-plant basis, as the water is often drastically different"

- Dustin Cohick, Product Manager and Josh Boehner, Marketing Applications Engineer, EVAPCO

REDUCING COOLING TOWER WATER CONSUMPTION THROUGH ADVANCED WATER TREATMENT TECHNOLOGY

Attribute	MU	Units
Conductivity	736	umho/cm
pН	7.9	
Total Hardness	255.7	ppm as CaCO ₃
Ca Hardness	121.9	ppm as CaCO3
Mg Hardness	133.8	ppm as CaCO ₃
Alkalinity	211.7	ppm as CaCO ₃

Attribute	MU	Units
Silica	14	ppm
Chloride	69.8	ppm
Sulfate	62.9	ppm
Phosphate	0.0	ppm
Sodium	59.7	ppm
Iron	<0.1	ppm

A makeup water sample analysis from a system in Phoenix shows high levels of conductivity.

It's interesting that in steps two through four, you're not looking at the water itself.

Correct, the most important part of the evaluation is what the water is contacting. We, of course, pull a sample of the makeup water and recirculating water, but we don't even look at that until later. What we're most interested in is everything that's physically part of the system.

Are there any other steps?

The next step is evaluating the temperatures. Higher temperatures mean that scale and corrosion both happen faster. Traditional HVAC temperatures are 95 °F into the tower and 85 °F out, but industrial sites are typically higher. I have even visited sites with temperatures close to water's boiling point. Identifying the temperature matters, whether it's high or low, as it strongly influences the treatment plan I propose.

After you assess the system, how do you analyze the makeup and recirculating water?

We have our own in-house laboratory. This helps us not only for the original evaluation at a new site, but also existing customers. Analyzing the makeup and recirculating water helps inform our decision-making when installing or retrofitting a current system, as the composition of the water can help us decide, for example, whether to use galvanized or stainless steel.

I would imagine in different locations there is different quality water. How does that impact the goal of using less water?

It's critical to assess each system on a caseby-case, plant-by-plant basis, as the water is often drastically different. The difference in the water for a plant in Iowa versus one in Arizona will drive the type of system needed and the technology used. This makes life difficult for companies with plants across the country and even the world.

What works well in one place won't necessarily work somewhere else. Take New York City, for example. They have some of the best water anywhere on the planet. New York City water has 100 conductivity. The conductivity of water is how well water can conduct electricity. The lower the conductivity, the better the water quality. There are less minerals and ions in the water. In contrast, Phoenix, Arizona, has a conductivity of 1,000 – ten times the amount of minerals coming out of the faucet than New York City. What that means is New York City cooling towers operate at 12 cycles of concentration. This is stellar water efficiency. Not every location can operate at this high a level of water efficiency without corroding the system. Meanwhile, Phoenix operates at 2.5 cycles. There is only so much you can control depending on where the system resides. Places that operate with lower cycles of concentration have the greatest opportunity to save water.

Ultimately, how much water can people save if they implement your technology?

Historically, clients who use our water treatment technologies to save water, in conjunction with the technology in our evaporative box, approach 40-50% less water usage. And the savings can be even more than that; each system is different.

Those are huge savings. What else do your clients save besides water?

The big one is time, and of course, time is money. We have worked with industrial clients that prior to incorporating our technology, spent an inordinate amount of time on maintaining their system. Cleaning flow meters, valves, and many other components of the system. And it all comes back to water treatment. The typical operating expense of maintaining their entire system is often reduced.

Thank you for sharing your insights on this topic.

For more information, visit www.evapco.com. BP

All photos courtesy of EVAPCO

1 http://www.bbc.com/future/story/20170412-is-the-world-running-out-of-fresh-water

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TEN-YEAR STUDY Oil-free Refrigeration Compressors Provide Consistent Performance

By Eddie Rodriguez, Danfoss Turbocor® Compressors

► Cooling large buildings typically requires the use of air- or water-cooled chillers that produce chilled water, which then cools the air. About 39% of buildings over 100,000 square feet use chilled-water systems employing various refrigeration compressor designs.

Selecting the right chiller and compressor requires a specifying engineer to determine the building's cooling load and the proper chiller capacity.¹ Calculations are also done to determine the return on investment between different systems by comparing the energy cost per ton of refrigeration along with the operational costs.

When buying a new chiller, specifying engineers and facility owners naturally focus on efficiency ratings to estimate the chiller's

"A significant factor that affects chiller performance over time is the oil used by the chiller's compressor."

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annual energy costs. In addition to the chiller's performance ratings, however, there is another variable worth considering: How will the chiller and the chiller's compressors maintain their rated performance in real-world operating conditions years after the purchase has been made? A significant factor that affects chiller performance over time is the oil used by the chiller's compressor.

This article discusses the impact of oil on chiller compressors and examines the performance of variable-speed centrifugal semi-hermetic compressors with oil-free magnetic bearings over a 10-year period in two real-world applications.

Consequences of Oil Fouling

Oil is used to form a seal that prevents refrigerant from returning to the suction port as well as lubricate the compressor bearings, gears and shaft seals. While necessary for operation, the oil over time becomes entrained in the refrigerant and circulates throughout the system. Eventually, the oil coats the heat exchanger tubes, which creates a thermal barrier that degrades efficiency – a problem known as "oil fouling."

A number of independent third-party studies detail the consequences of oil fouling, which include:

- A drop in heat transfer ratio from 1.0 to 0.65 at oil concentrations as low as 10%.²
- A loss of 10% efficiency after five years, 20% efficiency loss after 10 years in oil-lubricated chillers at Tsinghua University, China.³
- As much as 30% performance degradation in other cases.⁴



The Hershey Chocolate data center uses a 180-ton (600 kWr) Smardt WA062.2 water-cooled chiller equipped with two Danfoss Turbocor TT300 oil-free centrifugal compressors.

Performance degradation over time is not only due to oil fouling. Another study shows traditional oiled compressors, specifically screw compressors, suffer significant performance degradation due to excessive bearing wear, capacity slide damage, and other factors over years of operation.⁵

This study concluded that screw compressor wear significantly impacts performance by the fifth year of operation, and subsequent performance degradation was found to be as high as 26% on average after 15 years of operation.

To avoid mechanical wear and oil-related performance problems, Danfoss offers variable-speed centrifugal semi-hermetic compressors that employ oil-free magnetic bearings. With this type of compressor, chiller manufacturers are able to eliminate complex oil management systems conventional chillers need to lubricate mechanical compressor bearings.

Theoretically, an oil-free hermetic compressor design avoids the frictional inefficiency, degradation and maintenance issues associated with conventional oiled compressors. But how does it compare in actual practice after years of operation?

To find out, Danfoss initiated a research project in 2018 to compare the presentday performance of Danfoss Turbocor[®] compressors in operation for 10 or more years with their performance when originally installed. The study sought to determine

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if oil-free compressors experienced the same performance degradation found in traditional oiled compressor typesy – or whether they maintained their original level of performance. The study confirmed compressors with oilfree magnetic-bearings maintained consistent performance over a 10-year period.

Oil-free Compressors Used with Water-Cooled Chillers

The study analyzed two applications, including oil-free centrifugal compressors used on water-cooled chillers at a data center for The Hershey Company, a global confectionery leader famous for its chocolates, sweets, and snacks. In 1973, it opened Hershey's Chocolate World in Hershey, Pennsylvania, and then expanded to locations that today range from Times Square to Dubai to Shanghai.

To serve chocolate customers and fans worldwide, Hershey's Chocolate World also operates a data center located in Hershey. The data center operates around the clock using a chiller providing cooling for the electronic equipment.

To handle these conditions, the data center employs one 180-ton (600 kWr) Smardt WA062.2 water-cooled chiller using two Danfoss Turbocor TT300 oil-free centrifugal compressors. Optimized for R-134a refrigerant, each compressor provides up to a nominal 90 tons of refrigeration utilizing two-stage centrifugal compression.

The two compressors submitted for performance testing incurred over 38,967 and 38,928 hours of operation, respectively, resulting from operation 24 hours per day, seven days a week in data-center cooling for more than 10 years.

In January 2018, the compressors were removed from the chiller and replaced with new TT300 compressors. The existing compressors were sent to Danfoss' test

TT300 Compressor (90 tons nominal)	Suction Pressure	Discharge Pressure	RPM	Power (kW)	Mass Flow Rate (kg/min)
2007 test	359.33	918.88	31905	46.8	101.08
2018 test	362.1	919.75	30656	48.0	103.23
Deviation	0.77%	0.09%	-3.91%	2,56%	2.13%

TT300 Compressor (90 tons nominal)	Suction Pressure	Discharge Pressure	RPM	Power (kW)	Mass Flow Rate (kg/min)
2007 test	353.0	912.39	32002	46.7	100.18
2018 test	354,74	914.91	32005	49.0	100.33
Deviation	0.49%	0.28%	0.01%	0.62%	0.15%

laboratory at Innovation Park in Tallahassee, Florida.

Compressor No. 1 tested at 48.0 kW power consumption and Compressor No. 2, 49.0 kW power consumption, at pressures, RPMs, and capacities shown in Tables 1 and 2.

Although no official test standard pertains to standalone centrifugal compressors, AHRI 540-2015 was used as a test reference as explained below. These results fall within the AHRI 540-2015 uncertainty limits for the verification of published ratings for an application envelope with 95% for minimum mass flow and minimum refrigerating capacity and with 105% maximum power input.

These results were then compared with the original test parameters for each compressor when they were tested and shipped in 2007 from the Danfoss factory to the chiller manufacturer.

From its original 2007 power test value of 46.8 kW, Compressor No. 1 deviated 2.56% higher 11 years later as shown in Table 1. Mass flow was 2.13% higher. From its original 48.7 kW value, Compressor No. 2 deviated 0.62% higher for power consumption as illustrated in Table 2 and was 0.15% higher in mass flow.

The range of deviation for kW and mass flow as shown in Tables 1 and 2 were all within the acceptable uncertainty limits for performance per AHRI 540-2015. This range approximates the expected performance values for new compressors.

The results show the TT300 oil-free compressors experienced no significant performance degradation over an 11-year period. This evidence indicates the compressors provided consistent, long-lasting



An inside look at the Australian Broadcast Company (ABC) Studios in Melbourne, Australia.

performance that is likely to extend over the life of the chiller.

"In a data center, reliability is everything. This chiller with TT300 magnetic-bearing compressors has been, and still is, an extremely reliable chiller," said Steven C. Miller, Senior Maintenance Specialist for The Hershey Company Data Center.

"Operational and maintenance costs are way down because there have been very few repairs over the ten-plus years this chiller has been in service," he said. "We originally selected this technology due to low noise levels and a track record of success at other sites. In our case, the chiller with Danfoss Turbocor compressors has met and exceeded my expectations regarding performance."

Oil-free Compressors Used with Air-Cooled Chillers

The study examined the results of a second application involving the use of the compressors on air-cooled chillers at the Australian Broadcast Company (ABC) Studios, Melbourne, Australia.

Located in the city's vibrant arts district, ABC Studios offers state-of-the-art studios television facilities and services. The studios accommodate lighting, electronics, equipment rooms, production personnel, and a 350seat auditorium that needs to stay cool. This vast array of load conditions can cause significant load swings, requiring the chillers to react quickly.

TEN-YEAR STUDY: OIL-FREE REFRIGERATION COMPRESSORS PROVIDE CONSISTENT PERFORMANCE

Table 3: Compressor 1 performance values for ABC Studio						
TT300 Compressor (90 tons nominal)	Suction Pressure	Discharge Pressure	RPM	Power (kW)	Mass Flow Rate (kg/min)	
2008 test	357.74	917.67	32016	46.3	96.45	
2018 test	358.38	917.75	32026	47,5	95.56	
Deviation	0.18%	0.01%	0.03%	2.59%	-0.92%	
Deviation	0.18%	0.01%	0.0396	2.59%	-0.92%	

To handle the space-cooling requirements, ABC Studios replaced the existing chillers in 2008 with two 240-ton (840 kWr) air-cooled chillers (Smardt A0840-3C) each using three TT300 oil-free compressors. After a subsequent building expansion in 2014, three additional 230-ton (800 kWr) evaporative chillers (Smardt EB0-2E) were installed.

One of the three compressors from the existing chiller was selected for performance testing. The tested compressor incurred 10 years of operation with varying space-cooling needs for the studio situated in Melbourne's temperate oceanic climate. In September 2018, the compressor was removed from the chiller and replaced with a new TT300 compressor. The existing compressor was sent to Danfoss' test laboratory at Innovation Park in Tallahassee, Florida.

The TT300 compressor tested at 47.5 kW at the operating conditions shown in Table 3. These results also fall within the AHRI 540-2015 uncertainty limits as previously discussed. These results were then compared with the original parameters when the compressors were shipped in 2008 from the Danfoss factory to the chiller manufacturer.

From its original 2008 power test value of 46.3 kW, the compressor deviated 2.59% higher 10 years later as shown in Table 3. Mass flow was 0.92% lower. The range of deviation for kW and mass were all within

the acceptable uncertainty limits for performance per AHRI 540-2015. This range approximates the expected performance values for new compressors.

The results show the TT300 oil-free compressors experienced no significant performance degradation over the 10-year period. The data are additional evidence indicating consistent, long-lasting compressor performance that is likely to extend over the life of the chiller.

"The deciding factors for selecting the chillers were the small footprint due to limited space, no cooling towers, low noise due to the expanding residential towers in the adjacent area and the most efficient technology available, said ABC Studio Facility Manager Greg O'Brien. "The requirements were met along with the flexibility of multiple compressor chillers to handle the fluctuating loads and the low starting current (2 amps per compressor), which allowed the existing standby generator to start the chillers."

Conclusion

Oil-free magnetic bearing Danfoss Turbocor compressors maintained consistent energy efficiency and capacity for over a decade, translating into zero performance degradation and substantial energy cost savings over the life of the compressor.

Reductions in CO₂ emissions are also significant because the performance degradation commonly experienced with oillubricated compressors over the same period is avoided. There are additional benefits in that the compressors ran reliably and simplified maintenance, indicating many more years of like-new compressor performance that will extend over the chillers' lifespans.

About the Author

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

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COOLING TOWERS Finding the Right Fill for Your Process

By Bill Miller, P.E., Brentwood Industries, Inc.

► How often do you think about your cooling tower or the fill that provides the cooling engine for your process? Unfortunately, if you're like many plant operators, your cooling tower is but one piece of equipment in your large facility, and its ranking on your priority list is probably lower than many other expensive and more intricate pieces of equipment in your plant.

One of the challenges this lack of priority can yield is a lack of in-depth knowledge for a critical piece of the puzzle: the cooling tower. Just how critical it is becomes evident in the summer months, during the hottest days of the year, when production must be unexpectedly scaled back because the return cooling water from the cooling tower is so high it's negatively impacting plant efficiency.

Whether you have an existing cooling tower that needs some work done, or you're looking to purchase a new cooling tower to meet a plant capacity expansion, one of the choices you'll have is the fill around which the cooling tower is built. Choosing the right fill for your process and installation is an important decision since it can impact your plant's operation for years to come.

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"Fill designs vary in order to allow for different water qualities to circulate through the fill without negatively impacting the performance of the fill or causing structural issues to the tower from excessive weight gain."

- Bill Miller, P.E., Brentwood Industries, Inc.

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How Fills Work

Before discussing fills it's important to understand the basic function of a cooling tower. In general, cooling towers are fairly simple devices. The goal is to take water heated by your plant's process and cool it down, removing the same quantity of heat that your process added to it so that you can re-use the water in a recirculating loop.

The cooling tower is essentially just a box built to contain the water to be cooled. Because the water is cooled via the evaporative heat and mass transfer of water, the box has components that enhance that mechanism, such as air-moving equipment and components that improve the interactions of air and water, namely "fill."

There are many types of fills available to cooling tower repair/rebuild and manufacturing companies. Some basic examples are splash fills and film fills.

- Splash fills derive their name via the mode of cooling they provide: water splashes on fill surfaces, which increases the air/water contact.
- Film fills are so named because of the water film that forms on the surfaces of the fill. The generation of this very thin film of water on the fill's surface provides a very high amount of surface area for air/water contact, and as a result, film fills can offer the most amount of cooling for a given volume amount. Since film fills came into existence in the 1960s, fill manufacturers have developed a wide variety of different fill types and designs to address different water quality challenges that plant operators face.

Water Quality a Key Factor in Fill Choices

Due to the potential large volume of material, fill can be a substantial purchase. However, choosing the wrong fill can have an even greater impact on your bottom line due to reduced efficiencies and lost production on a day-to-day basis, and a need to replace fill many years sooner than expected. The key to choosing the right fill for your plant lies in your water quality, matching that water quality with a fill design that is appropriate, and utilizing a companion water treatment program that complements both.

There are three main factors that are evaluated when looking at choice of fill: Total Suspended Solids (TSS), Biological Activity/Control (via Total Aerobic Bacteria [TAB] plate counts), and Oil/Grease content in the circulating water. These can also be supplemented by calcium, magnesium, and silica evaluations related to the scaling potential of the



Shown are basic flute geometries.



A trickle fill has less surface area available than a film fill, but provides cooling in the same manner.



Modular splash fills, which are designed with water droplet-generating features, behave like traditional splash bar fills which are typically the most fouling-forgiving types of fills available.

COOLING TOWERS: FINDING THE RIGHT FILL FOR YOUR PROCESS

water; ammonia, sulfide, and nitrate evaluations related to the nutrients available to promote biogrowth; and information on the process being cooled, make-up water source, and circulating water cycles of concentration.

The three main factors are important because they characterize the solids available in the water to potentially plug the fill (TSS) and the potential items (biofilm growth and oils/greases) that would adhere the solids to the fill. The supplemental items help to provide a more complete picture of the potential difficulties for the water treatment program to keep dissolved solids from precipitating out and causing scaling issues, to keep biogrowth under control, and to understand what potential contaminants could be introduced to the system.



The Brentwood ThermaCross[™] fill is designed to increase cooling performance and improve fouling resistance.

Common Macro-structure Film Designs

Fill designs vary in order to allow for different water qualities to circulate through the fill without negatively impacting the performance of the fill or causing structural issues to the tower from excessive weight gain. One of the most basic design parameters used to account for this is the macro-structure of the flute corrugation. Common macrostructure designs include cross-fluted, offset-fluted, and vertical-fluted corrugations. These designs are found in film fills, trickle fills, and modular splash fills.

To prevent plugging of fills, the most important factor for fill design is water velocity. When the velocity of the water is higher, there is less of a chance for suspended solids to settle out on the surface of the fill, and there are greater shear forces applied to any matter that has adhered to the fill's surfaces. For this reason, the fills that are more resistant to fouling have vertical designs that maximize the force of gravity on the flowing water.

The impact of a vertical macro-structure applies to not only film fills, where it is widely acknowledged as a benefit for low fouling fills, but also to trickle fills and modular splash fills. In order to clarify this a little more, an understanding of the terms "trickle fill" and "modular splash fill" is required.

A trickle fill derives its cooling via water trickling along the fine strands that comprise the members of a trickle fill. As in a film fill, the trickling water forms a thin film along the many fine strands, but since the overall physical structure is not a solid sheet, there is much less surface area available to which fouling can adhere.

Another inherent aspect of trickle fills is the fact that the intersections of the fine strands provide numerous locations for the trickling water to split and thus reduce the water velocity as it moves through the pack. While that aspect of trickle fills generally helps their cooling performance when the pack is new and clean, it greatly increases the propensity for them to foul. The result is a fill that gives the impression



"The key to proper fill selection, especially if the goal is to provide a fill that will last for years, is to match the fill type with the water quality circulating in the cooling tower system."

- Bill Miller, P.E., Brentwood Industries, Inc.

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of being a low-fouling product since it is somewhat see-through, but which is easily misapplied when the low water velocity of the trickling water is ignored. When that happens, the cooling performance can suffer drastically due to the greatly reduced airflow that results from foulant build-up in the fill.

Modular splash fills, on the other hand, are fills that cool in the same manner as typical bar or grid type splash fills: droplet generation. Splash fills, including modular versions, are typically the most fouling-forgiving types of fills available. This can be true even for modular splash fills that resemble trickle fills but include vertical macro-structure geometries and droplet generation points throughout the pack. While the efficiency of an "as new" modular splash fill may, on paper, not quite reach that of a true trickle fill, if installed in a tower that has fouling potential, the cooling efficiency in the installation can beat that of a fouled trickle fill in a short period of time.

For film fills, the tradeoff has historically been balancing cooling performance with fouling resistance. Fills with the highest efficiency are cross-fluted film fills that provide a lot of surface area for water film coverage and constant mixing and redistribution of both the water and the air throughout the fill section. From a fouling perspective those features that provide great cooling lead to great tendencies to foul.

In an effort to compromise between cross-fluted designs and fully vertical-fluted designs with the goal of achieving a fill design that balances cooling performance and fouling resistance, several variations of offset-fluted designs have come to the forefront of product offerings in the past decade. With their ability to match common cross-fluted fill performance with greater fouling resistance, they have become the largest product offerings by volume, and they have many years of fieldproven performance backing them up.

Innovation Leads to Higher Performance, Low Fouling

The latest developments in fill designs have yielded both a further refinement of an "old" fill design and also a completely new design – all in efforts to keep evolving fill designs toward greater performance and narrowing the gap between "high performance" and "low fouling."

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Brentwood's ShockWave fill is designed to keep water velocity high, resulting in better fouling resistance.

An example is Brentwood's newest cross-fluted fill design. Called ThermaCross[™], it is a refinement of a 19-millimeter (three-quarterinch) cross-fluted product. It includes a patent-pending MicroBoost[™] design that maximizes the air-water interface along with a more vertical macrostructure for increased cooling performance and improved fouling resistance compared to shallower-angled 19 mm cross-fluted fills. The improved cooling performance enables it to perform up to 13% better than standard 19mm-spaced products.

Another example is Brentwood's patent-pending ShockWave[™] fill, which incorporates an enhanced vertical flute design. As with traditional vertical-fluted designs, there is a clear sight path visible through the air travel depth of the fill pack. Unique to the design is the way the diamond tube channel promotes full mixing of the air as it moves through the fill section while the microstructure promotes full utilization of the sheet surface for water filming.

The combination of these features leads to much improved cooling performance over traditional vertical-fluted fills. Another feature of the fill is the wide sheet spacing of 25.4mm (one inch) per sheet. Not only are the openings larger to permit larger particles to pass through the fill, but the fewer number of sheets increases the water loading per sheet for a given water flow. The increase in water loading helps keep water velocity high, resulting in commensurate fouling resistance.

Ensuring Years of Reliable Performance

The key to proper fill selection, especially if the goal is to provide a fill that will last for years, is to match the fill type with the water quality circulating in the cooling tower system. Reputable fill designers will offer guidelines based on the water quality parameters to help ensure the selection you make will provide years of reliable performance. The three main keys are TSS, Biological Activity/Control, and Oil/Grease content in the circulating water.

It's also important to factor in cost. When designing a new tower, total purchase price of the cooling tower is largely defined by the size of the tower. An often-overlooked ramification of this is that for the same required amount of heat rejection, a smaller tower will have higher efficiency fill in it than a larger tower. Thus, if making a purchasing decision based solely on upfront cost, you may end up with a tower that meets your design requirements for the first week it becomes operational. However, if the high efficiency fill in the tower is not appropriate for the water quality, then the up-front savings can easily be eclipsed by higher operating costs or lost production from your facility.

Looking at the long-term operating costs, or plant efficiency gains over time, is a better way to evaluate the total costs to your facility and can show the true benefits of giving a little bit of initial performance away to reap the rewards of consistent output over years of problem-free operation.

About the Author

Bill Miller, P.E. has worked for Brentwood for over 20 years. He is the global technical lead for Brentwood's Cooling Tower product line and also oversees the company's research and development as the Director of Application Engineering. Miller has published and presented several papers at the Cooling Technology Institute (CTI) and Electric Power Research Institute (EPRI) conferences, and is a member of multiple CTI committees related to cooling tower performance, fills, drift eliminators, and materials. He is also a member of ASHRAE. He has a Bachelor of Science in Aerospace Engineering from Pennsylvania State University, and is a licensed Professional Engineer in the Commonwealth of Pennsylvania.

About Brentwoood

Brentwood is a leader in the development, engineering, and production of plastic solutions for cooling towers. By offering the most complete line of internal polymer components in the industry, including fills and drift eliminators, Brentwood works with customers to ensure they receive the best-suited products for their specific projects and applications. For more information, visit www.brentwoodindustries.com/cooling-tower/.

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CHILLER & COOLING BEST PRACTICES

PROS AND CONS OF COOLING TOWER Power Transmission Technologies

By Jerome Jennings, SPX Cooling Technologies, Inc.



► Cooling towers can use several power transmission technologies, including a gear drive, belt drive, direct drive, and electronically commutated (EC) drive. Each has advantages and disadvantages. The proper selection strikes an appropriate balance of initial cost versus operating costs.

Gear Drives: Moderate Initial Costs, Low Lifetime Operating Costs

The gear drive, which has been used to transmit power for decades, relies on internal gearing that meshes to transmit power.

In a cooling tower application, a gear drive reduces the high-speed power from the motor to the lower speed required to power the fan. The induction motor is relatively small because the gearbox multiplies torque.

Gear drives are effective at all cooling tower power levels. Their thick, casted shells housing the gear teeth and oil bath can withstand the high heat and humidity inside the cooling tower. Gearboxes require additional "no load" power to overcome the friction of internal components and oil viscosity. Net efficiency of the gearbox varies per application, but is generally near 96%.

The gear drive requires little maintenance. For example, some gearboxes using synthetic oil do not require an oil change for five years, but cooling tower owners and service contractors should be diligent about inspecting for potential leaks. Another positive feature of the gear drive is that it runs off direct online power. A variable frequency drive (VFD) is not required, but may be included for added motor speed control and energy use benefits.



The gear drive reduces the high-speed power from the motor to the lower speed required to power the fan.

PROS AND CONS OF COOLING TOWER POWER TRANSMISSION TECHNOLOGIES

Belt Drives: Low First Cost, Higher Operating Cost

Belt drives have been around even longer than gear drives. They are used to transmit motion from one shaft to another with the help of a loop of flexible material, or belt, that runs over two sheaves



Belt drives transmit motion from one shaft to another with the help of a loop of flexible material.



The electronically commutated motor combines the motor, controller and fan together in one package, while using direct drive airfoil impellers.

(also called pulleys) to link the rotating shafts. This technology offers a smooth and effective transmission of power between shafts, even if they are at a considerable distance.

In a cooling tower application, the size of the sheaves determines the speed; different sized belts provide the speed reduction required. The smallest sheave connects to the motor, while the larger fan sheave is connected to a fan shaft. The ratio between those sizes dictates the speed reduction. Belts matching the profile and length requirements of the sheaves transmit power.

Unlike gears, belt drives are exposed to the cooling tower's hot, moist environment. The initial cost of a belt drive is low, but ongoing maintenance costs grow over time. Sheaves and other components corrode; belts stretch and lose tension. Starting at about 95% efficiency, belt drives can drop to the low 90s or even lower as the belts stretch and wear. Maintenance includes regular belt replacement and fan shaft bearing lubrication several times a year, contributing to its higher lifetime operating cost.

Belt drives are often employed in cooling towers with lower horsepower requirements. Like a gear drive, the belt drive does not require a VFD.

Direct Drive Motors: Low Maintenance, Higher Initial Cost

There are multiple direct drive options in which the motor directly drives the cooling tower fan. The direct drive motor offers reliability with minimal maintenance requirements.

A common direct drive option uses a permanent magnet motor. This is a type of electric motor with rare earth permanent magnets incorporated into the rotor. Use of this technology has grown over the past decade and is now widely used in vehicles, drones, computers, and numerous other applications that need powerful but relatively compact motors.

The permanent magnet motor directly drives the fan, eliminating a number of components, including gearbox, driveshaft, pillow block bearings and couplings. This in turn eliminates the need for alignment of the mechanical components, speeding installation, reducing installation costs and increasing system efficiency.

One disadvantage of the permanent magnet option is initial $\cos t - a$ direct drive with a permanent magnet motor is often the highest cost of all power transmission options. For the torque requirements of cooling tower applications, permanent magnet motors become heavier and taller than standard induction motors, due to elimination of the gear drive.

Permanent magnet motors require a VFD to operate. Although an extra initial cost, the VFD lets operators control speed and conserve energy.

Ensuring safe operation is a potential concern. With other power transmission options, when the motor is disconnected there is no power to it, making it safe to service. The permanent magnet motor can generate electricity even when power is shut off, potentially creating a dangerous situation. If, for example, wind turns the fan and fan shaft, electricity could travel to where a technician is working on the equipment. Another safety concern is the magnetic field produced, which could impact anyone wearing a pacemaker working near the motor.

A direct drive typically has the lowest maintenance cost over its lifetime because there is no need to replace the oil, no oil seals that can wear, and no need for routine alignment. Annual lubrication is recommended. Initial costs can be two to three times more than a gearbox. Due to the high first cost, payback can extend to 10 or more years.

Electronically Commutated Motor Combines Motor, Controller and Fan

The high-efficiency electronically commutated (EC) motor is a newer technology that combines a small DC motor and an inverter/speed controller into one package. The rotor portion of the motor typically uses rare earth permanent magnets and the integral speed control eliminates the need for an external VFD. For cooling tower applications, the fan, fan shroud, and fan guard are often incorporated to provide a complete mechanical drive package. This provides a simple and compact arrangement that is easy to install in the factory and to replace in the field as needed.

Cooling towers that use EC motors are usually of smaller capacity and footprint with a maximum application size of 10 horsepower (hp) or one-meter fan diameters. Compared to belt drives and other low-horsepower motors (less than 5 hp), EC motors are consistently more efficient. In small-hp applications, the EC motor presents no power transmission loss while other low-hp motors and belt drives can experience power transmission losses from 5 to 20 percent.

Because EC motors use sealed bearings, there is virtually no maintenance. The use of this technology for cooling towers is new and currently lends itself only to low-hp, small fan diameters.

Selecting the Right Option

When choosing among power transmission technologies, cooling tower specifiers, contractors and owners must evaluate costs across the



The permanent magnet motor directly drives the fan, producing a magnetic field.

	Belt Drive Gear Drive Direct		Drive	
			EC	РМ
Applicable Power	<100 HP	No Limit	<10 HP	<250 HP
Applicable Fan Diameter	<14 feet	No Limit	<4 feet	<30 feet
First Cost	\$	\$\$	\$\$\$	\$\$\$\$
Operating Cost	\$\$\$	\$\$	\$	\$
Energy Ethciency	+	++	++++	+++
Weight	Â	۵	Â	Â
Sound	(ال	⊲•)		-
VFD Required?	No	No	Yes, Integral	Yes, Externa

Shown is a comparison of available power transmission technologies.

entire cooling tower lifecycle. Factors such as energy efficiency, ease of maintenance, reliability and service life must be balanced against initial investment, installation costs, operational complexity and environmental impact. BP

About the Author

Jerome Jennings is Global Product Manager – Components, SPX Cooling Technologies, Inc. SPX Cooling Technologies is a leading global manufacturer of cooling towers, evaporative fluid coolers, evaporative condensers and air-cooled heat exchangers, providing full-service cooling solutions, components and technical support for HVAC, refrigeration, industrial and process cooling applications for nearly a century. SPX Cooling Technologies and its product brands are part of SPX Corporation. For more information, visit www.spxcooling.com and www.spx.com.

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Giandomenico Lombello Named CAREL Group Managing Director

The CAREL Board of Directors appointed Giandomenico Lombello, currently Group Sales and Marketing Director, as new Managing Director, replacing Francesco Nalini, who will continue in his role as CAREL'S CEO.

Lombello will report directly to the CEO and will play a general role in the direction, management and coordination of corporate operational process activities and functions. The appointment aims at strengthening the administrative structure of the Group, at guaranteeing lasting support for the management of the business and strong protection for operational processes in a period of high growth for CAREL.

"It is a great honour for me to accept this new role and to assist Francesco Nalini in the transition to the near future," Lombello said. "I hope to meet the expectations of the Board of Directors and to interpret this role in the best possible way. My goals are very clear,



Giandomenico Lombello, CAREL Group's new Managing Director.

and concern investors, customers and all CAREL employees."

Giandomenico Lombello graduated in electronic engineering from the University of Padua and, after four years' experience in the biomedical sector, joined CAREL in 1988 where he held various positions within the Group taking on posts of increasing responsibility including Sales and Marketing Director in 2008.

About CAREL

CAREL is one of the world leaders in control solutions for air-conditioning, refrigeration and heating, and systems for humidification and evaporative cooling. Our products are designed to bring energy savings and reduce the environmental impact of equipment and systems. Our solutions are used in commercial, industrial and residential applications. CAREL has 22 fully owned subsidiaries and seven production sites, as well as partners and distributors in a further 75 countries.

For more information, visit www.carel.com

ASHRAE Announces Certified HVAC Designer Launch

ASHRAE announced that applications for the new Certified HVAC Designer (CHD) certification are now open. World-wide computer-based testing opens June 3.

"For a long time, the certification committee had suspected an HVAC Designer certification would serve the needs of members, but the 'Industry Needs' survey data emphasized just how much need and demand there are," said Mark Fly, P.E., chair of the exam subcommittee. "Launching a new certification program is a commitment, but we're confident this is an investment from which ASHRAE members and their employees will benefit." The CHD exam blueprint and eligibility requirements, which have been approved by the ASHRAE Certification Committee, can be found in the CHD Candidate Guidebook.

The Certified HVAC Designer (CHD) certification validates competency of the HVAC Designer, *working under the responsible charge of an engineer,* to design HVAC systems to meet building/project requirements, including:

- Load calculations
- Equipment selection and sizing
- Mechanical equipment room design
- Duct and piping design
- Layout for the development of HVAC plans for permit and construction

The exam follows a 2018 industry-wide job analysis study with data that was gathered from more than 1,200 respondents from over 60 countries. The CHD application is currently open with a practice exam launching May 1.

For more information, visit ashrae.org/chd.

About ASHRAE

Founded in 1894, ASHRAE is a global leader in the advancement of human well-being through sustainable technology for the built environment. As an industry leader in research, standards writing, publishing, certification and continuing education, ASHRAE and its members are committed to shaping tomorrow's built environment today through strategic partnerships with organizations in the HVAC&R community and across related industries. For more information and to stay up-to-date on ASHRAE, visit ashrae.org

Report from Danfoss and Penn State University Explores Path to Building Resilience, Sustainability

Danfoss has published a report exploring the path to building resilience. The report, which was developed in conjunction with Pennsylvania State University's Architectural Engineering Department, explores the resilience challenge and its intersection with energy efficiency, in the context of an overarching demand for sustainability.

According to the report, the forms of the resilience challenge are potentially diverse – including climate change, disease pandemics, economic fluctuations, and terrorism. And communities, specifically urban areas that are expected to house nearly 70% of the earth's population by 2050, were not designed to handle the impacts.

Traditionally, the built environment was designed to be fail-safe. But, the report asserts that, as catastrophic events become more intense and more frequent, fail-safe is no longer possible; infrastructure instead must be designed to be safe to fail – redefining infrastructure strategy to integrate elements of sustainability and a new conception of high-performance buildings.

Properly designed buildings and effective controls can help to maintain targeted building temperatures indefinitely – or for a very substantial period – despite protracted power outages. And digitalization linked to heating and cooling will be critical to optimize building energy consumption. Scott Foster, Director of the Sustainable Energy Division of the United Nations Economic Commission for Europe, wrote in the report's preface: "Resilience has now become integral to life quality within the built environment and is consequently an important element in the overall sustainable energy equation. It will be impossible to meet our global carbon goals, or the targets of the 2030 Agenda, without successfully addressing the resilience challenge, which is in its essence a dimension of the global sustainability crisis that now defines the international action agenda."

Prioritizing and meeting the complex resilience challenge will require engagement from a variety of stakeholders, including local and national governments, which need to adopt

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policies to develop long-term climate and energy plans. Dr. Sez Atamturktur, Dr. James Freihaut, and Dr. Gregory Pavlak of Penn State University's Architectural Engineering Department contributed to the report. The report is available at: http://bit.ly/DanfossBuildingResilience

Johnson Controls Technology Initiative To Introduce Open-source Software for Building Retrofits

Johnson Controls has entered into an agreement with CBRE, World Resources Institute (WRI) and Lawrence Berkeley National Laboratory (Berkeley Lab) to test and deploy an open-source, web-based energy analysis tool to identify energy efficient retrofit opportunities in commercial buildings.

The initiative is part of the Johnson Controls and CBRE Innovation Lab, which was established three years ago to evaluate, connect and leverage products, services and energy data to create value for occupiers and investors of real estate. The initiative also supports the Building Efficiency Accelerator, a public-private collaboration that accelerates local government implementation of building efficiency policies and programs where Johnson Controls serves the role of co-convener along with the World Resources Institute.

Johnson Controls developed the LEAN energy analysis technology over the past eight years and has used the tool to analyze retrofit opportunities in over 700 buildings. Berkelev Lab is working with Johnson Controls to automate and improve the LEAN energy analysis tool and create an open-source version of the tool for public use. CBRE will be an initial deployment partner, using the tool to help their enterprise customers target costeffective energy efficiency retrofit opportunities across their real estate portfolios. WRI will use the open-source tool to help local governments around the world target the best opportunities for retrofitting public and private buildings within their jurisdictions.

"This is a big step forward in providing commercial, institutional and government building owners and managers with opensource, easy-to-use tools to target building efficiency improvement opportunities," said Clay Nesler, Vice President, Global Sustainability and Regulatory Affairs, Johnson Controls. "We believe this initiative will help drive greater investment in energy efficiency by turning readily available, monthly building energy consumption data into specific, costeffective recommendations for improvement."

An alpha version of the open-source LEAN energy analysis tool is available on GitHub at https://github.com/LBNL-JCI-ICF/better.

About Johnson Controls Building Technologies & Solutions

Johnson Controls Building Technologies & Solutions is making the world safer, smarter and more sustainable - one building at a time. Our technology portfolio integrates every aspect of a building - whether security systems, energy management, fire protection or HVACR - to ensure that we exceed customer expectations at all times. We operate in more than 150 countries through our unmatched network of branches and distribution channels, helping building owners, operators, engineers and contractors enhance the full lifecycle of any facility. Our arsenal of brands includes some of the most trusted names in the industry, such as Tyco[®], YORK[®], Metasys[®], Ruskin[®], Titus[®], Frick[®], PENN[®], Sabroe[®], Simplex[®] and Grinnell®. For more information, visit www.johnsoncontrols.com.

About CBRE Group, Inc.

CBRE Group, Inc. (NYSE:CBRE), a Fortune 500 and S&P 500 company headquartered in Los Angeles, is the world's largest commercial real estate services and investment firm (based on 2017 revenue). The company has more than 80,000 employees (excluding affiliates), and serves real estate investors and occupiers through approximately 450 offices (excluding affiliates) worldwide. CBRE offers a broad range of integrated services, including facilities, transaction and project management; property management; investment management; appraisal and valuation; property leasing; strategic consulting; property sales; mortgage services and development services. For more information, visit www.cbre.com.

About Lawrence Berkeley National Laboratory

Lawrence Berkeley National Laboratory addresses the world's most urgent scientific challenges by advancing sustainable energy, protecting human health, creating new materials, and revealing the origin and fate of the universe. Founded in 1931, Berkeley Lab's scientific expertise has been recognized with 13 Nobel Prizes. The University of California manages Berkeley Lab for the U.S. Department of Energy's Office of Science. For more information, visit www.lbl.gov.

About World Resources Institute

WRI is a global research organization that spans more than 50 countries, with offices in Brazil, China, Europe, Ethiopia, India, Indonesia, Mexico, the United States and more. Our more than 700 experts and staff work closely with leaders to turn big ideas into action at the nexus of environment, economic opportunity and human well-being. For more information, visit www.wri.org.

Daikin Expands Modular Comfort Systems' Territory in New York

Daikin North America LLC and Daikin Applied (Daikin) have enhanced their relationship with Modular Comfort Systems, expanding its sales territory in Central and Western New York State, including Buffalo and the seven surrounding counties.

"Modular Comfort Systems has the expertise essential to grow Daikin's leadership in this market, as they've proven over our 50 year relationship," said Kirk Thorne, Executive Vice President, Sales, Marketing and Aftermarket at Daikin Applied. "We have a long-term commitment to continued growth in North America and expanding our global leadership. Modular Comfort Systems' leadership in VRV and applied sales will strengthen that position. All of us here at Daikin are proud of this latest achievement," said Takayuki (Taka) Inoue, Executive Vice President and President, Daikin Business Unit at Daikin North America LLC.

Modular Comfort Systems Principal Drew Reagan cited the depth of Daikin's portfolio as critical to their success. "Daikin's industry leading equipment technology allows us to execute innovative system design, project order accuracy, and exceptional post sale support at a very high level. Streamlining representation from Central to Western New York will strengthen the Daikin brand name and create a synergy between markets," he said. Daikin has established a dedicated service district to support customers across the state, including Albany, Syracuse, Rochester and Buffalo. Daikin plans to add additional resources in both Rochester and Albany in future months.

About Modular Comfort Systems

Modular Comfort Systems, Inc. is a leading sales engineering firm serving the unique commercial, industrial, and institutional HVAC needs of Upstate New York. The company was founded in 1969 on the principle that customer service and support are paramount in the HVAC industry. Our sales engineers work diligently to develop the perfect HVAC solution for any project. Modular Mechanical Service specialize in solutions from installation and start up to maintenance, with our aftermarket group offering a complete inventory parts to support any system. Together we form an unbeatable package of professionals seeking to ensure every HVAC need is met, time and time again. Learn more at https://www.mcsmms.com.

About Daikin

Daikin Industries, Ltd. (DIL) is a Fortune 1000 company with more than 70,000 employees worldwide, and is the world's No. 1 air conditioning company. Daikin North America LLC (DNA) and Daikin Applied (DAA) are both subsidiaries of DIL. DNA, DAA and their affiliates manufacture heating and cooling systems for residential, commercial and industrial use and are sold via a select group of independent HVAC contractors. DIL manufacturing operations include facilities at Houston, Texas; Fayetteville, Tennessee; Faribault and Owatonna, Minnesota; and Verona, Virginia. For additional information, visit www.northamerica-daikin.com.

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