

CHILLER & COOLING BEST PRACTICES

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August 2019

WATER TREATMENT & COOLING SYSTEM ASSESSMENTS

10 Water Treatment Solution Lets
Mother Nature Do the Work

26 The Need for KPIs in Actionable
Energy Monitoring Systems

COOLING TOWERS & CHILLERS

16 Busting Four Myths About
Absorption Cooling

22 Continuous Refrigerant
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WATER TREATMENT & COOLING SYSTEM ASSESSMENTS

10 Water Treatment Solution Lets Mother Nature Do the Work

By Mike Grennier, Chiller & Cooling Best Practices Magazine

26 The Need for KPIs and Production Data in Actionable Energy Monitoring Systems

By Staffan Akerstrom and Paul Tate, Empowered Solutions



COOLING TOWERS & CHILLERS

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FROM THE EDITOR



I had the opportunity to participate in a 2-day compressed air audit recently. The centrifugal air compressors were water-cooled, supported by cooling towers. The cooling towers had always struggled to keep temperatures where they needed to be so chillers had been added to help them. What was really interesting was this plant had cancelled their chemical water treatment program, two years prior, replacing it with moss.

This sphagnum moss was in what looked like a crab-cage and management said they couldn't be more pleased with performance. So, I began asking questions about the companies behind this innovative solution and came into contact with both Dr. David Knighton (Creative Water Solutions) and with Steve Chewing (Southeastern Laboratories). I hope you enjoy Mike Grennier's interview article with them and am thrilled to announce they will both be speaking at our conference in October.

I've enjoyed learning more about the YORK strategies at Johnson Controls. Rajesh Dixit provides us with an excellent article titled, "Busting Four Myths About Absorption Cooling."

Efficiency conversations get really interesting (and complex) when comparing electric driven technologies to alternative power sources like waste heat, natural gas and steam.

Shelli Cosmides, from Bacharach, has sent us a very interesting article about refrigerant monitoring. It's an application story about an Xcel Energy district cooling application covering 16 chillers in different Denver buildings. Refrigerant monitoring has provided the Thermal Energy team there many, many benefits.

Monitoring energy use is always the first step to taking actions to improve performance. Knowing the right Key Performance Indicators (KPI's) to create and prioritize, from this data, isn't always as simple as it might sound. Staffan Akerstrom and Paul Tate, from EnPowered Solutions, have sent us an excellent article on this topic.

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

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RESOURCES FOR ENERGY ENGINEERS

INDUSTRIAL COOLING SYSTEM TECHNOLOGY NEWS

Johnson Controls Widens Range of Quantech™ Air-Cooled Scroll Chillers

Johnson Controls has expanded its line of Quantech™ QTC3 Air-Cooled Scroll Chillers with two models that offer a smaller footprint and increased efficiency. With the introduction of Quantech models 40T and 50T, the new product range is expanded from 40 to 230 tons, and is part of the stock program available for quick shipment.

“This is an exciting step for Quantech to offer customers smaller units, that continue to deliver a high level of efficiency within a compact footprint,” said Curtis Rager, Product Portfolio Manager North America Johnson Controls. “These scroll chillers are completely self-contained for easy installation, making them ideal for both retrofits and new construction where limited space is available.”

The 40T and 50T models are outfitted with brazed plate evaporators and microchannel condensers allowing for more efficient heat transfer to help reduce total cost of ownership. The QTC3 scroll compressors include two independent circuits for partial redundancy.

The environmental design of the QTC3 includes zero-ODP HFC-410A refrigerant and up to 50% less refrigerant charge. Units include full-load and part-load efficiencies that meet or exceed ASHRAE standards. The unit also contains native building automation system (BAS) communications, including BACnet®, Modbus and N2.

Made-to-order options including variable speed drive condenser fans and integral pump packages that offer a single purchase, shipment and install solution are also available with these new units. For more information visit, www.quantech-hvac.com.

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, please visit 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.



Johnson Controls Quantech™ QTC3 Air-Cooled Scroll Chillers expand to offer a smaller footprint and increased efficiency.

RESOURCES FOR ENERGY ENGINEERS

INDUSTRIAL COOLING SYSTEM TECHNOLOGY NEWS

Baltimore Aircoil Company Announces Nexus™ Modular Hybrid Cooler

Baltimore Aircoil Company (BAC) is proud to introduce the Nexus™ Modular Hybrid Cooler, the world's first intelligent, plug-and-play, modular, hybrid fluid cooling system. The Nexus is engineered to simplify system design and optimize water and energy savings, while providing the lowest installation, operating, and maintenance costs.

The Nexus Modular Hybrid Cooler simplifies both the design and installation of fluid cooling systems. The units are up to 8 feet shorter in height, have a 40 percent smaller footprint and are 35 percent lighter than traditional fluid coolers. Modules are designed to be moved with a pallet jack and fit in a freight elevator – eliminating the need for special rigging equipment. Structural steel requirements can be reduced by up to 50 percent, and permanent ladders or elevated platforms can be eliminated. All fans, pumps, accessories and controls are factory installed, and wired, for true single-point wiring.



Baltimore Aircoil Company has introduced the Nexus™ Modular Hybrid Cooler

BAC's patented hCore™ Heat Transfer Technology delivers exceptional heat transfer performance, durability, and longevity in a compact, corrosion-resistant package that has 65 percent less internal fluid volume and requires no passivation. The Nexus Cooler's new, patent-pending DiamondClear™ design uses 60 percent less spray water volume than traditional systems, has turbulent spray water flow, and the spray water basin can be inspected while in operation. BAC's innovative iPilot™ Control System with patent-pending, embedded intelligence minimizes operating cost by effectively balancing water and energy savings based on customer needs and preferences. The EC Fan System provides superior efficiency as well as high external static capability, with a direct-drive radial fan and a variable-speed electrically commutated (EC) motor. It completely eliminates maintenance associated with traditional fan drive systems and delivers superior reliability.

The Nexus Modular Hybrid Cooler has the highest uptime and reliability. As standard, it is a passivation-free unit with premium non-corrosive materials to keep you up-and-running at the most critical times. Code compliance is also very important for our customers so a non-combustible option that meets the most stringent fire codes will now be available.

"This product highlights our leadership position in innovation, as we have created the world's first truly smart hybrid cooling solution, with the ability to switch between evaporative and dry cooling in a modular compact footprint," said Don Fetzer, BAC President.

With over 80 years of industry-leading innovation and experience, BAC creates cutting-edge cooling equipment for the HVAC, Industrial, and Refrigeration marketplaces. We solve customers' unique needs with our expertise and wide range of high-performance systems. BAC leverages the power of evaporative cooling by optimizing the balance of water and energy, but the true BAC difference lies in our absolute commitment to creating sustainable solutions and delivering value to our customers.

For more information about Baltimore Aircoil Company, visit www.BaltimoreAircoil.com, tel: 410.799.6200, email: info@BaltimoreAircoil.com

INDUSTRIAL COOLING SYSTEM TECHNOLOGY NEWS

Chase Cooling Systems Releases New Brewery-Specific Chiller Package

Chase Cooling Systems is proud to introduce a new chiller package, specifically configured to work with brewery applications. The plug-and-play design comes pre-assembled with all necessary adjustments already made. The package is ready for installation & startup as soon as it's delivered.

The brewery specific package contains a chiller from the QBE series. The units have cooling capacities up to 4 tons when producing the glycol temperatures required for brewing processes. Arrangements can be made to accommodate larger needs as well. The package includes a standardized pump, compressor, and temperature control adjustments. These arrangements meet the typical needs of most breweries. Should a customer require further customization, Chase Cooling Systems does have options for non-standard set-ups.



An optional stainless-steel cabinet is available on QBE series chillers.

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INDUSTRIAL COOLING SYSTEM TECHNOLOGY NEWS

Multi-refrigerant Danfoss DSH Scrolls Give OEMs Low-GWP Flexibility

Danfoss has qualified its range of DSH scroll compressors for use with R454B and R452B refrigerants, giving OEMs “ultimate flexibility” when offering alternatives to R410A.

Already a popular option for commercial chillers and rooftop systems using R410A, with Intermediate Discharge Valve (IDV) technology to enhance seasonal part-load cooling efficiency, the DSH scroll compressors now support R454B and R452B refrigerants. The option to use new, lower-GWP refrigerants was prompted by the EU’s ongoing phase-down of high GWP refrigerants, limiting availability and increasing the price of R410A.

Meanwhile, in countries where refrigerant GWP is already taxed, switching to R454B or R452B will provide savings on the tax value up to 78% and 67% respectively.

The compressors’ multi-refrigerant compatibility, along with similar drop-in performance versus R410A, is designed to make refrigerant transition as easy as possible for OEMs without the need to make radical system alterations, thus accelerating time to market, both for cooling and reversible systems altogether.

The changes also enable OEMs to make late line customizations and reduce stock inventories, which increases overall flexibility and ease of stock management.

Mathieu Stoll, Director of A/C Marketing at Danfoss Cooling, said: “Around the world, refrigerant transition is happening at different speeds. By using Danfoss DSH scroll compressors with IDVs, OEMs can now respond to market changes more easily – whether that’s new efficiency requirements or the GWP phase

The compact layout of the chiller package saves users space for tight-setups, yet still provides easy access to important maintenance components. The non-ferrous fluid circuit is guaranteed not to rust and can accommodate glycol concentrations up to 50%. An optional stainless-steel cabinet, in lieu of the standard powder-coated galvanized steel cabinet, is available on QBE series chillers. The stainless-steel cabinet provides enhanced corrosion protection and cohesion with other common brewery equipment.

All brewery packages include components that have been doubly tested by highly knowledgeable staff. The testing process ensures that all equipment is ready for immediate startup upon arriving at the customer’s final destination.

**About Chase Cooling Systems**

Chase Cooling Systems provides quality industrial chiller equipment for nearly all process cooling needs. Products are available to serve a variety of applications & industries. Process chillers range in cooling capacity from 0.5 ton to over 300 tons. With both packaged process chillers and individual cooling accessories, Chase Cooling Systems has the unique ability to service every component in a cooling system. Experienced cooling experts see to the safe development and implementation of our chillers and equipment across the United States.

Additional information on Chase Cooling Systems can be found at their website www.chasechillers.com

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INDUSTRIAL COOLING SYSTEM TECHNOLOGY NEWS

down. That's ultimate flexibility. And with a GWP level of 466, R454B in particular can be viewed as a potential long-term solution."

Benefits of the new, enhanced compressor range include:

- Drop-in multi-refrigerant support for R454B and R452B, offering late line customization and reduced inventory with minimal redesign effort,
- Danfoss IDV technology to enable higher part-load efficiency,
- 10 models from 7.5 to 40 TR and a wide range of manifold options,
- Operating maps to fit a wide range of applications, both reversible and cooling only, including chillers and rooftop units.

R454B and R452B refrigerants are classified as A2L (mildly flammable) and are regulated under EN378 and IEC60335-2-40. OEMs therefore need to take the appropriate compliance measures in certain applications.

For more information – and to see other line components ready for refrigerant transition – visit www.airconditioning.danfoss.com or www.Coolselector.danfoss.com.

About Danfoss

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



Multi-refrigerant Danfoss scrolls with IDVs DSH qualified for R454B, R452B and R410A refrigerants.

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Water Treatment Solution Lets MOTHER NATURE DO THE WORK

By Mike Grennier, Chiller & Cooling Best Practices Magazine

ProMoss™ is a plant-based water treatment solution harvested and sold by Creative Water Solutions (CWS), Plymouth, Minnesota.

► Ongoing water treatment is part of every company's effort to ensure its industrial chiller and cooling systems run efficiently and reliably – and importantly – help protect the environment.

While most rely on chemicals for water treatment, others are finding success in what can be accurately and fairly described as a green solution because it takes the form of a moss. More precisely, this plant-based

alternative to chemical water treatment leverages the properties of sphagnum moss, and it's being harvested, processed and sold as ProMoss™ to companies throughout North America by Creative Water Solutions (CWS), Plymouth, Minnesota.

Chiller & Cooling Best Practices interviewed Dr. David Knighton, Co-founder and Co-owner of CWS to gain insight into the technology.

Good morning! How did you first learn about sphagnum moss?

I'm a retired vascular surgeon, and I've always been interested in science and new medical discoveries. I was traveling and read an interesting article about sphagnum moss used in World War I to successfully treat wounds. The same moss had been used long before by the Vikings to preserve water and food on their voyages. The moss also naturally purifies water where it grows in bogs.

"I was traveling and read an interesting article about sphagnum moss used in World War I to successfully treat wounds. The same moss had been used long before by the Vikings to preserve water and food on their voyages."

— Dr. David Knighton, Co-founder and Co-owner of Creative Water Solutions



I began to hypothesize whether the moss could be of further use in medicine or other applications. I then decided to take it to another level and my business partner, Vance Fiegel, and I began studying it. We eventually came to the conclusion the natural properties of the moss could be used to improve water quality in various applications. I even tested it on my hot tub. Within a week of putting it in the tub it made the spa water perfect. That really got me thinking.

Our research led to the launch of Creative Water Solutions in 2004. Initially, we geared ProMoss for home spas and swimming pools, and then we began selling it for use in commercial swimming pools and spas. We later we found it to be very successful for industrial boiler and cooling tower treatment

programs. It's used widely today in all of these applications.

What exactly is sphagnum moss and where does it come from?

It's a plant that grows naturally in bogs in New Zealand and along the U.S.-Canada border where there are huge major amounts of the right species of this particular moss.

We acquire the moss from these areas and we also operate our own moss processing facility in Northern Minnesota. We harvest it by hand to protect the bog from any damage. Once the moss is picked, we airlift it out by helicopter and transport it to our process facility by truck.

To further protect the bogs and the quality of the water where it grows, we only pick the top



Dr. David Knighton, Co-founder and Co-owner of Creative Water Solutions.



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half of the plant and leave the bottom half in place. The bogs regrow in five to seven years.

Describe the process for turning the moss into a commercial product.

The leaves of the moss are dried out at our facility and processed into the final product. The leaves, which contain the unique biological properties that make ProMoss a sustainable water treatment solution, undergo medical-grade sterilization before they are shipped so it doesn't introduce a non-invasive species anywhere it's used.

The product is also safe to dispose in landfills, and we even encourage users to be creative and use it as mulch when they're through with it.

Tell us more about these biological properties that make it work.

Sphagnum moss removes a percentage of positively charged metal ions, which are called cations, in the process water. These cations include magnesium, calcium and iron. In addition to absorbing cations, it also releases hydrogen ions in the exchange process.

It also contains slow-release biochemicals called sphagnans that clarify the water by flocculation. In addition, the sphagnans inhibit and remove organic contamination, which is vital to reducing biofouling. For example, a cooling tower might have a high turbidity level, which

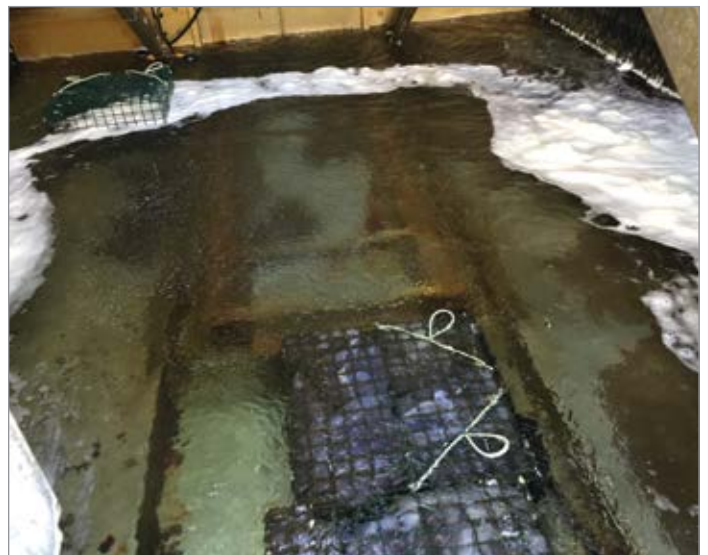
means you can't see through the water. But it's not unusual to see crystal clear process water in the same cooling tower within a week after using the moss.

Why is it important to remove a certain amount of positively charge ions in process water?

Hardness, alkalinity, and/or pH create scaling, which limits the amount of process water that can be recycled in evaporative systems. This also causes problems in other types of systems. ProMoss lowers the scaling potential by lowering the hardness and alkalinity and pH levels in the water.

This is particularly important in an open cooling tower, which uses evaporation as part of the heat-removal process. The process leaves behind minerals, which are the dissolved solids that create scaling. The dissolved solids increase in concentration over time, requiring blow-down when the concentration gets too high. Blow-down, of course, is when the concentrated water is drained off and diluted with fresh makeup water to prevent scaling.

The moss minimizes the amount of dissolved solids available to form scale. Users can increase the Cycles of Concentration limit on their cooling tower, which means they don't need to drain any sooner than necessary. The result is less water consumption and reduced sewer treatment costs.



Serving as a source of slow-release biochemicals, ProMoss acts as a potent water clarifier. Shown is a cooling tower basin before being treated with moss and the same basin two weeks after treatment (left to right).

A Comprehensive Approach to Water Treatment

CWS has steadily grown its network of water treatment companies trained in the application of ProMoss for commercial and industrial use. One company that has worked with CWS since the introduction of the product is Southeastern Laboratories, Inc. (SEL). The firm is a leading regional water treatment company with its corporate office, laboratory and production facilities in Goldsboro, North Carolina.

According to SEL Vice President of Field Operations Steve Chewning, the goal of SEL as with any other professional water treatment company, is to not only treat water, but also conserve it.

“Let’s say you have a cooling tower and your process water is prone to scaling,” Chewning said. “One strategy to prevent scaling is to use fewer chemicals or moss and just blow down water. Some would think that’s a great strategy because it might address the scaling issue, but there’s still a major problem: It wastes a ton of water.”

The better approach, said Chewning, is to take a comprehensive approach to ensure an effective water treatment program.

“A properly applied water treatment program will prevent problems with things like scaling and corrosion in order to maintain system efficiency – and get the job done with the least amount of water loss possible,” he said.

Chewning said no two water treatment programs are alike because of requirements unique to each facility. The first step in recommending a water treatment program

using sphagnum moss, chemicals, or a combination of both involves a system assessment.

The assessment takes a number of variables into consideration, including the type of system, i.e., an open evaporative cooling tower, or a closed-loop system. It also factors in the characteristics of the water, namely its ionic content. Another variable examined is the mechanical hydraulics (or flow) and process water temperatures. The assessment of an open cooling system also considers the amount of exposure to contaminants.

“We take into account all these factors and weigh the strengths and weaknesses of chemicals or sphagnum moss and decide on the best approach,” Chewning said.

“For example, moss is an excellent choice for removing existing organic contamination in a cooling tower, whereas chemicals would be a better choice to inhibit corrosion in a closed system.”

Chewning said the right water treatment program is driven by the experience, technical expertise, and services of the company offering water treatment services. He said SEL emphasizes the importance of professionals earning and maintaining a Certified Water Technologist (CWT) certification through the Association of Water Technologies (www.awt.org).

“Nearly all of our service specialists have earned the CWT distinction,” Chewning said. “We think of ourselves as water consultants because there’s so much that goes into it, including energy and water conservation.”



Steve Chewning, Vice President of Field Operations, Southeastern Laboratories, Inc.

As far as experience, SEL has provided water treatment services and products to a wide range of industrial, commercial, governmental, and institutional users since 1973. SEL’s engineers also average 20-plus years of experience.

Chewning has also been in the industry for several decades. He said sphagnum moss represents one of the industry’s most exciting technological developments in recent years.

“The advancements we’ve seen over the years are nearly always associated with devices designed to replace chemical treatment,” Chewning said. “However, they haven’t always worked. With ProMoss we’ve seen the results – and based on actual experience, it’s no wonder it’s gaining momentum.”

For more information visit www.selaboratories.com.

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**JAN
24**

Proper Installation & Sizing of VSD Air Compressors

Presenter Ross Orr, Systems Engineer, Compressor Energy Services

January 24, 2019 – 2:00PM EST

**FEB
28**

Visualizing KPI's: Specific Power, Flow, Pressure, Dewpoint

Presenter Ron Marshall, Chief Auditor, Marshall Compressed Air Consulting

February 28th, 2019 – 2:00PM EST

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**MAR
14**

How to Design a Centralized Vacuum System

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

March 14th, 2019 – 2:00PM EST

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**APR
04**

Safety and Quality in Compressed Air: Why You Should Care

Presenter Loran Circle, Senior Consultant, Circle Training & Consulting

April 4th, 2019 – 2:00PM EST

Sponsored by BEKO Technologies and Trace Analytics

**APR
25**

Techniques for Determining Savings from Aeration Blowers

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

April 25th, 2019 – 2:00PM EST

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**MAY
16**

Selecting & Sizing Heat of Compression Desiccant Dryers

Presenter Hank van Ormer, Technical Director, Air Power USA

May 16th, 2019 – 2:00PM EST

Sponsored by Henderson Engineering Company

**JUN
06**

Selecting & Sizing Oil-Free Air Compressors

Presenter Tom Taranto, Owner, Data Power Services

June 6th, 2019 – 2:00PM EST

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**JUN
27**

Understanding Flow for Proper Vacuum Pump Sizing

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

June 27th, 2019 – 2:00PM EST

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**JUL
18**

Control Strategies for Multiple VFD Air Compressors

Presenter Ron Marshall, Chief Auditor, Marshall Compressed Air Consulting

July 18th, 2019 – 2:00PM EST

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**AUG
22**

Piping and Storage for Compressed Air Systems

Presenter Tom Taranto, Owner, Data Power Services

August 22th, 2019 – 2:00PM EST

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**DEC
12**

Air Compressor Lubrication & Maintenance

Presenter Loran Circle, Senior Consultant, Circle Training & Consulting

December 12th, 2019 – 2:00PM EST

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WATER TREATMENT SOLUTION LETS MOTHER NATURE DO THE WORK

Additional Energy Costs Per Year Due to Bio Fouling				
Tons of Chiller Capacity	Bio Film Thickness (mm)			
	0.2	0.3	0.6	0.9
300	\$ 7,906	\$ 15,811	\$ 35,575	\$ 53,363
500	\$ 13,176	\$ 26,352	\$ 59,292	\$ 88,938
900	\$ 23,717	\$ 47,434	\$ 106,726	\$ 160,088
1200	\$ 31,622	\$ 63,245	\$ 142,301	\$ 213,451
2000	\$ 52,704	\$ 105,408	\$ 237,168	\$ 355,752

The cost of energy for water-cooled chillers increases due to the formation of biofilm in process water.

How does sphagnum moss reduce biofouling?

First, it's important to know approximately 90% of the problems we encounter with cooling water systems are associated with organic contamination that creates biofouling.

In every type of cooling water system, such as a cooling tower, chiller, or the tubes of a heat exchanger, the process water forms a thin layer of organic contamination. This organic contamination is very insulating. It's actually about four times more insulating than mineral scales. Suffice it to say, it's very heat-transfer resistant. Low heat transfer co-efficiency, in turn, increases the amount of energy needed to cool the process water.

Biofouling also causes corrosion because anaerobic bacteria on the surface of the metal are shielded from oxygen and continue to grow if left untreated, which can increase daily operating costs and decrease the life of equipment. Sphagnum moss is very effective at keeping systems cleaner and free of biofouling resulting from organic contamination.

How do you determine the amount of moss to use in a particular system?

What amazes me is how nature has engineered the perfect device over thousands of years

for slowly dispensing of the sphagnum moss biochemicals.

To answer your question, we've developed some general guidelines based on extensive research and testing based on a variety of factors associated with cooling water systems, including the type of application, different types of problems to address and different water conditions.

Our general guideline for a cooling tower, for example, calls for a dosage of between 50 to 100 grams of product to treat 1,000 gallons of water for one month. The amount of product will vary based on the factors I've described. A cooling tower might only require 50 grams/1,000 gallons, or it could require as much as 200 grams/1,000 gallons, especially where there is a lot of opportunity for accumulation of organic contamination such as in a textile mill or agricultural processing application.

The total dosage, of course, is based on the total amount of water being treated. More water requires more of the product. It also calls for ongoing measurement and

monitoring as with any treatment program, which is why metering is so important. Meters are inexpensive and I have to wonder why they're not used more often given the growing importance of measuring water usage.

How long does the product work once it's been put to use?

The moss is placed in a contact chamber to allow the water to contact the moss leaves and to release their sphagnans. After years of research and applying ProMoss in industrial applications, we've found it to be consistently effective for a one-month period before the biochemical properties are depleted.

In general, the old moss is replaced with the same dosage of new moss after about one month. As long as the product is applied with the right dosage and the conditions of the cooling system remain unchanged, it just works.

Some might say this all seems too good to be true as far as sustainability. Is there a catch?

There is no catch. We all know the amazing things nature can do. What we've done is figured how to take nature's chemistry and put it to use as a viable green solution for water treatment programs.

Thank you for providing these insights. BP

For more information about ProMoss, visit www.cwsnaturally.com. For more about the use of moss or chemicals in water treatment programs, contact Southeastern Laboratories, Inc. Vice President of Field Operations Steve Chewning, tel: 919 271-7204 email, s_chewning@selaboratories.com, or visit www.selaboratories.com.

All photos courtesy of Creative Water Solutions.

To read similar [Water Saving System Assessment](http://www.coolingbestpractices.com/system-assessments/water-savings) articles, visit www.coolingbestpractices.com/system-assessments/water-savings

Busting Four Myths About ABSORPTION COOLING

By Rajesh Dixit, Johnson Controls

► Absorption chillers have been around for more than 75 years, with several thousand chillers operating successfully all over the world today. Yet myths about cost, operation and performance surround this technology, particularly in North America. Look beyond the myths and you'll discover absorption cooling technology can be efficient, cost-effective, flexible and reliable.

Myth 1: Absorption Chillers are Inefficient

The facts say otherwise. In the right applications, these chillers can be more cost-effective.

The coefficient of performance (COP) for an electric chiller is typically 6 to 6.5; for an absorption chiller, it can range from 0.7 to 1.4. Some people automatically rule out absorption chillers because of this huge difference –

but it's not an apples-to-apples comparison because:

- COP is calculated differently for the two chiller types: An electric chiller is driven by electricity purchased from the grid, while an absorption chiller is driven by available waste heat or low-cost natural gas.



“Absorption chillers may be the most cost-effective option considering utility costs and the availability of waste heat. Even without waste heat, absorption chillers can use low-cost natural gas as an energy source.”

— Rajesh Dixit, Johnson Controls

- ✦ The electric chiller's COP does not account for losses of 60 to 70 percent in electricity generation, transmission and distribution process.

In short, COP alone is not a sufficient basis for comparison. For example, let's use the typical chiller COP values:

- ✦ Electric centrifugal chiller: 6.50
- ✦ Direct natural gas-fired absorption chiller: 1.20
- ✦ Double-effect steam absorption chiller: 1.40
- ✦ Single-effect steam absorption chiller: 0.70



A YORK® double-effect, direct fired absorption chiller.



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BUSTING FOUR MYTHS ABOUT ABSORPTION COOLING

And looking at typical operating costs based on cents/ton-hours assuming that natural gas is \$5/MMBTU, electricity is \$0.15/kWh, and steam is \$4 per 1,000 lb.:

- Electric centrifugal chiller: 8.12
- Direct natural gas-fired absorption chiller: 5.00
- Double-effect steam absorption chiller: 3.43
- Single-effect steam absorption chiller: 6.86

It turns out the chiller with the highest COP – the electric chiller – does not necessarily yield the lowest operational cost. The direct gas-fired absorption chiller and the two-stage steam chiller are more appropriate choices.

Of course, utility costs vary and, in many cases, an electric chiller makes more sense. The point is that it's worth considering absorption chillers, especially if electricity costs are high or rising, demand charges are in effect, or natural gas and waste heat costs are low. For example, here are a couple of applications where an absorption chiller makes sense:

- A commercial building in New York City where the absorption chiller runs from 8 a.m. to 8 p.m., Monday through Friday, April to September.
- A hybrid application where the absorption chiller runs during the day and the electric centrifugal chiller runs at night.

Myth 2: Absorption Chillers are Expensive

This is not always the case. In the right applications, they can deliver the highest payback.

Absorption chillers may be the most cost-effective option considering utility costs and the availability of waste heat. Even without waste heat, absorption chillers can use low-cost natural gas as an energy source. With these factors, as well as initial capital expense and COP, you will find that absorption chillers deliver a higher payback compared to chillers driven by electricity.

Myth 3: Absorption Chillers have Rigid Operating Requirements

This myth has gone away since the flexibility of the technology has increased dramatically in recent years.

Chances are you've heard absorption chillers must always operate at the design point, closer to the full load, and that you shouldn't mess with flow rates and that the chilled water's leaving temperature must be above 44 °F (7 °C) and entering condenser water must be close to the design temperature, typically 85 °F (29.4 °C). But things have improved a lot in the last 25 years. Here's the reality:

- Water flow rate can be changed at 5% per minute, up to 50% of design over 10 minutes.
- Units can be designed with varying flow rates in a wide range.
- There's excellent turndown from 100 to 10 percent cooling load.
- Entering condenser water temperatures can be as low as 68 °F (20 °C).

Salt % in Solution	54%	57%	58%	60%	61.5%	63.5%
Crystallization Temperature	-16.1°C (3.02°F)	-3°C (26.6°F)	0.9°C (33.6°F)	10.5°C (50.9°F)	18°C (64.4°F)	26°C (78.8°F)

Table 1.

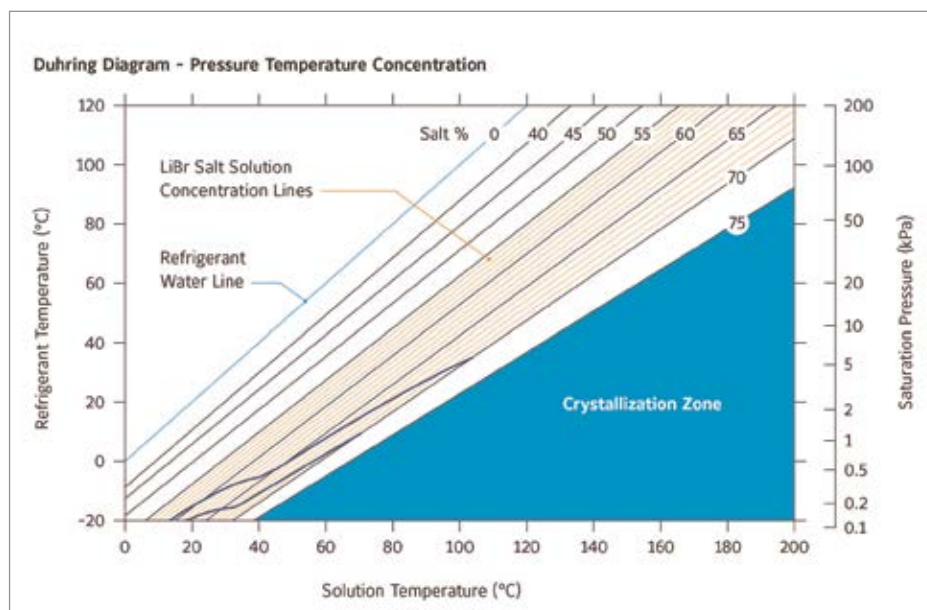


Figure 1: Duhring Diagram.

It's true absorption chillers have slower response times due to the inertia of the lithium bromide solution on highly fluctuating loads. The temperature of entering condenser water must be 68 °F (20 °C) or higher (no matter who makes the absorption chiller), while electric chillers can handle temperatures as low as 55 °F. Electric centrifugal chillers certainly respond better to fluctuating loads and they respond faster to issues such as power loss, making them a sound choice for mission-critical applications, i.e., data centers.

Even so, operating flexibility for absorption chillers has dramatically improved over the last several years. Lithium bromide water-based cycles can now achieve low leaving evaporator temperatures from 34 °F (1 °C) down to 23 °F (-5 °C), which is perfect for dairy and brewery applications.

The use of absorption chillers on passenger vessels further illustrates the technology's evolution. Absorption chillers have been successfully designed to overcome the vessel's rolling, pitching and tilting, demonstrating true operating flexibility.

Myth 4: Absorption Chillers are Not Reliable

In reality, properly designed units prevent crystallization. People considering absorption chillers are concerned about the crystallization of lithium bromide, a salt similar to table salt. When lithium bromide is fully dissolved in water, overheating or overcooling can cause it to crystallize. While chiller controls can prevent overheating/overcooling, crystallization is most commonly caused by a low entering condenser water temperature.

Suppose a chiller is working at full load and has non-condensable gases, most likely due to low corrosion inhibitor levels. The cooling tower temperature control is lost at the same

time, moving the unit toward the crystallization zone. Salt solution concentration values directly impact crystallization temperature (A 57% solution has 57% salt and 43% water, with a crystallization temperature around -3 °C, or 26.6 °F. A 60% solution has 60% salt and 40% water, with a crystallization temperature around 10.5 °C or 50.9 °F).

If the solution temperature drops below the crystallization temperature, the solution crystallizes. Just a 3% difference in salt content has a huge impact on the temperature at which crystallization occurs. Even a change of .5 to 1 percent makes a big difference.

The risk of crystallization is generally high at full, or near-full load, and significantly less at part load. The lower the salt percentage, the better – because that means the crystallization temperature is lower.

Low-entering condenser water temperature is what causes a lower solution temperature – and that principle directly affects chiller design. For example, a 57% solution has a crystallization temperature of 26.6 °F (-3 °C). That's not possible in real life because water entering from the cooling tower cannot drop to such low temperatures. However, if the same unit is designed with a high absorber entering concentration, such as 63.5%, Table 1 shows a crystallization temperature of 78.8 °F (26 °C). This temperature is entirely possible in day-to-day operation, particularly if the temperature of condenser water entering from the cooling tower into the absorber section is poorly controlled.

In the PTX diagram shown in Figure 1, which is the Dühring Diagram and the X and Y axes and slanting lines represent a combination of pressure, temperature and concentration.

The lithium bromide solution entering the absorber is the line most prone to

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BUSTING FOUR MYTHS ABOUT ABSORPTION COOLING

crystallization. This is referred to as the absorber distribution line. To the lower right is the crystallization zone. The farther the distance from the crystallization zone, the better the protection against prevention of crystallization.

To achieve maximum distance from the crystallization zone, the unit should be designed to minimize the solution concentration which is best achieved by ensuring less salt, more water. That makes the solution easier to boil; we don't need to heat it to a very high temperature. A lower temperature also means lower corrosion, increasing reliability and extending equipment life.

The combination of low pressure, low temperature and low concentration provide excellent protection against crystallization and corrosion. Don't count on sophisticated

controls to keep you out of the danger zone. The unit should be intrinsically designed so that even if the controls aren't working, the solution won't crystallize.

Let's look at an example using a single-effect absorption chiller. As shown in Figure 2, the modern unit on the left is designed with a lower-concentration salt solution entering and leaving the absorber. (Note: values are drawn from actual use.) The conventional unit on the right is designed with relatively high lithium bromide concentrations. The crystallization temperatures make it clear the unit on the left is far less likely to crystallize than the unit on the right. Less salt, more water!

Let's use another example with a double-effect chiller, which typically operates with higher pressure, temperature and concentrations than a single-effect, or single-state, chiller. As in the previous example and shown in Figure

3, the unit on the left is designed with lower concentration salt solutions, providing the best protection against crystallization. The "small" half-percent or 1% difference in salt solution makes a big difference for the conventionally designed unit on the right. Controls are important – but design makes the difference.

Absorption Technology Offers Multiple Benefits

Absorption cooling technology offers significant advantages:

- It's truly sustainable, driven by waste heat or low-cost heat, with eco-friendly water as a refrigerant.
- Maintenance is relatively minimal, primarily requiring qualified service representatives to analyze vacuum water quality on the condenser water side and the lithium bromide solution once or twice a year, depending on hours in operation.
- This technology is proven across a full range of applications: small, medium and very large; commercial, industrial and district cooling.

It's true absorption chillers tend to have a larger footprint and higher heat rejection to the cooling tower. The latter is especially important if an electric chiller is being replaced by absorption, or an absorption chiller is being added to the plant room. Equally important, ensure any service personnel working on the unit are qualified in absorption chillers. Troubleshooting differs from that for an electric chiller or boiler. Knowledgeable staff can speed the process.

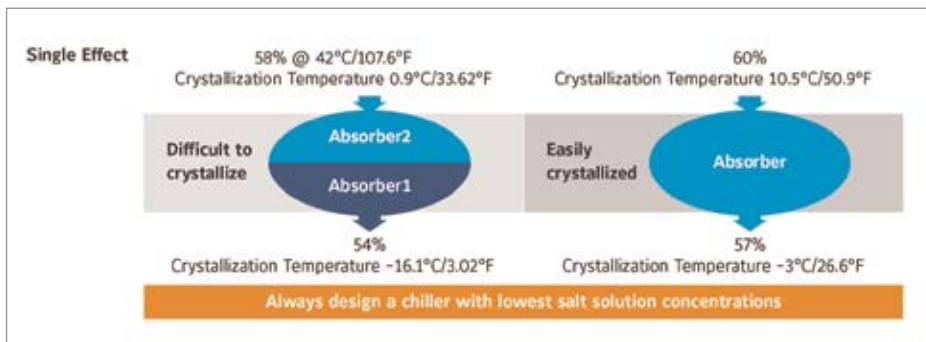


Figure 2.

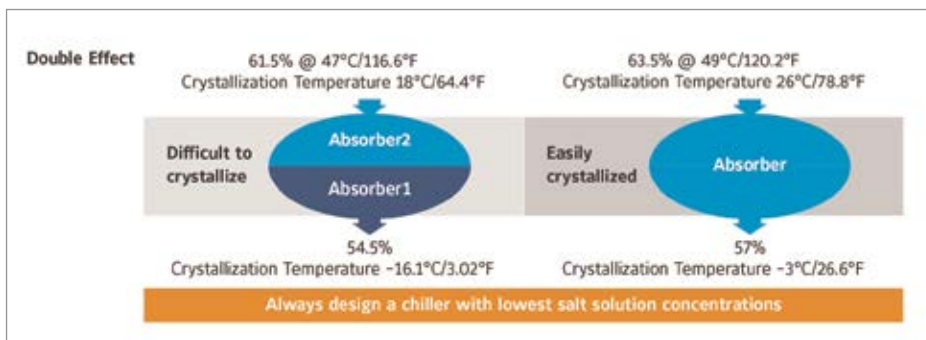


Figure 3.

Absorption chillers are common in Europe and the Asia Pacific and being seriously considered in the Middle East and Latin America. As the United States and Canada see lower natural gas costs and a greater focus on sustainability, absorption chiller use is likely to grow.

Weigh All the Factors

It's time to dispel the myths surrounding absorption chiller technology. These chillers are reliable, flexible and sustainable. They use water as the refrigerant for zero ODP/GWP, are driven by waste heat or low-cost natural gas and operate under vacuum for quiet and reliable operation. They also help reduce missions, electric and water costs. Absorption chillers also offer a quick, economic payback

where electric costs are high. The key is to look beyond academic COP and initial costs. Weigh all the factors discussed above, and you may well discover that the most efficient, cost-effective choice is indeed an absorption chiller. **BP**

About the Author

Rajesh Dixit is the Director of Global Product Management (Thermally Driven Chillers and Heat Pumps), Chiller Solutions, Building Technologies and Solutions for Johnson Controls.

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, please visit www.johnsoncontrols.com, or follow us @johnsoncontrols on Twitter.

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Continuous Refrigerant Monitoring System at EXCEL ENERGY IN DENVER DELIVERS

By Shelli Cosmides, Bacharach, Inc.

Excel Energy's Denver District Cooling Building in Denver, Colorado.

► Xcel Energy is headquartered in Minneapolis, Minnesota, and is the largest electrical energy provider in Colorado. The company recently upgraded its refrigerant monitoring systems at its Chilled Water building in downtown Denver, creating an efficient and reliable method for continuous monitoring of refrigerant used in 16 chillers in different locations – while supporting the

need for safety, system performance, and reductions in energy and refrigerant costs.

Serving Millions of Customers

In addition to Colorado, Xcel Energy also provides electricity and natural gas to eight states in the Upper Midwest and Southeast. Its thermal energy business began in 1998, but its history as an electrical power supplier

began more than 100 years ago in many of the states it serves.

The company serves more than 3.6 million electricity customers and two million natural gas customers. It is a forward-thinking energy company when it comes to providing clean power. It has set a carbon reduction goal of 80% from 2005 levels by 2030 and has



“Having reliable, continuous monitoring that we could see from a central location would allow us to dispatch a technician only when having to make an assessment or deal with a minor issue.”

— Michael O'Malley, Operations Manager at Xcel Energy's Thermal Energy Department

an aspirational goal of offering 100% carbon-free electricity to customers by 2050. Xcel Energy currently employs about 12,000 people.

Consistent Refrigerant Monitoring Needed

Refrigerant monitoring updates were needed at its downtown Denver location. The different types of refrigerant monitoring systems in use at the time offered no communications ability among plant locations in the city. The Thermal Energy team was spending time conducting constant walk-throughs of five separate buildings to check the health and functionality of 16 chillers and related mechanical equipment, including the refrigerant.

There was also inconsistent monitoring and the absence of data that could identify leaking refrigerants. This, plus the lack of consistency and reliability in the refrigerant equipment used throughout the plants, made troubleshooting difficult and finding correct spare parts from manufacturers arduous. The result was sub-optimal refrigerant use, monitoring and communications, plus inefficiencies in maintenance and repairs and potential safety issues.

To address the need for updated monitoring, Xcel Energy installed Multi-Zone Halogen Gas Monitor (HG-MZ) refrigerant monitors at its five locations to monitor the chillers. Each plant has its own HG-MZ monitors and they all communicate with the building automation system, which records levels of refrigerant readings while each plant is continually monitoring for potential refrigerant leaks. The HG-MZ units use an NDIR (Non-Dispersive Infrared) sensor that enables early refrigerant leak detection to 1 parts per million (ppm) and a pump that allows for fast sequential sampling up to 16 points.

Michael O'Malley, Operations Manager at Xcel Energy's Thermal Energy Department

in Denver, has been with the company for 10 years and has double that experience in operations management.

O'Malley and his team are responsible for a system that includes five different locations, 16 chillers and four miles of underground pipes that distribute chilled water to some of the city's most important downtown buildings, including the art museum, main branch of the city's public library, convention center, hotels, data centers, courthouses and Denver city and county buildings. In each building heat exchangers have been installed, eliminating the need for owners to provide their own equipment.

A Key Requirement: Active Sampling Refrigerant Monitoring

After evaluating refrigerant monitoring products and understanding the operation of the legacy system, O'Malley thought it important to find active sampling refrigerant monitoring equipment.

A system that used a pump for sequentially monitoring different locations would get air

through to the sensor and the possibility of increasing sampling frequency could help to prevent any serious consequences. To be proactive and quickly counteract any refrigerant leaks, O'Malley wanted to set up alarm sensitivities at levels lower than what a passive refrigerant monitor is able to detect.

"The cost of a large refrigerant leak to our organization could range from \$10,000 to \$100,000 or more, depending on the size of the leak," said O'Malley.

With different refrigerant gases, such as R22, R123, and R134a at multiple locations, it was also important the same monitoring system within the different buildings look for all these refrigerant types and that all monitors could communicate with the main plant.

Mile-high Location Calls for Technical Expertise

The implementation and installation of the first new refrigerant monitor involved a collaborative effort between Xcel Energy, Bacharach and the local manufacturer's representative.



As a reliable refrigerant monitor, Bacharach's HGM-MZ ensures Xcel Energy chillers remain in good operating condition.

CONTINUOUS REFRIGERANT MONITORING SYSTEM AT EXCEL ENERGY IN DENVER DELIVERS

A number of refrigerant monitors were installed at different Xcel Energy facilities, so there were some concerns about product reliability. O'Malley wanted to make sure the products would last a long time, be reliable and not require a lot of maintenance.

Once Xcel Energy selected the unit it wanted, the initial installation went great. Shortly after, however, the team experienced issues with filters and false alarms. Due to Denver's mile-high altitude, the diaphragms in the pump were working much harder. The issue was quickly remedied by replacing the sealed unit with a more robust rubber diaphragm that would not crack or break.

The HGM-MZ unit was installed at a remote plant, and as budgets allowed, a total of five units were eventually installed. The main monitor of the system is located at Excel Energy's main building. At the other locations, monitors are located just outside each chiller mechanical room. The networked system links the monitors back to the main facility.

"It was easy enough for us to try out the first HGM-MZ. During the implementation, we got

fantastic technical support so it was great," said O'Malley.

Advanced Sensors Support Need for Safety

The role of technology is inseparably linked to the Xcel Energy Chilled Water Plant. It remains an important safety factor to the team to have highly sensitive leak detection technology incorporated into the refrigerant monitors.

Using a technologically advanced sensor that recognizes a variety of refrigerants and a system that provides faster cycle times for all monitoring zones would provide continual sampling to detect any refrigerants that might leak into the mechanical room.

"It's important that the operations team have confidence that it's safe to go into the room – that no refrigerant leak happened in the mechanical space and that nothing is leaking into the environment. We need to keep refrigerant inside the chiller. That's important, so I'm not constantly buying refrigerant," O'Malley said.

The local representative noted Xcel Energy was not using the same gases in all the chillers and not all those gases were supported in the product they were using. This situation could be addressed by the HGM-MZ unit's extensive library of gases built into the monitor plus the accuracy of the refrigerant readings provided.

The HGM-MZ has a library of over 60 refrigerant gases, solving the refrigerant variety issues within the plant for detecting R22, R123 and R134a. Product standardization keeps maintenance easy by using the same product for spare parts and for quick replacement.

Each HGM-MZ pulls air from sample points in up to 16 zones at a distance of up to 1,200 feet. The monitor's proprietary NDIR sensor measures the presence of a target gas as an air sample is pumped through the monitor. This measurement is displayed on the instrument's digital display and can be relayed via Modbus to a connected BMS/BAS. The unit can also trigger relays for a "Low" or "High" alarm if the user-specified alarm thresholds are exceeded.

The Xcel Energy Operations Team has had a significant reduction in the frequency of the walkthroughs they need to conduct. The system also keeps refrigerant emissions at bay by achieving 1-ppm performance. It also solved the issue of needing to monitor for different refrigerants at different locations.

Finding Refrigerant Leaks Early

Reducing lost refrigerant, cutting technician travel time for repair work and having the right system to do the job were important from a cost and environmental perspective.

"It's critical we find refrigerant leaks early. Most importantly, we are concerned with the negative effects on the environment. I don't want refrigerants getting into the atmosphere,"



Shown is a charcoal filter and detection point beside the HGM-MZ refrigerant monitor.

O'Malley said. "The second concern is the financial impact. The machines' performance will suffer if they don't have the refrigerant. It's like gas leaking out of your car."

Because of the time it took to check the legacy product, it was critical to have a product that would constantly be drawing sequential samples at the chillers and recording refrigerant levels to ensure the product was in operation, no matter the location.

"Having reliable, continuous monitoring that we could see from a central location would allow us to dispatch a technician only when having to make an assessment or deal with a minor issue," O'Malley said.

The technicians' time alone would save costs. Additional benefits include system performance, lower energy costs and reduced refrigerant cost.

"Set-It-and-Forget-It" System Helps Address Code Compliance

Being able to rely on the equipment in continual operation was another important consideration.

The local representative remembers visiting the Xcel Energy chiller plant in downtown Denver and noted it was the largest underground chiller plant he had ever visited. He said Xcel Energy wanted a "set-it-and-forget-it" type unit and they had some concerns surrounding code compliance.

Wanting to focus on refrigerant sensitivity, the representative demonstrated the refrigerant monitor could detect leaks down to 1 ppm.

"The monitors have been reliable. I don't recall having to change out the pumps in quite

some time," said O'Malley. "You basically hang them on the wall and will get years and years and years of service out of them."

Keeping its Environmental and Reliability Commitment

The facilities supplied with water by Xcel Energy are either directly owned by the building's owners, or leased. At any time customers can request records from Xcel Energy on the management of the system.

"If a customer wanted to see records on how we're managing the system, all we would have to do is pull the data to show them the preventive maintenance we are doing and the historical data," said O'Malley. "The monitor can talk back to the building management system if the pump goes bad, or if the unit sees refrigerant. It will tell you and you don't have to walk by it to find out. Functionally, it 'talks' the building system language."

Based on the equipment performance, impression and usability, O'Malley and his operations team are making good use of the MZs reliability, ensuring the 16 chillers remain in good operating condition and helping keep Xcel Energy's environmental commitment and reliable service to customers. **BP**

About Bacharach, Inc.

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

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The Need for KPIs and Production Data in ACTIONABLE ENERGY MONITORING SYSTEMS

By Staffan Akerstrom, P.E., CEM, and Paul Tate, P.E.,
LEED AP BD+C, Empowered Solutions, LLC

Monitoring energy usage of systems such as cooling towers can take energy optimization to the next level.

► Have you ever woken in the middle of the night in a cold sweat wondering if your plant is using more energy than it should, putting you at a disadvantage as compared to your competition? Even if your energy monitoring or energy management system is in place you may not have the required insight to improve your performance and keep you competitive.

But lost sleep isn't necessary. Simple but effective integration of readily available data in the plant can provide a whole new level of actionable information. Here's what you need to know.

Take Control of Energy Efficiency

To get needed insight you would need to have the ability to record or log data across multiple systems, including production data. As the old adage goes, you can't manage what you don't measure. It follows that if you are able to measure something with a greater level of precision and correlate it to the bottom line with production data, you will be able to manage it even better. Overall Equipment Effectiveness (OEE) measures the percentage of manufacturing time that is truly productive.

The same should be measured as it relates to energy so that the overall energy used to make each widget is as low as it can be. Most will already be familiar with the concept of Key Performance Indicators (KPIs) and how they can inform system optimization. By adding the factor of production data and establishing energy intensity KPIs, you can take your energy optimization to the next level, stay on top of costly or dangerous miscalibrations, and truly take control of your energy efficiency.



“As you crawl into bed each night you won't be worrying about energy budget overruns or peak demand rates, you can relax knowing that the KPIs and your energy monitoring system have got your back.”

— Staffan Akerstrom, P.E., CEM, and Paul Tate, P.E., LEED AP BD+C, Empowered Solutions, LLC

What KPIs Should be Tracked?

KPIs are important tools for optimizing any system, and chillers and cooling system are no exception.

We recommend placing sensors at key points in a chiller system for monitoring energy usage in kW including the cooler tower pump, chiller, cooling tower fan, and AHU fan, as well as water return temperatures, chilled water supply temperature, and chilled water flow.

To take a more precise look at your system and add value to your KPIs, adding monitoring for chilled water supply temperature, chilled water flow and chilled water return temperature may be of much greater value than monitoring the kW of the chiller itself. Location matters as well. Many times, plants make the mistake of installing power meters on panels around the plant but if the area covers more than one production line or department, the value of this measurement is limited. Tracking should be system-based and not area-based.

Include KPI Production Data

Any system within your plant consuming energy has crucial indicators that should be monitored to ensure efficiency, reliability, and maintainability. You can aggregate the various energy usage KPIs of a given system to realize a system-wide KPI, or taken a step further aggregate each essential system KPI to give you a reading on overall plant energy performance. These system or plant energy performance KPIs are the best indicators of overall energy use and should be carefully monitored across the board to ensure efficiency.

A fully developed system should include KPIs for individual systems as well as the plant. Each energy or water system in the plant has its own KPI, including kW/ton of refrigeration for the ammonia plant and cfm per kW for compressed air, and so on, with more granular

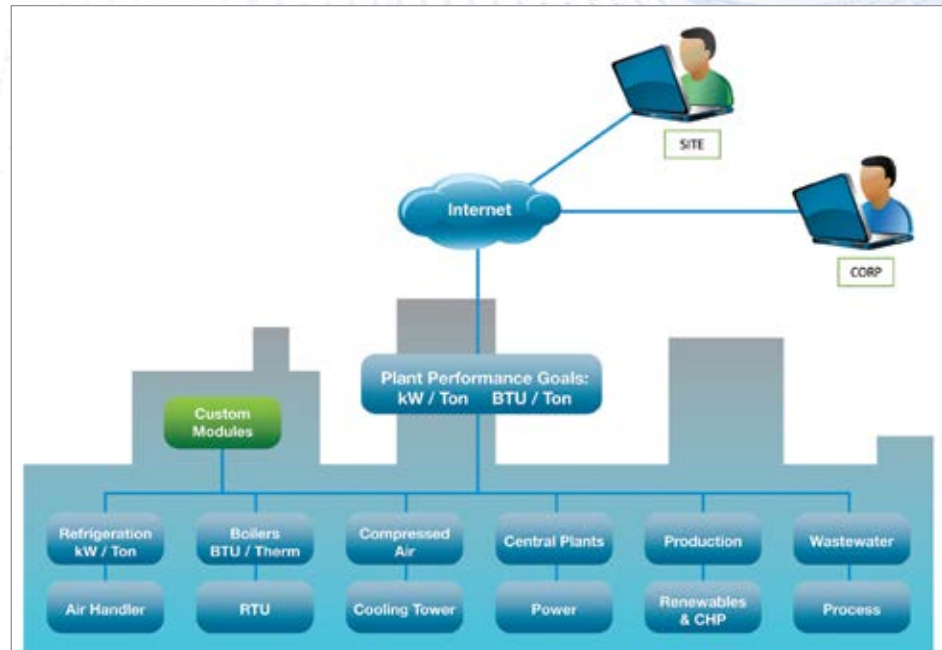


Figure 1: Depicted is the basic KPI architecture for a fully developed system.

KPI's for components of each system as shown in Figure 1.

For the plant as a whole, total energy per unit of production would be an overall metric to track. The energy usage per unit of product, say kWh per gallon of ice cream, provides an overall perspective of the plant energy use at all levels of production. By putting targets to each of the systems and for the plant as a whole you can see the interactive effects of energy reductions for a plant and the impact on the total energy per unit of product.

For example, by shutting off the 400 Watt Metal Halide lights in the storage at night you may be forced to increase the amount of heating in the space as well. By installing Variable Frequency Drives (VFDs) on motors in a conditioned Motor Control Center room you may increase the amount of cooling required while saving energy with the VFD's.

Including production data can be done in a number of ways, either queried from an SQL database, or directly taken from a PLC on the

production line. This data should be correlated with the actual reported production values and can then be combined with your KPI data to generate energy intensity KPIs, such as kWh per pound of product. Once you are able to establish these energy intensity KPIs you can use them in a variety of ways to improve your process and save money and time.

Leveraging KPIs for Effective Decision-Making

Employing energy intensity KPIs based on energy monitoring for various systems will help simplify tracking and reporting and enable informed and effective energy decisions.

Once you are tracking KPIs, you will be able to see how much energy each component of each system is using, but the real value comes when you begin to correlate these energy KPIs with production data, creating an energy intensity KPI and the ability to view it in real time.

This data point is effectively how much energy you use as it relates to your end product which is not equal at all levels of production. Figure 2

THE NEED FOR KPIS AND PRODUCTION DATA IN ACTIONABLE ENERGY MONITORING SYSTEMS

shows the impact of production levels have on energy usage.

A low production level requires much more energy by unit of production since many times there is an inherent energy use to simply run the plant and energy systems are usually

less efficient at part load. Production data is essential to monitoring and optimizing your system, since it is your best measure of the real and scalable output of your plant.

Tracking your system operations over time with this data is the tool you need to optimize

systems to hit target energy goals and verify the energy savings from implemented efficiency measures. As discussed previously, there are two main areas of focus, first optimizing each system within the plant, and second optimizing the overall energy per unit of product.

Additionally, this data can allow you to compare performance of similar systems, proactively address slipping efficiencies, compare shift operations to one another, and identify equipment left operating when not needed. Production KPIs can be used to establish a baseline for a system operation to be compared with an optimized system, or against several optimization possibilities.

Energy use is probably one of the biggest costs in your plant and understanding why charges are fluctuating is the key to controlling the cost. You can use energy KPIs to actively manage and forecast your plant energy budget and stay on top of your utility bills by checking their accuracy against your own numbers.

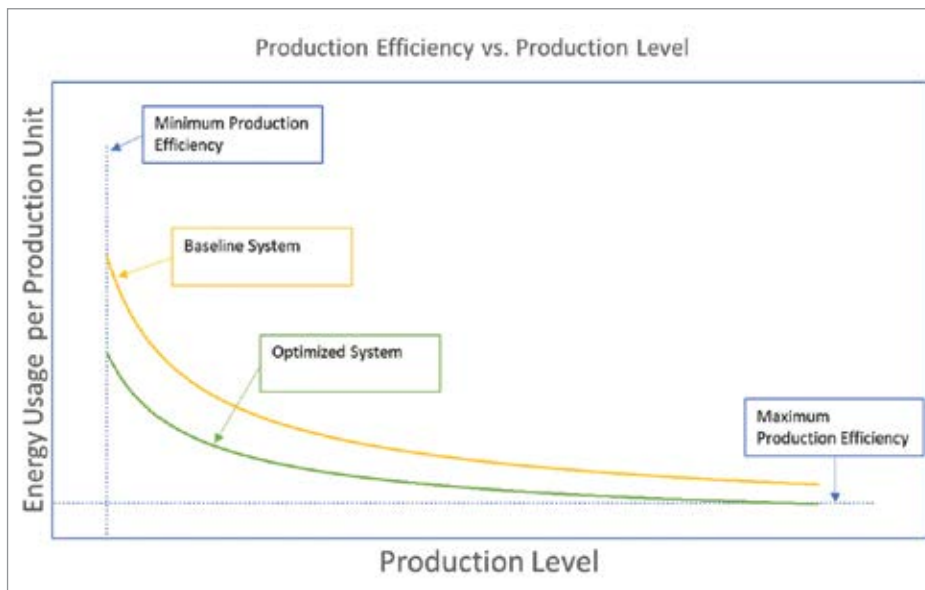
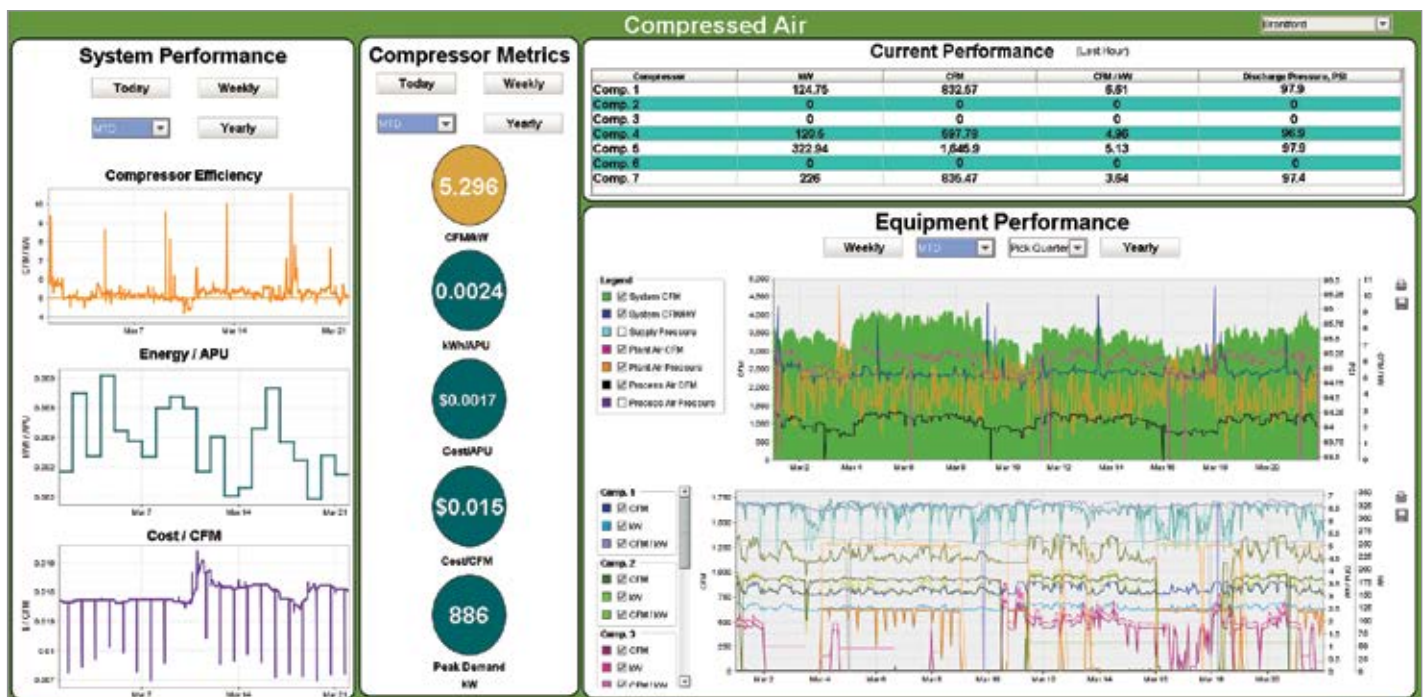


Figure 2.



Empowered's software provides visibility into the most important KPIs of a compressed air system.

Using System Software for Reports and Alerts

It's beneficial to occasionally take a step back and evaluate your energy usage at multiple levels, establish reachable goals, and optimize your plant at every level. However, we all know there are only so many hours in the day, and oftentimes the big picture can be put on the back burner in favor of more pressing issues. A great way to stay on top of your KPIs is to use your system software to set up regular reports and customized alerts.

An alert is a notification of a preset condition, i.e., "at 09:47:35, peak demand for month transitioned to active." By setting alerts for important conditions, you can rest easy knowing they will not go undetected. When you see your utility billing rate for peak demand, you will be glad you set an alert. Example of alerts include:

- Peak demand alerting: Set targets for plant peak at kW and get alerts when actual demand is approaching target value to take action.
- Energy budget alerting: Set weekly or monthly energy usage targets and get alerts when actual usage is approaching target value.
- Operating below target efficiency: Set targets for system or equipment efficiency and get alerts if efficiency is continuously below target for the set number of hours.
- Sensor/meter reading out of range: Have system operators provide input on the normal range of values for key operational parameters like power, pressures, temperatures, and flow rates and get an alert if a sensor is continuously out of range for a set amount of time.

Alerts should be meaningful and actionable to avoid becoming noise. They can be used at the plant, system, and equipment level, and can also help ensure the safety of your plant workers in many cases.

By sending alerts, plant operators will learn how actions they may be taking impact the cost and energy use of the plant. For example, what is the real impact of having another air compressor operating at part load just in case? What is the impact of starting another chiller when your shift starts just because that's the way it was always done? Learning through alerts and energy faults can be an easy and inexpensive way to optimize the plant.

Finding Patterns of Energy Use

Once your energy intensity KPIs are in place for each system and on the plant level, you can keep an eye on potential problems with alerts, while focusing on high-level monitoring using reports. Tracking a snapshot keeps you out of the red, but examining a longer-term description of the energy use throughout your plant is how to find the more difficult energy inefficiencies.

Take for example your cooling system running at normal levels, but on a weekend, when no production is taking place, it runs because you need some cooling for the security office. You can find such instances in weekly or monthly reports and begin trimming subtle, but wasteful inefficiencies.

Another integral aspect of having complete oversight of your energy usage is your ability to ensure the quality of your data and the integrity of your various meters and sensors. In the installation phase, it's essential to ensure instrumentation is scaled properly, that calculated values are accurate, and

assumptions are known at startup. If this is done properly the deployment of alerts to detect anomalies such as flat-lined data, fixed value, or out-of-range data can help find faulty sensors immediately.

As you monitor for unexpected values based on KPIs and other related data, you can calibrate or replace sensors as needed, and integrate new equipment and instrumentation. By making sure your instruments are accurate from the start and setting alerts, you can be on top of any metering issues before they become costly or dangerous.

Taking Action and Making a Difference

The reality of integrating energy KPIs and production data into your system and monitoring routine is that it will make your life easier. Having actionable information in real time as it relates to energy is the best way to not only optimizing your energy efficiency, but also maintaining control of your systems and preventing wasteful and costly mistakes and malfunctions.

As you crawl into bed each night you won't be worrying about energy budget overruns or peak demand rates, you can relax knowing that the KPIs and your energy monitoring system have got your back. **BP**

About Empowered Solutions, LLC

Empowered Solutions is a leading energy, engineering, commissioning, and controls company that provides customer-focused consulting services to commercial, industrial, institutional and utilities across the US and Canada. Empowered Solutions is a single-source provider of energy and engineering consulting services aimed at improving energy efficiency, enhancing control of energy assets within buildings and manufacturing, and ensuring system operations are optimized through retro- and new building commissioning. For more information, visit www.enpowersolutions.com.

All photos courtesy of Empowered Solutions, LLC

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INDUSTRIAL COOLING SYSTEM INDUSTRY NEWS

ASHRAE Learning Institute Announces HVAC Design Training Schedule

ASHRAE Learning Institute (ALI) has released its remaining 2019 schedule of HVAC Design and Operations training offerings.

“The HVAC Design Level I and II training teaches a systematic approach to guide a design team to a solution that optimally meets the client’s expectations,” said Donald Brandt, course instructor. “This training allows practicing engineers, designers and industry professionals an opportunity to expand their exposure to HVAC systems design procedures for a better understanding of system options.”

HVAC Design: Level I – Essentials provides intensive, practical training ideal for recent technical or engineering school graduates and engineers new to the HVAC field. Developed by industry-leading professionals selected by ASHRAE, the training provides attendees with the fundamentals and technical aspects of HVAC design, installing and maintaining HVAC systems, that can be put to immediate use.

HVAC Design Level II – Applications provides instruction in HVAC system design for experienced HVAC engineers and those who have completed the HVAC Design: Level I – Essentials. The training covers the technical aspects of design and methods to increase energy savings through innovation in HVAC design.

ALI courses provide professional development through in-depth information that is timely and practical.

The courses offered are as follows:

DATE	LOCATION	LEVEL
July 14-16, 2019*	Denver, Colo.	Level I
August 5-9, 2019	Detroit, Mich.	Level I and II
September 9-11, 2019*	Nashville, Tenn.	Level I
September 16-20, 2019	Jersey City, N.J.	Level I and II
October 7-11, 2019	Salt Lake City, Utah	Level I and II
November 4-8, 2019	Atlanta, Ga.	Level I and II

*Presented in partnership with APPA, including added focus on Facilities Management.

To register, visit the HVAC Design and Operations page on www.ashrae.org.

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 www.ashrae.org.

Danfoss Turbocor® oil-free compressors selected by the Solar Impulse Foundation

The Danfoss Turbocor® Oil-free Compressor has received the endorsement of the Solar Impulse Foundation as one of the top 1000 solutions for protecting the environment. Already recognized as the world leader in oil-free, magnetic bearing compressor technology for the HVAC industry, this prestigious award further validates the Danfoss Turbocor® Oil-free Compressor as being a viable solution for reducing harmful greenhouse gas emissions while also providing economic benefits to end users through an ROI in less than three years and reduced energy consumption.

With this new endorsement, Danfoss is the second company in the world today with Soprema that has three products selected by the Solar Impulse Foundation.

Danfoss Turbocor® compressor range has achieved the high score of 4.0 assessed on the criteria of technological feasibility, environmental and socio-economic benefits and profitability. Danfoss Turbocor® compressors feature oil-free, magnetic bearing technology that reduces energy consumption up to 40 percent compared to traditional fixed-speed compressor technology. The oil-free technology also sustains high levels of efficiency over the life of the compressor with no degradation of performance. The sustainable performance of the Danfoss Turbocor® compressor provides annual emission savings of up to 194 metric tons CO₂ per year.



Danfoss Turbocor® compressor range TT, TG and VTT selected by the Solar Impulse Foundation in March 2019.

More than 68,000 Turbocor compressors have been installed in water- and air-cooled chiller systems worldwide. They can be found in apartment blocks, skyscrapers, nuclear power stations, shopping centers, hospitals, heaters, airplane hangars, naval and commercial vessels and data centers globally.

“We are very proud that our Danfoss Turbocor has been appointed as one of the top 1000 solutions for protecting the environment. The market for highly efficient solutions is growing rapidly, partly because of the increased focus on energy savings and partly because of urbanization which creates a need for more commercial buildings. Turbocor demonstrates that bold technology strategies are instrumental in securing long-term growth and profitability in our core businesses,” says Danfoss President and CEO Kim Fausing.

The one thousand Efficient Solutions, individually assessed by independent experts for the World Alliance, will comprise the very best the world has to offer in clean and profitable solutions to protect the environment. These Efficient Solutions follow five United Nations Sustainable Development Goals (SDG). They will be presented to governments, businesses and institutions to encourage them to adopt more ambitious environmental targets and energy policies. The mission of the World Alliance is to accelerate climate action by achieving a closer alignment between the private and public sector. The World Alliance is backed by Solar Impulse Foundation, whose Initiator, Chairman and Pilot, Bertrand Piccard, wants to exemplify what is possible with current innovation, claiming we’re now at a turning point: “In the past, cleantech was not profitable, but today it is. Finally, we can reconcile economy and ecology.” World Alliance has about 1,700 members and is rapidly growing.

About Danfoss

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

YORK® YZ Magnetic Bearing Centrifugal Chiller wins Edison Award

Johnson Controls announced the YORK® YZ Magnetic Bearing Centrifugal Chiller was presented a Bronze Award at the 2019 Edison Awards celebration in New York City. The cutting-edge chiller was selected as a winner in the Environmentally Friendly Solutions sub-category of the Energy and Sustainability award category.



The YORK® YZ chiller provides centrifugal chiller energy efficiencies as low as 0.1 kW/ton in off-design conditions.

“The entire Global Chiller Products team at Johnson Controls is honored to be selected for this prestigious recognition,” said Laura Wand, vice president and general manager, applied systems, building technologies and solutions at Johnson Controls. “Our long-standing commitment to delivering revolutionary chiller solutions to our customers led to the design and engineering of the industry’s most efficient, environmentally-friendly centrifugal chiller.”

Named after Thomas Alva Edison, the Edison Awards annually honor excellence and innovation in new product and service development, marketing, and human-centered design, and are one of the highest accolades a company can receive in the name of successful innovation.

Products go head-to-head in 16 categories including: aerospace innovation, consumer goods, health & wellness, social innovation. Finalists are selected by members of the Edison Awards Steering Committee and a panel of over 3,000 leading professionals, including senior executives with diverse marketing, scientific, and business

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backgrounds, vote on the winners. The panel of judges evaluate all award entries based on concept, value, delivery, and impact.

The YORK® YZ Magnetic Bearing Centrifugal Chiller is optimized for ultimate performance around next-generation low-global warming potential (GWP) refrigerant R-1233zd(E) to provide the highest possible efficiency. The YORK® YZ chiller provides centrifugal chiller energy efficiencies as low as 0.1 kW/ton in off-design conditions where typical fixed-speed chillers experience performance issues. It has the potential to reduce annual electricity consumption by an average of 35 percent.

The YORK® YZ Chiller was designed with a holistic approach to system design with engineering optimization for every component around R-1233zd(E). The chiller is a unique combination of advanced technologies, including a variable speed magnetic bearing compressor, high-speed hermetic induction motor, falling film evaporator, and adaptive capacity control logic, all supported by the YORK® team with decades of experience.

The YORK® YZ Chiller has received numerous awards including the AHR Innovation Award Cooling Category Winner, China Refrigeration 2018 Innovation Product Award, Buildings Money-Saving Products Award and Consulting Specifying Engineer 2018 Product of the Year Award. It has also been named a finalist for these awards - RAC Cooling Industry Award, Energy Awards 2018 and HVR Awards 2018.

To learn more about the YORK® YZ Magnetic Bearing Centrifugal Chiller, visit www.YORK.com/Next.

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 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 New Video Series

SPX Cooling Technologies, Inc., a full-line, full-service industry leader in the design and manufacture of cooling towers and other specialized heat exchangers, announced a new, continuing video series covering best practices for installing the Marley NC Cooling Tower. The first four episodes are now available, with additional installments to publish in the coming months. Available for viewing are:



Episode 1: Site Prep, Tower Arrival and Unloading – covers steps for making the cooling tower staging and receiving process trouble-free and efficient and outlines where to locate the components and literature included with the cooling tower shipment.

Episode 2: Installation Instructions and Drawings – reviews documents that arrive with the cooling tower shipment, including bills of materials, and lists of all necessary hardware to be located and organized before beginning cooling tower installation.

Episode 3: Necessary Hardware – outlines the tools and fasteners required for proper cooling tower installation, as well as joint-sealing instructions to help prevent leaks.

Episode 4: Hoisting Modules – provides hoisting guidelines to pick and position cooling tower modules with ease.

View the full video library at www.spxcooling.com/Contractor-Resources. For additional information, visit www.spxcooling.com

About SPX Cooling Technologies, Inc.

SPX Cooling Technologies, Inc. is a leading global manufacturer of cooling towers, evaporative fluid coolers, evaporative condensers and air-cooled heat exchangers

providing full-service cooling solutions and support to customers in the heating, ventilation and air conditioning (HVAC), power generation, petrochemical, industrial, and refrigeration markets for nearly a century. SPX Cooling Technologies and its product brands are part of SPX Corporation. For more information, please visit www.spxcooling.com.

About SPX Corporation

SPX Corporation is a supplier of highly engineered products and technologies, holding leadership positions in the HVAC, detection and measurement, and engineered solutions markets. Based in Charlotte, North Carolina, SPX Corporation had approximately \$1.4 billion in annual revenue in 2018 and about 5,000 employees in 16 countries. SPX Corporation is listed on the New York Stock Exchange under the ticker symbol “SPXC.” For more information, please visit www.spx.com.

B&W SPIG Awarded Contract for Cooling Tower Upgrade Services

Babcock & Wilcox SPIG, Inc. (SPIG) has been awarded a contract to provide cooling tower upgrade services for BASF Dow HPPO Production BVBA’s propylene oxide manufacturing facility in Antwerp, Belgium.

SPIG will use its proven service engineering expertise to develop customized solutions to improve the performance of the plant’s existing cooling towers. SPIG also will replace eight existing cooling tower cells with new units.

“This agreement marks an important milestone in our relationship with our customers, BASF and Dow,” SPIG Managing Director Alberto Galantini said. “SPIG’s global reach and unmatched expertise in delivering custom-engineered cooling tower solutions allows us to efficiently and effectively meet our customers’ needs.”

SPIG has begun engineering on the project and is scheduled to complete its work in the second quarter of 2020. The project will be realized without impacting the plant’s production capacity.

SPIG’s experience includes wet, dry and wet/dry hybrid cooling solutions as dictated by site-specific requirements. The company supplies mechanical and natural draft systems and designs for a wide range of project specifications such as high seismic loads, vibration control, corrosion, noise control, sub-freezing operation, and seawater use.

Specialized services include preventive maintenance, equipment upgrades, replacement and spare parts, online performance monitoring, and a commitment to research and development to continually seek new and more efficient cooling system solutions.

About SPIG

SPIG is a subsidiary of Babcock & Wilcox Enterprises, Inc. and a global turnkey cooling systems supplier. Since 1936, SPIG has provided customers with an extensive range of high quality cooling towers, air-cooled condensers and related services. For more information, please visit www.babcock.com/spig.



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