The Magazine for ENERGY EFFICIENCY and WATER CONSERVATION in Industrial Cooling Systems

CHILLER & COOLING BEST PRACTICES

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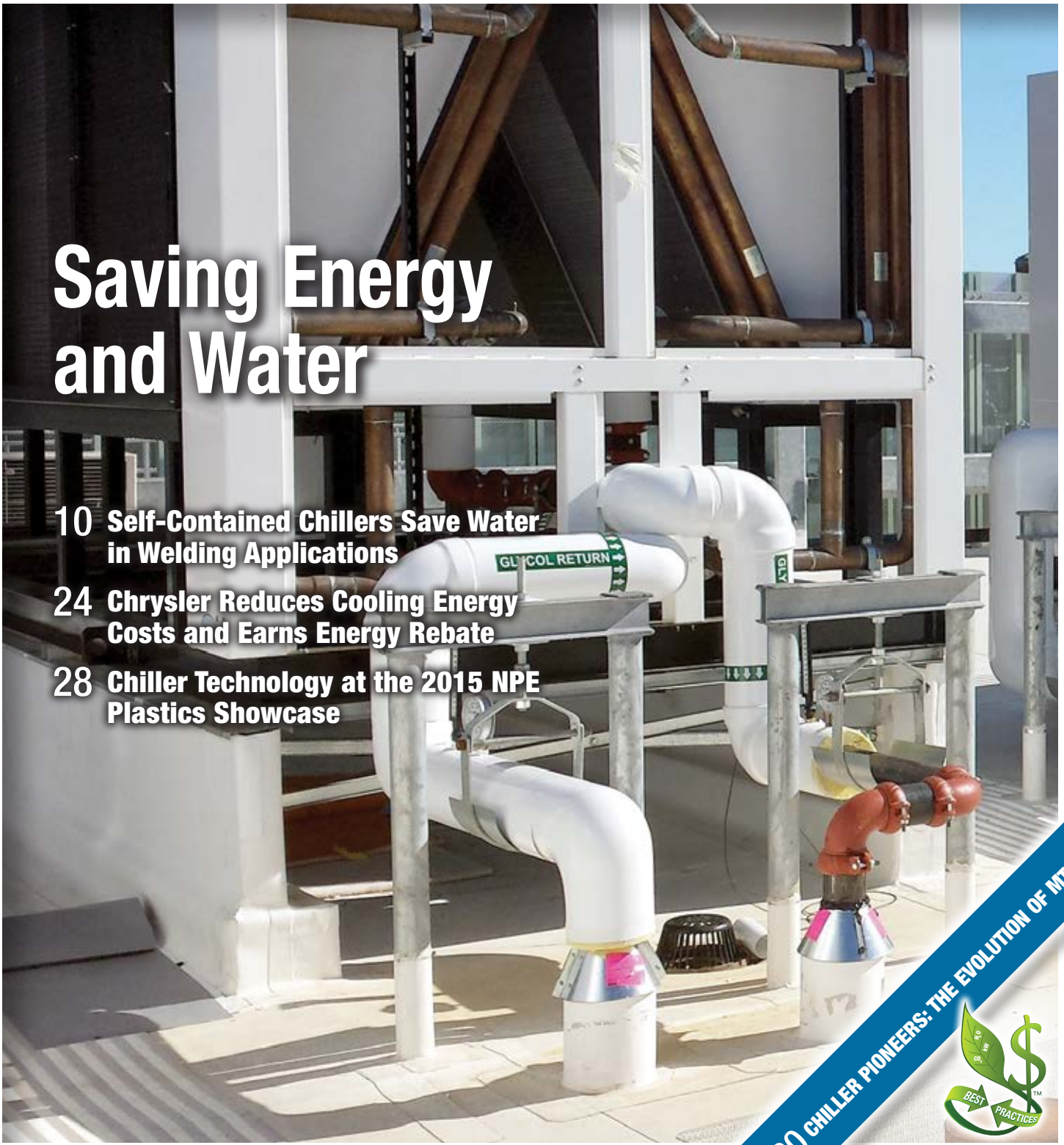

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*Magazine Cover Image Provided Courtesy: The Arctic Chiller Group as part of their article on page 14, "Saving Energy with Oil-Free Magnetic Bearing Centrifugal Chillers."

FROM THE EDITOR | Energy and Water Savings

Thank you for your overwhelmingly positive response to the first March 2015 Issue of *Chiller & Cooling Best Practices Magazine.* Responses included:

- From a Tier 1 automotive company; "I supervise paint operations and this is great! We need this kind of information-will this become a monthly magazine? How can we help?! I'll put you in touch with the engineering firm helping us optimize chiller systems to provide case studies."
- From a chiller sales and service company; "Our key account with 30 factories has had us start auditing chiller systems one year ago. We are very interested in free-cooling and have reached out to the company profiled in the magazine."
- From an air compressor sales and service company; "We have chillers in our line-card but our salesmen walk right by the applications in the plants. We will encourage them to read this magazine as we'd like to expand this side of our business."

I learned a ton (pun intended) helping to create this issue and hope you will as well. Our first article, written by Tom Snow from the T.J. Snow Company, focuses on how chillers can reduce water consumption in welding applications while increasing spot and resistance welding quality.

Jackson Ball, from the Arctic Chiller Group, supplies us with an in-depth look at how centrifugal chillers, using oil-free magnetic bearings, are being applied to save energy. The evolution of another significant chiller manufacturer, MTA, is profiled from a technology standpoint. A pioneer in cycling refrigeration system and heat exchange technology, MTA is entering a new technology phase with both their chillers and cycling refrigerated air dryers.

Chrysler's Technology Campus is home to some 14,000 people. Expert chiller system auditor Mike Flaherty, (tekWorx) and Bryan Whitfield (Chrysler) share a case study on how the chiller systems' average annual kW/ton was reduced 28 percent with a simple ROI of 1.7 years — assisted by a $200,000 rebate from DTE Energy. How does one go about applying for energy incentives for chiller systems? Panda Aumpansub, from Havtech Inc., shares her insights into what data and processes are required in the article, "Acquiring energy incentives for industrial chiller systems."

Lastly, we hope you enjoy our Show Report on chiller technologies at the 2015 NPE International Plastics Showcase.

Thank you for investing your time and knowledge with *Chiller & Cooling Best Practices* and please remember to visit our new website at www.coolingbestpractices.com.

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CHILLER & COOLING SYSTEM INDUSTRY NEWS

Innovative Berg Hybrid Chiller/Air-blast Cooler Saves Energy and Water

Berg reports an innovative hybrid chiller combining a chiller and an air-blast fluid cooler provided a major plastics facility in Quebec with extraordinary water and energy savings. The customer's initial requirement called for most of the load to be chilled water type cooling as the temperature requirement was stated to be within the range of 7˚C to 25˚C. After a thorough review and understanding of customer's process, it was suggested to the client that most of the load could successfully operate at higher supply temperatures. The customer approached the process equipment supplier with this idea and they agreed to make a few small (no-charge) modifications to accommodate the suggestion. This simple suggestion resulted in the majority of the load being satisfied with ambient produced *free-cooling* rather than

Berg Skid-Mounted Hybrid Chiller (remote air-blast cooler is not shown).

CHILLER & COOLING SYSTEM INDUSTRY NEWS

high horsepower mechanical cooling. The result was now only 22% of the load would require a chiller supplying mechanical cooling at 7˚C while the balance could be satisfied with cooling at 30˚ to 35˚C.

The most energy-efficient solution would be to utilize ambient based cooling equipment and the most environmentally friendly solution would be a Hybrid Chiller incorporating a fluid cooler that consumes no water (there is no need to treat the inlet air with a misting system to achieve temperature). Also, there would be no evaporative cooling requiring water make-up as required by an evaporative cooler, or a need for introducing water for temperature trimming, nor will the system require the constant attention of chemical treatment. However, such a system would not be able to attain and maintain the lower temperature requirement during the hotter summer months. To meet the 7˚C requirement a chiller would have to be used in conjunction with the fluid cooler.

Berg designed a Hybrid Chiller system that integrates both the *Air-Blast* cooler and a chiller. The system is equipped with Berg's advanced system manager controls that automatically allows for a seamless transfer between the *Air-Blast* cooler and the chiller. The *Air-Blast* cooler will satisfy all of the process demands for most of the year, even taking advantage of a cooler spring and fall nights. The chiller takes over to supply the portion of the process that requires 7˚C when ambient temperature rises above 2˚C. Applying the Berg Hybrid Chiller system, the customer stands to save approximately $100,000 in annual operational costs due to energy, municipal water usage and chemical treatment savings. The system payback is less than two years and the customer will continue to enjoy these savings for many years to come.

Visit www.berg-group.com.

Mokon Offers Space-Saving Heating/ Chilling System

Mokon® has redesigned its Full Range temperature control systems to reduce the overall cabinet size and floor space requirements. The combination heating/ chilling system is available in one convenient package and is ideal for applications including plastic processing, jacketed vessels, reactors, multiple-zone processes, laboratory, sanitary, food, chemical, and other processes that have heating and chilling cycles.

Mokon's Full Range System integrates a Mokon circulating water system with an Iceman chiller to provide heating and chilling from a single, compact, self-supporting unit delivering optimal performance. The system is ideal for specific-use applications or when your process requires a wide variety of temperatures. They are also practical for applications that require multi-zone control, and installations where supply water or drains are not accessible.

The Full Range System is available in standard heating capacities up to 96 kW, pumping capacities up to 120 GPM, chilling capacity up to 40-Tons, and temperature range of -20˚F to 300˚F (-29˚C to 149˚C).

Full Range Systems offer many standard features to provide accurate temperature control while heating and/or chilling processes, including stainless steel centrifugal pumps, a highly efficient brazed plate evaporator, insulated nonferrous plumbing and components, a microprocessor-based controller with LED readout, a NEMA-rated electrical enclosure with a safety disconnect switch, and a heater canister with stainless steel diverter.

Mokon's Full Range Heating/Chilling System

Mokon's Full Range Systems meet NFPA 79 electrical safety standards for industrial machinery and are equipped with UL 508A labeled electrical sub-panels. The overall design provides for long-life, durability, and accurate continuous process control. Built with many unmatched features and capabilities, Mokon's engineers will custom design systems to meet specific process requirements, including NEMA 4, NEMA 4x or special wash down demands. A wide variety of additional options are available, including stainless steel construction, higher and lower operating temperatures, larger heating and chilling capacities and stationary skid-based assemblies. Mokon's circulating liquid heating and chilling equipment is proudly designed and manufactured in the U.S.

Visit www.mokon.com.

Leak Detection Kit Reveals Leaks in Water- and Water/Glycol-Based Industrial Systems

The Spectroline® OLK-402 Industrial Leak Detection Kit accurately and efficiently pinpoints leaks in water- and water/glycol-based industrial systems. It allows inspection of the entire system under all operating conditions. At the heart of the kit is the OPTI-LUX™ 400 high-intensity, violet light LED leak detection flashlight. Its high-output violet light causes dyes to fluoresce more brilliantly and with greater contrast than with standard blue light inspection lamps. This rechargeable lamp is extremely compact and lightweight. It has an inspection range of up to 25 feet (7.6 m) or more.

The Spectroline® OLK-402 Industrial Leak Detection Kit

Also included in the kit is a 16-oz (473 ml) twin-neck bottle of WATER-GLO® 802 concentrated water dye. This dye is perfect for detecting leaks in all types of water-based systems. When a leaking system is scanned with the OPTI-LUX 400 flashlight, WATER-GLO 802 will glow bright green, revealing the exact source of a leak.

Rounding out the kit is an 8-oz (237 ml) spray bottle of GLO-AWAY™ dye cleaner, a smart charging cradle with AC and DC cord sets, dye treatment tags and fluorescence-enhancing glasses. All these components are packed in a rugged carrying case.

Visit www.spectroline.com

Johnson Controls Introduces Quantech Air-Cooled Chillers

Johnson Controls recently introduced Quantech Air-Cooled Chillers, now available exclusively through an independent sales network. Quantech chillers ship virtually immediately from inventory, making replacement available in as little as two days to minimize downtime and restore comfort quickly. Quantech chillers offer up to 50 percent annual energy cost savings compared with the replaced chillers, have a low lifecycle cost, meet or exceed ASHRAE standards, and help earn LEED credit with a low refrigerant charge.

"When an HVAC system goes down, occupants want relief and mechanical contractors want to provide a solution as quickly as possible," said Harvey Elder, vice president and general manager, North America Applied Systems, Johnson Controls. "We can deliver these chillers in days, not weeks or months, with the added benefits of high efficiency and a low lifecycle cost."

The Quantech line includes the Quantech QTC2 and QTC3 15- to 175-ton, air-cooled scroll chillers, as well as the Quantech QTC4 160- to 210-ton, air-cooled screw chillers with variable speed drives, which are built to order.

Quantech chillers are manufactured as part of the Johnson Controls product portfolio in manufacturing plants in North America and are shipped from a logistics-center warehouse near Dallas. Service contractors and design-build contractors can source chillers from Quantech representatives. Additionally, service contractors will receive fast selections and quick delivery. Johnson Controls' 140 years of engineering backs up the dependable, strong track record of these chillers, which are smaller, lighter, quieter and require less maintenance.

Visit www.johnsoncontrols.com.

The Quantech QTC4 Air-Cooled Chiller (160 to 210 tons) combines VSD screw refrigeration compressors, heat exchangers, condenser fans and chiller controls to deliver unmatched efficiency.

CHILLER & COOLING SYSTEM INDUSTRY NEWS

Frigel Nears Completion of $7 Million Manufacturing Plant in Bangkok, Thailand

At NPE 2015, Frigel announced that it is nearing completion of its new 9,000-square-meter (97,000-square-feet) manufacturing facility in Bangkok, Thailand, as the company continues to meet growing demand for its advanced process cooling technology.

The new $7 million plant is slated for completion in April and is primarily focused on serving customers in the burgeoning Asia Pacific market. The total investment for the plant includes costs for land, construction and production machinery. The new facility, which began construction in 2013, is expected to be fully operational in September 2015. Frigel will transition to the new facility from its existing 1,000-square-meter (10,764 square-feet) Bangkok plant beginning this summer.

Frigel's process cooling technology is uniquely designed to help plastics processors and manufacturers across a wide spectrum of industries maximize efficiencies in cooling plant equipment — and as a result — save costs and improve productivity and sustainability.

According to Frigel CEO Duccio Dorin, the sizeable increase in the company's Thailand manufacturing operation signifies the company's commitment to the Asia Pacific market. He added that it also signals clear optimism for overall company growth as manufacturers worldwide increasingly adopt advanced process cooling technologies.

"The whole market is moving toward more advanced process cooling technology as companies seek to more effectively satisfy their process cooling needs, and it's a trend that continues to accelerate given today's productivity, operational costs and environmental challenges," Dorin said. "We're excited about the plant nearing completion since it will only help to enhance Frigel's reputation for quality products and service in not only Asia Pacific, but elsewhere as the increased manufacturing capability supports our corporate-wide production goals."

Frigel is a recognized pioneer in advanced process cooling technology — including the Ecodry 3DK Closed Loop Adiabatic Liquid Cooler system, a patented adiabatic technology that is easily adaptable to any climate, system or process. The system provides the ability to increase water and energy savings, improve cooling precision, and lower maintenance when compared with a conventional cooling system. The new facility in Thailand will manufacture Ecodry 3DK, as well as other Frigel products, including Microgel Chiller/TCUs. The compact, portable units allow plastic processors to maintain precise, microprocessor-controlled temperature at molding machines. When compared to central chillers, Frigel Microgel units are able to greatly enhance productivity and energy efficiency.

In addition to the plant in Thailand, Frigel has two manufacturing facilities in Italy, including its Corporate Headquarters in Scandicci (Florence), as well as Brazil, where it also provides sales, engineering, parts and product support. Additional operations that provide sales, engineering, parts and service include the United States, Germany and Australia. Strategically located throughout the world, Frigel provides comprehensive industry expertise and support virtually everywhere manufacturers are located.

Visit www.frigel.com

Johnson Thermal Systems Settles Into New Location

Johnson Thermal Systems (JTS) has been growing rapidly over the last two years, and the company recently relocated to a new facility with over 45,000 square feet. All JTS products are engineered and manufactured at its location just outside of Boise, Idaho. The new facility has been set up with overhead cranes to make loading and unloading material and manufacturing projects a breeze. In addition, the company now has an in-house powder coating and paint station.

Inside the new Johnson Thermal Systems facility in Boise, Idaho.

In 2014, JTS expanded several new OEM product lines in addition to custom projects. The ET series offers versatility to serve industrial chiller applications. With upgraded components as standard, the ET Series offers the most value in its class, while still carrying the level of JTS quality, reliability and support. Standard features include scroll compressors, micro-channel condensers, stainless steel brazed plate evaporators, stainless steel pumps, large reservoirs, a microprocessor-based controller, and cleanable air filters.

Visit www.johnsonthermal.com.

New Magnetic System from SKF Offers Oil-Free, Energy-Efficient Solutions for Centrifugal Compressors in Chillers

SKF recently launched a new magnetic system, an oil- and contact-free drive solution for centrifugal compressors in chillers. Combining a high-speed permanent magnet motor and active magnetic bearings with integrated controls, the magnetic system can operate with variable speed drives from various manufacturers to deliver energy savings of at least 10 percent versus conventional centrifugal compressor designs. In addition, the system's vibration- and nearly friction-free performance capabilities enable extremely quiet operation.

"Our magnetic system can help OEMs streamline product design, development and assembly, as they produce new highly energy efficient centrifugal compressor chillers," said Richard Law, SKF Global Segment Manager, Fluid Machinery. "This innovative technology also reduces maintenance costs for the user and provides them with reliable and cost-effective air conditioning."

Electromagnets levitate the compressor shaft, allowing it to rotate without contact. By eliminating the mechanical contact and the losses that occur with oil-lubricated bearings, the magnetic system from SKF reduces energy use and costs significantly. By eliminating the need for oil lubrication, the system also improves heat transfer efficiency in the evaporator and condenser. The permanent magnet motor at the heart of this SKF solution is more energy-efficient than induction motors at full and partial loads, and offers a higher power factor/lower current draw. It also operates with a smaller size variable speed drive than induction motors.

The system's active magnetic bearings are capable of speeds in excess of 40,000 RPM, and can accommodate instant and frequent start-ups and transient surge forces. An active control system tracks and maintains rotor position to within a micron-sized orbit up to 15,000 times per second, eliminating vibration. High-speed permanent magnetic motor solutions from SKF utilize technology pioneered by S2M, one of the world's leading producers of magnetic bearings and high-speed permanent magnet motors. Acquired by SKF in 2007, S2M has been refining contact-free, levitating bearing technology for more than 30 years.

SKF's new oil- and contact-free drive solution for centrifugal compressors in chillers

Visit www.skf.com.

> **"Our magnetic system can help OEMs streamline product design, development and assembly, as they produce new highly energy efficient centrifugal compressor chillers."**
>
> **— Richard Law, SKF Global Segment Manager, Fluid Machinery**

SELF-CONTAINED CHILLERS
Save Water in Welding Applications

By Tom Snow, CEO, T.J. Snow Company

➤ Resistance Welders Are Thirsty

Long known as water hogs, resistance welders are widely used in factories that manufacture products made from sheet metal and wire. Sub-categories of the resistance welding process include spot welding, projection welding, seam welding, butt welding and flash welding.

An adequate flow of cooling water is one of the most important variables of the resistance welding process, and the typical machine requires 2 to 3 GPM of water per cooling circuit.

Since there are often several parallel circuits per machine, the total water flow needed can be substantial. As an example, the water cooling needs of special-design automated "multi-gun" resistance welders with multiple transformers and tips can easily total 10 to 20 GPM (Figures 1 and 2).

The Days of Plentiful, Inexpensive Water Are Gone

In the past, plants often connected resistance welders to their incoming city water supply and never gave it another thought. However, since the days of plentiful and cheap city water are gone, and sewer charges are often substantial, self-contained water recirculators and chillers have become a popular option.

When a chiller is substituted for city water being wasted, the payback can be as short as a year.

Heat Sources of the Welding Process

There are numerous heat generators in the resistance welding process, starting with the large transformer typically located inside the machine frame, which generates heat internally as it converts incoming line voltage and current into the high secondary amperage used for welding. Small-diameter copper water tubes are typically built into the transformer core, and there are usually at least two other circuits to cool the high voltage contactor section of the welder control.

Some resistance welding applications, especially spot welding aluminum, require as much as 100,000 secondary amps to generate enough localized heat to fuse the metal through the resistance of the material at the joint.

Figure 1: Large special-design resistance spot welders, such as this T. J. Snow 46-gun machine for welding wire automotive seat frames, require a huge volume of water to keep the components cool. Visual flow indicators arranged along the top of the machine frame facilitate balancing the water cooling circuits.

Additional heat is produced in the large copper conductors of the welder's "secondary loop." The final heat source in the resistance welding process — which can be the hardest to cool — are the electrodes that contact the material being welded.

Water Storage Causes Cooling and Quality Problems

Roof-mounted water towers have long been the most common way to supply cooling water to spot welders, but they present a unique set of problems, including inconsistent process water temperatures due to varying ambient air temperatures.

In addition, dirt and other contaminates can cause problems, such as at a Japanese-owned automotive parts manufacturer in Kentucky that had cherry trees planted all around their building. The trees were beautiful when they blossomed each spring, but the cooling tower got clogged with a cloud of blossoms that blew into the system.

Another reason why a cooling tower is not recommended for use with spot welders is that water flow is often inadequate because the central system's pump capacity is rarely increased when additional water-cooled machinery is installed.

Other plants use well water or large recirculating reservoir tanks, sometimes cooled by radiators or even numerous bags of ice, but a self-contained water chiller is far superior, especially when properly sized for the application (Figure 3).

Although well water is often viewed as "free," the minerals present usually clog the welder's small-diameter water cooling circuits. In addition, well water is often too cold to suit the application.

Although common sense would indicate that cooling water for resistance welders should be as cold as possible, condensation quickly becomes a problem when the prevailing dew point, the temperature at which water vapor will condense, is above the process water temperature.

Since dew point temperatures above 70˚F are common during the summer months, chillers should be set to avoid internal "sweating" of the welder's transformer, which will eventually cause it to short out. Also to be avoided are puddles of water at the operator's feet caused by condensation dripping off the electrode holders.

To solve the condensation problem, some chillers being manufactured today include an Automatic Dew Point Compensation feature, which is highly recommended.

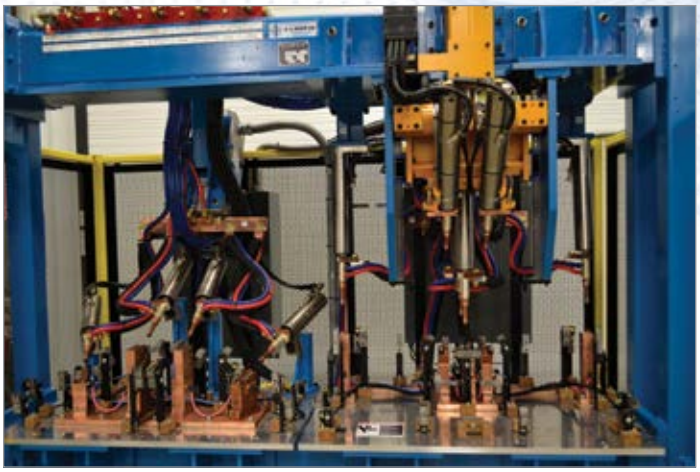

Figure 2: Multi-gun spot welders consume large quantities of cooling water. Blue water hoses are used to distinguish cool incoming water from the "water out" circuits represented by red hoses.

Figure 3: This MTA 1-ton Model TAEevo self-contained air-cooled water recirculator and chiller is ideally suited for use with this 100 KVA press-type resistance spot welder.

The Impact of Water Flow Rate on Welding

When it comes to removing heat generated by the resistance welding process, the water flow rate is often considered more important than temperature. Therefore, it's especially important to select a chiller with a properly sized pump and to plumb the system to minimize or eliminate head pressure caused by running water lines in the ceiling.

SELF-CONTAINED CHILLERS SAVE WATER IN WELDING APPLICATIONS

Figure 4: This T. J. Snow dual gun spot welder is cooled by a dedicated 1-ton MTA Model TAEevo self-contained air-cooled water recirculator and chiller.

Figure 5: Self-contained chillers are often connected to multiple resistance spot welders located near one another in a work cell. Note the two different types of water manifolds and visual flow indicators used to balance the flow to multiple cooling circuits.

The ideal set up is to connect a chiller to just one resistance welder (Figure 4), or a group of similar machines located close together, and to run the lines on the floor (Figure 5).

Sizing Your Refrigeration Capacity

Selecting the proper refrigeration capacity of a chiller used with resistance welders is not always an exact science, since the welder or group of welders to be cooled may not run all the time. A good rule of thumb that has worked through the years is to specify one ton of refrigeration for each 100 KVA of welding capacity.

A large built-in reservoir tank that serves as a "thermal fly-wheel" will help prevent short-cycling, and a dual compressor system, if available, can enable one side to shut down automatically when not needed.

Water Conservation is Key

With continuing drought in many parts of the world, buying a self-contained chiller to go along with your resistance welder is perhaps one small way to help save the world.

At the very least, installing a chiller should improve your process and save money. BP

For more information, contact Tom Snow, CEO of T.J. Snow Company, tel: (423) 308-3165, email: TomSnow@tjsnow.com, or visit www.tjsnow.com.

To read more about ***Water Savings,*** please visit www.coolingbestpractices.com/system-assessments/water-savings.

Tom Snow and T. J. Snow Company

Tom Snow is CEO of T. J. Snow Company, Chattanooga, Tennessee, a 52-year-old family-owned company that has long offered self-contained air-cooled chillers to go along with its standard and special design resistance welders.

As a stocking distributor for MTA and Koolant Koolers, the company has expanded its chiller sales into many non-welding applications.

Known for its large inventory of various models, T. J. Snow Company is often able to ship a chiller the same day an order is received. The company has sold chillers throughout the United States and in several foreign countries.

For further information, go to www.industrialwaterchiller.com.

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SAVING ENERGY

with Oil-Free Magnetic Bearing Centrifugal Chillers

By Jackson L. Ball, Group Vice President,
The Arctic Chiller Group

Image Provided Courtesy: The Arctic Chiller Group.

➤ It's been more than a decade since oil-free magnetic bearing centrifugal compressors hit the HVAC market. With unheard-of part-load energy efficiency and zero oil-related maintenance, these ultra-quiet machines are totally sustainable because there is no oil to change the heat transfer rates in the heat exchangers. Now there are more than 35,000 of them out there logging over 55 million run-hours, and all of them have an initial cost premium. While the technology was targeted at the HVAC market, which is accustomed to centrifugal compression and larger loads, many lessons have been learned after a decade of seeing the good and the bad applications in other markets. When you apply the technology properly, there are opportunities to save big energy dollars across many sectors — from plastics and pharmaceuticals to foods, metals and manufacturing.

Figure 1: Three Chillers Installed by The Arctic Chiller Group Atop a Major Hotel

Choose the Right Chiller Loading

During the initial years of market expansion, there were the anxious adopters and the skeptics. Too many applications were designed and negotiated around how the owner could afford magnetic technology with the least premium cost over traditional lubricated, mechanical bearing chillers. So, if a facility had 300 tons of load, a 300-ton chiller was often selected to meet cost versus value assessments, thereby minimizing the upfront premium. Capital cost rebates and financial incentives, such as demand-response, have been created by many public utilities to help bridge the cost gap and reduce overall kW usage across the grid.

Now engineers know that the real advantage of magnetic bearings lies at loads of 85 percent and below the facility load. So, for your 300-ton load, you should choose a 350- to 400-ton magnetic chiller and force it to run in its "sweet spot," which will help it reach energy levels that lubricated chillers probably cannot achieve. Traditional lubricated chillers must use

pressure and velocity to push oil through the entire system and keep it miscible with the refrigerant on its journey. Therefore, its kW/ton gets higher as the load goes down. The opposite occurs when there is no oil — the compressor may operate at minimum pressure ratio to just meet the demand and cool the compressor. Engineers now leverage these facts.

The Real Cost of Oil — It's Not Just About Maintenance

There was and is a lot of excitement about reduced maintenance and the elimination of oil-related mechanical bearing rebuilds and service contracts to maintain warranties. But oil is much more than maintenance cost. Enter the National Institute of Standards and Technology (NIST), the Department of Energy (DOE), the Refrigeration Service Engineers Society (RSES), and Wolverine, each of which recently performed studies of the actual effect of the oils typically used in chillers with R134a refrigerant (the currently favored refrigerant for centrifugal chillers that meets government environmental mandates). The studies verify that oil indeed affects the U-Value inside the heat exchangers. It changes the bubble formation at the tube surface. Additionally, the effect is seen with very small amounts of oil and is linear in the negative effect versus oil concentration.

The newer studies[1,2] validated an older American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) study showing that there was about an 8 percent U-Value loss after 4 to 5 years of operation (Figure 2). Important takeaways from these studies include:

1. With oil typically found in chillers, properties that promote miscibility necessary to lubrication lead to reductions in heat transfer rates in the heat exchangers.
2. Oil concentrations above 0.5 percent cause reductions in bubble size formation at the tube surface, which reduces heat transfer rates.
3. The effect was highest between 1.3 percent and 3.5 percent. The negative effect increased in a linear fashion with the oil percentage above 0.5 percent.

Oil in Chillers Can Never Be Sustainable

Simple math for calculating the British Thermal Unit per Hour (BTUh) shows the inescapable truth:

BTUh = U-Value x Area of Tube Surface x Logarithmic Mean Temperature Difference (LMTD)

The BTUh is the demand on your chiller that you need to meet. The tube surface area is fixed, so you must change the LMTD between

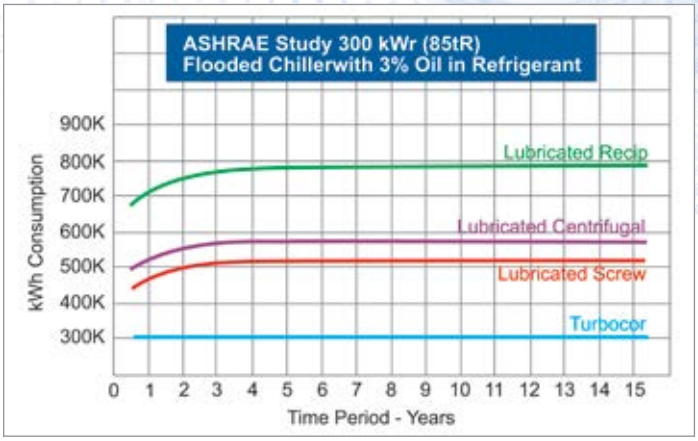

Figure 2: Energy Consumption of Various Chiller Types Over Time (from ASHRAE)

the chiller's saturated suction temperature and the leaving chilled water. And, once oil has taken out about 8 percent in U-value, it takes more energy to overcome the loss. Worse yet, LMTD is, as its name indicates, logarithmic, so it takes larger changes to make a smaller effect. Any way you cut it, these modern studies show that oil costs you big money — not just in maintenance. The larger loss is heat transfer rate for the life of the machine. This is many times the premium cost of the oil-free chiller, and people are starting to understand that fact and see it in their operating costs.

New Approach for Magnetic Chillers Unlocks Even More Value

However, that's only half the picture that has emerged from the oil-free phenomenon. Controls have become more sophisticated and extend beyond just the chiller — all the way to the cooling tower fan, the bypass valves, and the sensors at air handlers and processes. The magic of magnetic bearings includes the very low lift capabilities, the new controls, and the strategies that can unlock unprecedented energy savings. Keep in mind something key about centrifugal systems: no differential pressure, no lift — no lift, no capacity. The idea is to operate at the minimum size "pressure-ratio envelope." When you are operating at these very low lift conditions, if you quickly try to increase the demand, there is nowhere for the compressor to go. So, a better approach was needed to operate safely where only a magnetic system could go.

Direct Chiller Control of the Cooling Tower Equipment

To reach these targets, you no longer approach chiller control based on return water temperature. The preferred approach for magnetic drives is to base chiller control on a floating Saturated Discharge Temperature (SDT), which also reacts faster than water temperature changes, and

SAVING ENERGY WITH OIL-FREE MAGNETIC BEARING CENTRIFUGAL CHILLERS

Figure 3: Air-Cooled Chillers Installed by The Arctic Chiller Group at a Hospital Campus

is now available as a floating set-point. By manipulating the SDT, the operating envelope can be squeezed downward as load changes, which saves energy at the sacrifice of available capacity. In many part-load situations, that is perfectly acceptable.

By extending this logic outwards and directly correlating this new settable refrigeration cycle SDT to the control of cooling tower set-point and fan speed, an ideal balance can be closely approximated, and you can operate at extremely low lift conditions safely. A controller should have an enthalpy input to provide automatic control of floating cooling tower set-point as it approaches wet-bulb temperature, and optimized fan speed — all controlled by the chiller. This approach enables unprecedented system energy efficiency by this direct tie between the refrigerant compression cycle and tower-side enthalpy performance in real time.

Remember, these are magnetic drives, so this approach gets us into very low and directly controlled lift and system pressure ratios under all load and ambient conditions. Because of centrifugal compression, during cold or inverted start conditions, it is necessary to provide direct control of an automatic condenser water bypass valve so that it will open — and remain open — once the chillers have reached normal operating pressures.

Air-Cooled Chillers Save On More Than Maintenance

Two widely held beliefs have changed. One was that air-cooled chillers could not be as efficient as water-cooled chillers. The other was that due to the higher head pressure and condenser approach, you could never have air-cooled centrifugal chillers. While it is essentially true that water-cooled chillers can deliver better energy performance, proper loading of modern air-cooled chillers using magnetic compressors can result in superior simple energy costs and total cost of ownership. In Figure 4, notice that at 70 to 80 percent of load, the air-cooled chiller saves energy without a cooling tower, fans, condenser pumps or water treatment.

The secret is controlling refrigerant circuits individually with generous condenser surfaces, high-cfm-type electronically commutated (EC) fans, and refrigerant-to-refrigerant economizers to cool the compressor during higher load points and pressures typical for air-cooled chillers. By selecting an oversized chiller, or adding additional condenser/fan banks, a facility can meet its demand and save significantly in simple-energy and maintenance dollars for the life of the equipment.

Air-Cooled Chiller Free and Trim Cooling

There are two ways to do free and trim cooling. One is to install chilled water coils before the condensers in the same air stream, which means they share the same fan. When ambient temperatures drop, the condenser needs less and less fan energy, and the free cooling needs more. Therefore, there are two disadvantages to sharing the same fan and cabinet. One is you cannot do trim cooling as effectively while refrigerant circuits are also still running. The other is you always have the pressure drop of both condenser and free cooling coils — even when only running in one mode. The ideal configuration — if you have the space available — is to provide the free-cooling system with its own set of fans. It should also be piped in series with the chilled water return so that it can provide very effective trim cooling whenever the ambient

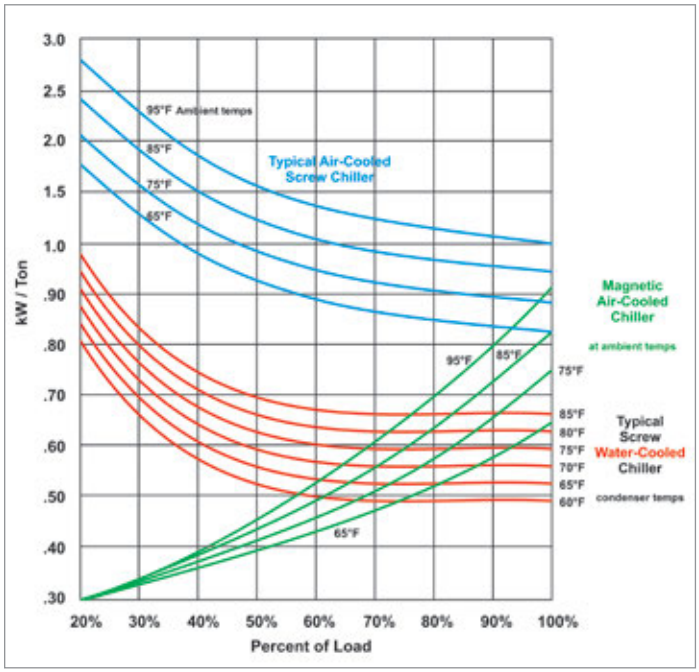

Figure 4: Air-Cooled vs. Water-Cooled Chiller Performance

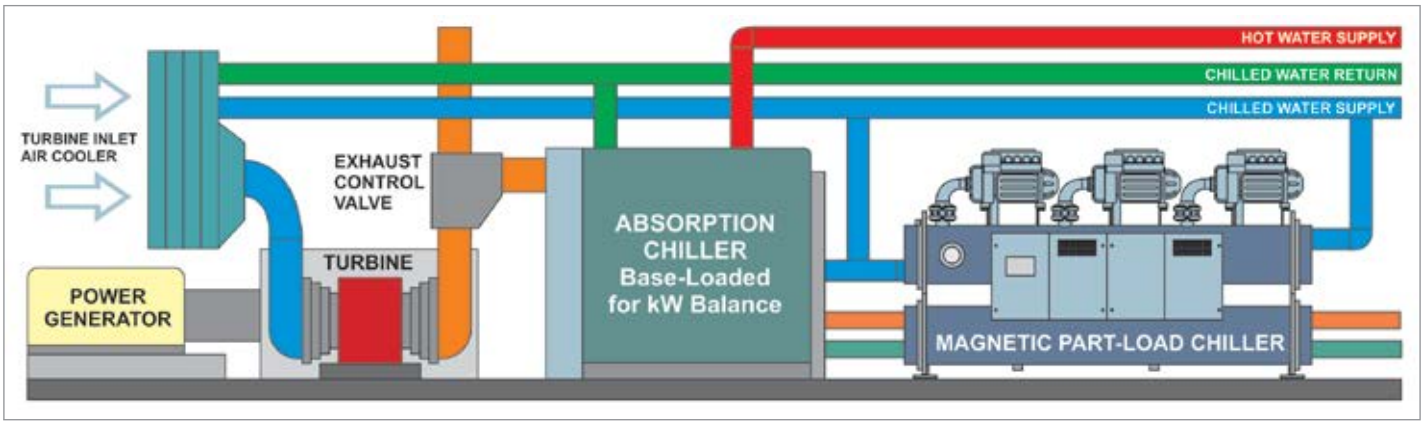

Figure 5: Co-Generation System with Natural Gas Turbines, Diesel Generators, Absorption Chillers and Magnetic Chillers

temperature is low enough, eventually taking on 100 percent of the load (if designed for that).

A reasonable compromise is to equip air-cooled chillers with an individual refrigerant circuit for every compressor, with chilled water return coils sharing the same fan. As both the temperature and the load reduce, controls can dedicate each circuit and its respective fan to one duty or the other. Half of the chiller could perform free or trim cooling, and the other half could cool what's left of the chilled water load with refrigeration.

Increase Savings with Chilled Water Temperature Resets

To squeeze energy out of the chilled-water side, facilities should enable multiple levels of chilled water set-point control. That way, as the load is reducing or processes are offline, the chilled water set-point can automatically rise by a degree or two at intervals that make sense for the air handlers or processes affected. Engineers often specify pressure-independent flow control valves to balance and widen the Delta T across loads, and vary the chilled water flow with the real load.

By selecting the right chiller loading, and resetting set-points strategically (by leveraging the floating SDT with a floating cooling tower set-point and fan speed as the temperature approaches wet bulb), you can achieve significant energy savings. These techniques are a culmination of best practices learned since the magnetic technology emerged.

Combined Cooling, Heating and Power

Co-generation is coming back with a strong natural gas supply at sustainable prices for the foreseeable future. DOE suggests that industrial applications for waste heat recovery and combined duty equipment will save billions of dollars over the coming years. Modern co-generation includes natural gas turbines and diesel generators with absorption chillers to capture the waste heat and run at very steady-state loads, while using magnetic chillers that can handle part loads and trim cooling very reliably. The magnetic chillers also provide redundancy to the absorption system. Figure 5 shows a complete system.

Emerging technologies, such as binary-cycle and organic Rankine cycle equipment, will significantly reduce waste heat by operating at lower temperatures and producing electricity directly. These systems are described below:

Binary Cycle Co-Generation Systems: These systems use lower temperature 300˚F geothermal and industrial waste heat across heat exchangers and heat transfer fluids to heat a rapidly expanding gas to drive turbines. Thermal fluids or waste gas never contact the generator impellers (Figure 6, pg. 19).

Organic Rankin Cycle (ORC) Systems: This type of system can be described as a magnetic compressor operating in reverse. ORC uses low-grade heat or gas and generates economical DC electrical energy in a variable-speed, oil-free environment. ORC can use renewable sources like geothermal and solar.

Bridging the Financial Gap

While rebates help when available, they are not uniform across the markets. By doing the due diligence of correlating your facility load profile with the available ambient air temperatures, energy usage and rates with any cash rebates, owners can determine the amount of premium required to meet their payback objectives.

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SAVING ENERGY WITH OIL-FREE MAGNETIC BEARING CENTRIFUGAL CHILLERS

Figure 6: Sample Impellers from a Co-Generation System

There are many energy service companies in the market that analyze the overall energy-related opportunity and provide up to 100 percent financing for solid energy-saving projects. Some specialized companies provide complete turnkey engineering, construction and life cycle support for energy-related systems and the assets.

Taking this one step further, there are businesses now emerging that sell the thermal effect of the equipment as a utility with the premise that the thermal utility can be acquired at less cost than purchasing, owning, maintaining and operating infrastructure equipment that is not considered core competency. Under this model, there is no capital purchase or lease — even the service is outsourced.

The technology and funding channels are here and available now. Modern approaches to magnetic compression and the correlated control of the chiller ecosystem have unlocked unmatched sustainable value for facility owners. After all, that's what it is all about — sustainable owner value. BP

About the Arctic Chiller Group

With factories in the U.S. and Canada, The Arctic Chiller Group is a world leader in chillers and chilled water systems. Arctic manufactures ultra-high efficiency chillers using magnetic bearing oil-free compressors. The product range includes water-cooled chillers up to 1500 tons and air-cooled chillers up to 400 tons with trim and free-cooling options. These products provide facility owners with unmatched savings in energy, noise and total lifetime cost of ownership. The ArctiChill division is the world leader in modular, medical and process chiller systems with many features, options and owner benefits. Scroll, screw and oil-free centrifugal models are available with pumping, free-cooling and controls.

About the Author

Jackson Ball is Group Vice President and co-owner of Arctic Chiller Group. With more than 25 years experience in process and HVAC heat transfer, he is a well-known evangelist of oil-free, low-energy cooling designs and leading-edge control technologies. He is also a regular speaker at energy functions around North America. BP

For more information contact Jackson Ball, Group Vice President, The Arctic Chiller Group, tel: (678) 234-2821, email: jacksonb@arcticchillergroup.com, or visit www.arcticchillergroup.com.

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To read more about ***Chiller Technology,*** please visit www.coolingbestpractices.com/technology.

"Modern approaches to magnetic compression and the correlated control of the chiller ecosystem have unlocked unmatched sustainable value for facility owners."

— Jackson L. Ball, Group Vice President, The Arctic Chiller Group

CHILLER AND CYCLING REFRIGERATED DRYER PIONEERS: THE EVOLUTION OF MTA

By Clinton Shaffer, Editorial Associate, Chiller & Cooling Best Practices

MTA's headquarters in Tribano, Italy

What do the beginnings of innovative businesses have in common? Certainly abstract attributes like creativity, intelligence and dedication all play a part, but in many cases the origins of great businesses have another, more concrete thing in common — a garage. Amazon, for instance, was originally founded by Jeff Bezos in his garage. Walt and Roy Disney made some of their first animated films in their uncle's garage. And, last but not least, Steve Jobs, Steve Wozniak and Ronald Wayne designed the first Apple computer in a garage.

The MTA assembly facility in Conselve, Italy

As it happens, MTA (M.T.A. S.p.A.), a globally recognized company that produces chillers, refrigerated dryers and other air treatment equipment, also started in a garage. Since its inception in 1982, MTA has grown from four partners in Italy to an international organization with 440 employees across the globe. MTA is based in Tribano, Italy, and has an assembly facility in Conselve and a manufacturing facility that spans 25,000 m^2 in Bagnoli. There are also seven sales offices located in countries around the world, including France, Germany, Spain, Romania, the U.S., and Australia.

In our discussion with some of the key leaders at MTA, the team at Chiller & Cooling Best Practices Magazine learned about the history of the company, key innovations that helped drive MTA's success, and newer products that have the company poised for a promising future.

Pioneering Refrigerated Air Dryer Technology

In line with other great entrepreneurial stories, MTA started with four people in a garage, along with an idea that would help change an industry. In this case, the idea was a new concept for a refrigerated compressed air dryer — the thermal mass cycling dryer.

"We got our start in 1982," Founder and Managing Director Antonio Pengo told us. "We didn't have any money, but we had a lot of energy. We came from the dryer industry — three of us had a background in R&D engineering, one in sales. We made two heat exchangers in our garage. For thermal mass, we used paint cans filled with glycol."

Aside from Mr. Pengo, the other founders included Giuseppe Cassetta, Mario Mantegazza and Giancarlo Milani. They helped pioneer the thermal mass dryer, or a cycling refrigerated dryer that cools compressed air and gases using a thermal storage medium. For their design, the founders of MTA used a glycol-water mixture. In contrast to a non-cycling dryer, which runs continuously, the thermal mass dryer has the ability to shut down at a set temperature and cool compressed air with the storage medium, helping to save energy.

The non-cycling thermal mass refrigerated dryer brought MTA global recognition as a compressed air dryer manufacturer. Their innovative dryer design could handle airflows of 20,000 m^3/hour at 3 bar with a huge reduction in the necessary thermal mass media (80 kg vs. the typical 800 kg). At that time, the market for cycling refrigerated air dryers was on it's way to becoming the major market segment it is today.

"MTA has and continues to be an engineering pioneer in energy saving technologies," said Roberto Bettin, MTA's Director of International Sales Companies. "Innovations in heat exchangers, thermal mass media and refrigeration circuits allow us to lead the way in helping refrigeration compressors cycle OFF."

In 1989, MTA disrupted the cycling refrigerated dryer market again. This time it was with the introduction of a patented thermal mass dryer that used silica as the thermal storage media. Using aluminum fins and a compact silica mass, the new design was capable of generating even more energy savings while maintaining the expected pressure dew point range.

MTA Enters the Process Cooling Industry

Leveraging the success of its refrigerated dryer product line as a springboard, MTA started entering other markets. In 1991, the company released a tank air-cooled hermetic compressor (TAE) designed for plastic injection molding applications. MTA's first chiller, the RPE, offered an alternative to traditional chillers. Similar to MTA's refrigerated air dryer ideology, the new chiller created cold water storage, enabling the compressor to turn on and off as needed rather than running continuously.

Around 1995, MTA began adopting free-cooling techniques in its chiller system designs, using separate coils for the water and the refrigerant. While this type of design started as total free-cooling, a technique that could only capitalize on the very low ambient temperatures of winter months, it has since been improved to a design that can modulate between partial and total free-cooling. When a chiller operates at partial-mode free-cooling, the energy-saving benefits can be reaped during the transitional seasons of spring and fall as well.

"Low ambient temperatures can and should be used as a "free" energy source, replacing the electricity required to run refrigeration compressors," said MTA U.S. Sales Manager, Don Joyce. "Partial-mode free-cooling is now possible by dual heat exchanger sets using their own fans, separating the chiller and free-cooling systems."

Additionally, MTA's typical process cooling applications now include far more than injection molding. The company serves customers in meat and poultry processing, plastics manufacturing, metalworking, welding, brewing and winemaking.

Eight years after MTA developed its first chiller, process cooling became its largest revenue stream, encompassing a whopping 55 percent of the business. Another 23 percent of the company's business remained in compressed air treatment, and the final 22 percent came from industrial HVAC.

Innovating Again — New Refrigerated Air Dryers

MTA reached its most recent milestone in early 2014, when it launched its DE iTECH refrigerated dryers in Europe (launched for the U.S. market in May of 2015). Designed to handle airflows of 10 to 1000 scfm, MTA's new cycling dryers exploit the synergies between process cooling and compressed air treatment — namely a technique similar to free-cooling, thermal storage operation, and the exact same ambient sensors.

MTA's Don Joyce, John Medeiros and Angelo Mastrangelo next to their just-launched DE iTECH refrigerated air dryers at the 2015 AICD Conference and Exhibit

CHILLER AND CYCLING REFRIGERATED DRYER PIONEERS: THE EVOLUTION OF MTA

MTA employees at the company's 30th anniversary event

The DE iTECH refrigerated dryer is based on the premise that dryers are typically sized for peak demands, yet rarely need to perform at that level. With MTA's patented Pulse Technology, a microprocessor controls the dryer and adjusts the amount of refrigerant used to correspond with actual airflow. This is in direct contrast to non-cycling dryers that work continuously, indiscriminate to the level of airflow. The adjustments to refrigerant levels are based on temperature sensors, installed in both the compressed air and refrigerant circuits.

The dryer is a three-stage module, the first of which includes the air-to-air heat exchanger. The pre-cooling designed into the system operates on the same premise as free-cooling, in that it takes advantage of existing air temperatures. As air enters the dryer, it is pre-cooled by the outgoing air in the air-to-air heat exchanger. The effect is twofold: (1) Inlet air is pre-cooled, eliminating some of the work that the air-to-refrigerant heat exchanger needs to perform, and (2) The outgoing cold air is reheated to prevent condensate from forming on the plant's piping.

The DEiTECH Family of Refrigerated Air Dryers

The air then enters the air-to-fluid heat exchanger where it is cooled to the required dew point by the refrigerant circuit, which operates counter flow. Water vapor condenses out of the air and is efficiently separated by the demister and removed by the condensate drain. The cold air leaving the system then re-enters the air-to-air heat exchanger where it is reheated by the incoming air, as mentioned previously.

The refrigerant circuit operates separately, but within the same unit. Refrigerant is compressed from a gas into a high-pressure liquid, and it is then injected into the air-to-refrigerant heat exchanger through a bypass capillary. The microprocessor then controls when the refrigerant moves out of the heat exchanger via a solenoid valve. Depending on the airflow, refrigerant will remain in the air-to-refrigerant heat exchanger, where it acts as a thermal mass.

Achieving Energy Savings with Different Modes of Operation

For high and medium airflows, the dryer runs constantly, maintaining complete and reliable dew point control. The aforementioned microprocessor opens and closes a solenoid valve installed on the

suction pipe of the refrigeration compressor to release pulses of refrigerant back into the refrigerant compressor. As variations in airflow occur, the Pulse Technology adjusts accordingly and compresses less refrigerant during times of lower airflow. Consequently, the compressor uses less refrigerant and consumes less energy.

For low airflows, the dryer uses thermal storage operation and cycles on and off. When the refrigeration capacity is greater than the airflow, the excess capacity cools the heat exchanger. At a specified temperature, the refrigeration compressor can then turn off, leaving the remaining refrigerant in the circuit to act as a thermal mass in the air-to-refrigerant heat exchanger. The obvious advantage is that the refrigerant compressor works much less, saving in energy costs.

The DE iTECH refrigerated dryers have a digital readout display providing the real-time information maintenance personnel need to ensure proper operation. This controller has the capability to connect the dryer to a supervisory system, like a MODBUS, for remote visibility and control. The following statuses are always accessible from the digital readout:

- Status of the dryer, including "off," "dry," and "high dew point" indicators
- Compressor status
- Condensate drain status
- Level of energy savings
- Any alarm status, including three different coded alarms, a programmable user alarm, and a general alarm contact for remote alarm indication
- Service warning that informs facility personnel that preventative maintenance should be performed

Growth and Investments in the U.S.

MTA has grown substantially in the more than thirty years it has been in business. What was once a tiny operation working out of a garage in Italy, is now an international company focused on expanding its market share abroad — particularly in the U.S.

According to John Medeiros, the Managing Director for the U.S., the U.S. is a big part of MTA's global plans, especially with the cycling air and thermal mass dryers:

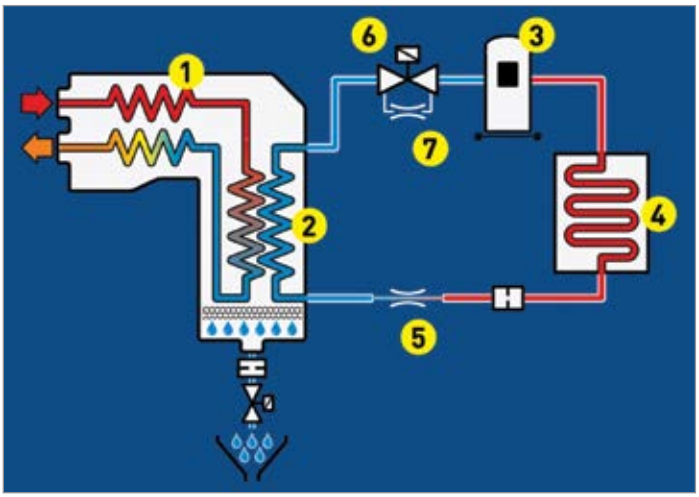


Figure 1: Air enters the system and is pre-cooled by the air-to-air heat exchanger (1). It then moves down to the air-to-refrigerant heat exchanger (2), where it is brought to an exact dew point. Air then passes again through the air-to-air heat exchanger, where it is reheated to prevent pipe sweating. At the refrigerant compressor (3), refrigerant gas is pushed through the condenser (4) where it is converted to a high-pressure liquid. That liquid is then metered through a capillary (5) into the air-to-refrigerant heat exchanger. The refrigerant stays in the heat exchanger until the microprocessor allows it to pass through a solenoid valve. During partial-load settings, a small portion of the refrigerant will pass through a bypass capillary (7).

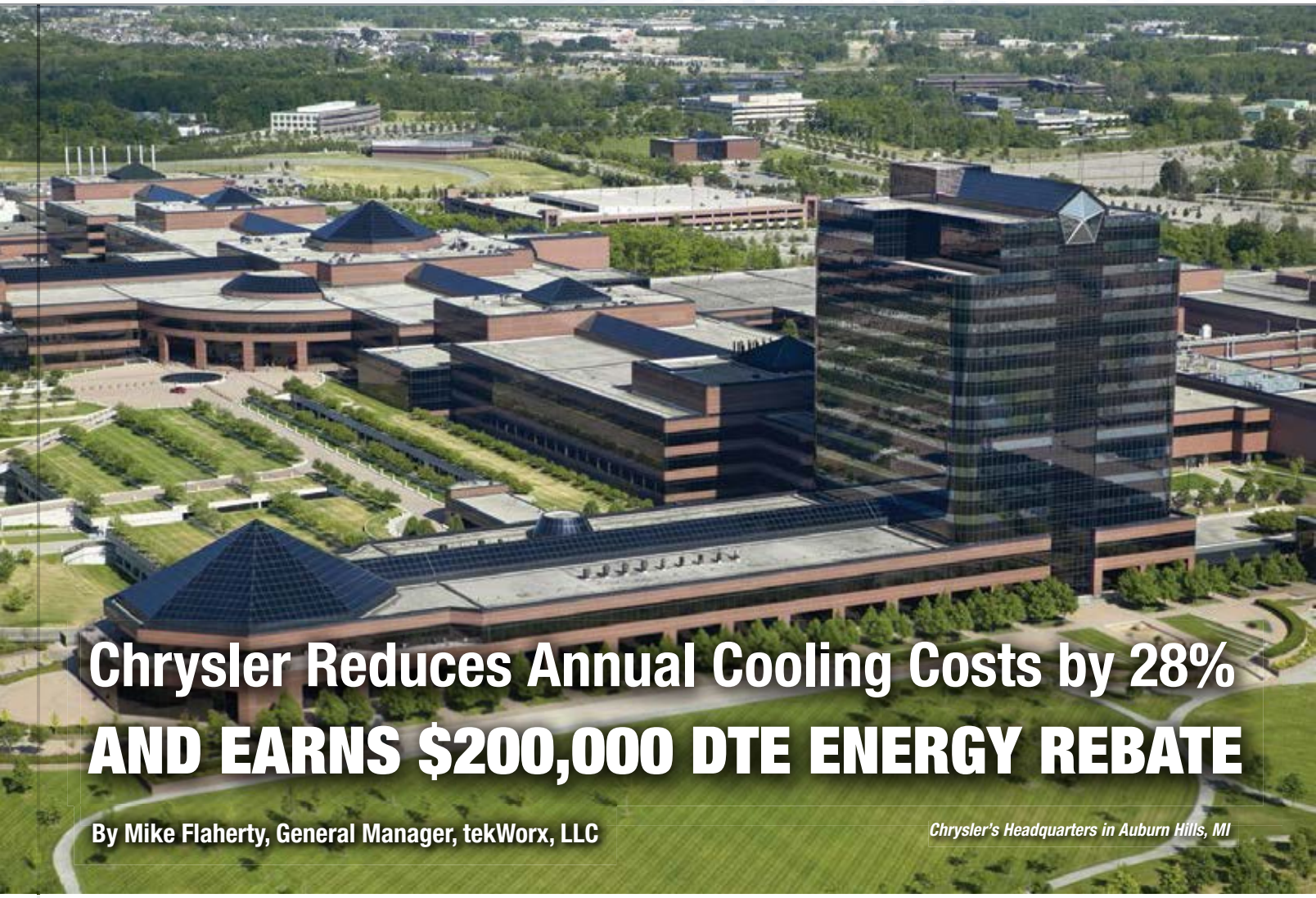
"The company is currently investing the required capital in inventory and human resources in order to expand," said Medeiros. "We are supporting our chiller OEMs and compressed air sales channel partners with very significant levels of inventory in our Buffalo (New York) area warehouses."

Medeiros added that he believes the release of the new DE iTECH refrigerated air dryers in the U.S. market will further stimulate company growth.

The synergies within MTA's three key business segments — process cooling, compressed air treatment and HVAC — are all evident in the company's product designs. From MTA's innovative partial-mode free-cooling chillers to their newly introduced refrigerated dryers, all technologies are designed to run reliably and save in energy costs. The clever engineering and innovation that put MTA on the map has the company poised for another thirty years of success. BP

For more information, contact Don Joyce, MTA U.S. Sales Manager, tel: (716) 693-8651, email: djoyce@mta-usa.com, or visit www.mta-it.com.

To read more about Cooling Technology, please visit www.coolingbestpractices.com/technology.



Chrysler Reduces Annual Cooling Costs by 28% AND EARNS $200,000 DTE ENERGY REBATE

By Mike Flaherty, General Manager, tekWorx, LLC

Chrysler's Headquarters in Auburn Hills, MI

Chrysler's Technology Center (CTC), located in Auburn Hills, MI, is home to some fourteen thousand employees responsible for keeping the automotive giant in motion. Completed in 1991, the complex is essentially a small city, encompassing 5.3 million square feet situated on over 500 acres. In addition to corporate offices, the facility houses a full laboratory level of various wind tunnels with thermal testing capabilities, a 1.8-mile evaluation road, a noise/vibration facility, an electromagnetic compatibility center, an environmental test center (able to create rain, snow and extreme temperatures), and a pilot production plant.

Within CTC's walls lies one of the largest central utility plants housed under one roof. The chilled water plant is powered by fourteen 1260-ton chillers and eight 1200-ton plate/frame heat exchangers installed to take maximum advantage of the Michigan climate. Two groups of cooling towers, broken up into north and south banks, and two 3-million-gallon storage tanks are on hand to meet the year-round cooling required by the facility's critical R&D functions and 24/7 operations. This equipment produces forty-five million ton-hours of cooling annually, with fifteen million ton-hours of free cooling and thirty million ton-hours of mechanical cooling.

CTC's chiller plant is piped in a primary/secondary configuration wherein the storage tanks function as the hydraulic decoupler between the generation (primary) loop and the distribution (secondary) piping loop. Going on twenty-four years old, the aging control system was manually overridden and an inarguable candidate for upgrades.

Identifying Potential Efficiency Projects

Bryan Whitfield, a Senior Energy Specialist in Chrysler's Manufacturing Engineering Group, is continually tasked with identifying efficiency projects throughout the automaker's manufacturing property portfolio. Chrysler's energy improvement projects, past and present, tend to focus on the paint and assembly plants that consume an incredible 70 percent of the energy used in the entire vehicle production process — everything from assembly and stamping to power-train manufacturing operations. Having previously been CTC's central plant and building

automation manager for eight years, Whitfield knew its systems and their limitations and realized it was ready for optimization.

System Assessment Reveals Inefficient Operation

A preliminary energy assessment performed by tekWorx revealed several operational inefficiencies at CTC, the most glaring of which was inconsistent operation from manual control. Constant speed pumps with balance valves burned extra horsepower, more chillers were running than necessary to meet the building load, and the constant speed secondary distribution pumps were running outside their efficiency curve. Data logs also showed low chilled water ΔT, due primarily to the underutilized storage tanks. Early findings calculated that these identified inefficiencies added up to 25 to 30 percent of the cooling energy costs, and that a project correcting them would yield a payback of less than two years.

Given that this estimated payback fit within Chrysler's guidelines and knowing that a utility rebate was possible, Whitfield requested funding. Chrysler management agreed, at which point Bryan Whitfield and Stuart Fisher, CTC Site Energy Engineer, put together a performance-based request for proposal (RFP) with the following requirements:

- The project had to have a two-year simple payback. Furthermore, any anticipated utility rebates were not to be included in the payback calculation since the rebates themselves were not guaranteed.
- A guaranteed improvement in overall plant efficiency of 25 percent, measured in kW per ton
- The system could not be shut down at any time so as to not interrupt the R&D equipment runs and related processes.
- The existing mechanical system infrastructure could support only minor changes. Specifically, the existing chillers, towers and pumps had to remain in place, and no major piping changes were allowed.
- The aging building automation system had to be replaced with an industrial programmable logic controller (PLC) system that provided improved user interface functionality.

Four suppliers bid the project and tekWorx was selected.

Receiving $200k DTE rebate on behalf of Chrysler are L to R: Didier Papin, Karl Ziegenmeyer, Darin Sharkey, Bryan Whitfield, Brian Terlecki, Stuart Fisher, Steve Londo, Paul Bedich, and Sean McCoy (DTE/KEMA).

Recommended Approach

The mechanical portion of the tekWorx solution was based on converting CTC's system to full variable flow to reduce pumping power and improve system ΔT. This pragmatic approach meant that variable frequency drives (VFDs) were only added to equipment where the combined cost and efficiency gains fit the payback requirement and where a reasonable service life remained. As a result, only ten of the fifteen primary pumps, eight of ten secondary pumps, and nine of the condenser water pumps that fed the North Cooling Tower Bank were outfitted with VFDs. VFDs were not installed on the remaining six condenser water pumps feeding the South Cooling Tower bank, as they were running at the optimal point of their efficiency curve. Similarly, VFDs were not recommended on the two-speed cooling towers, as the cost/benefit ratio would not fit the overall guideline. Finally, the age of the existing chillers, coupled with the cost of their corresponding 4160V VFDs, meant outfitting the chillers with drives was highly impractical.

The control solution from tekWorx was based on a PLC platform and sophisticated adaptive control techniques that would provide real-time optimization of pump sequencing, chiller sequencing, water temperature reset, and storage tank utilization. The PLC system would be integrated into the existing site-wide Building Automation System (BAS) to facilitate remote access. Chrysler already had sufficient instrumentation in place. Other than some calibration, the only other suggested modifications were the addition of new BTU meters and Differential Pressure (DP) sensors for accurately verifying the savings.

CHRYSLER REDUCES ANNUAL COOLING COSTS BY 28% AND EARNS $200,000 DTE

Phased Implementation Keeps Plant Running

With Chrysler's approval of the tekWorx plan, Fisher worked with CTC Central Energy Plant Manager Darin Sharkey to devise an implementation strategy that would keep the plant running during the changeover. The system equipment would be divided into three phases, and each phase would be commissioned individually.

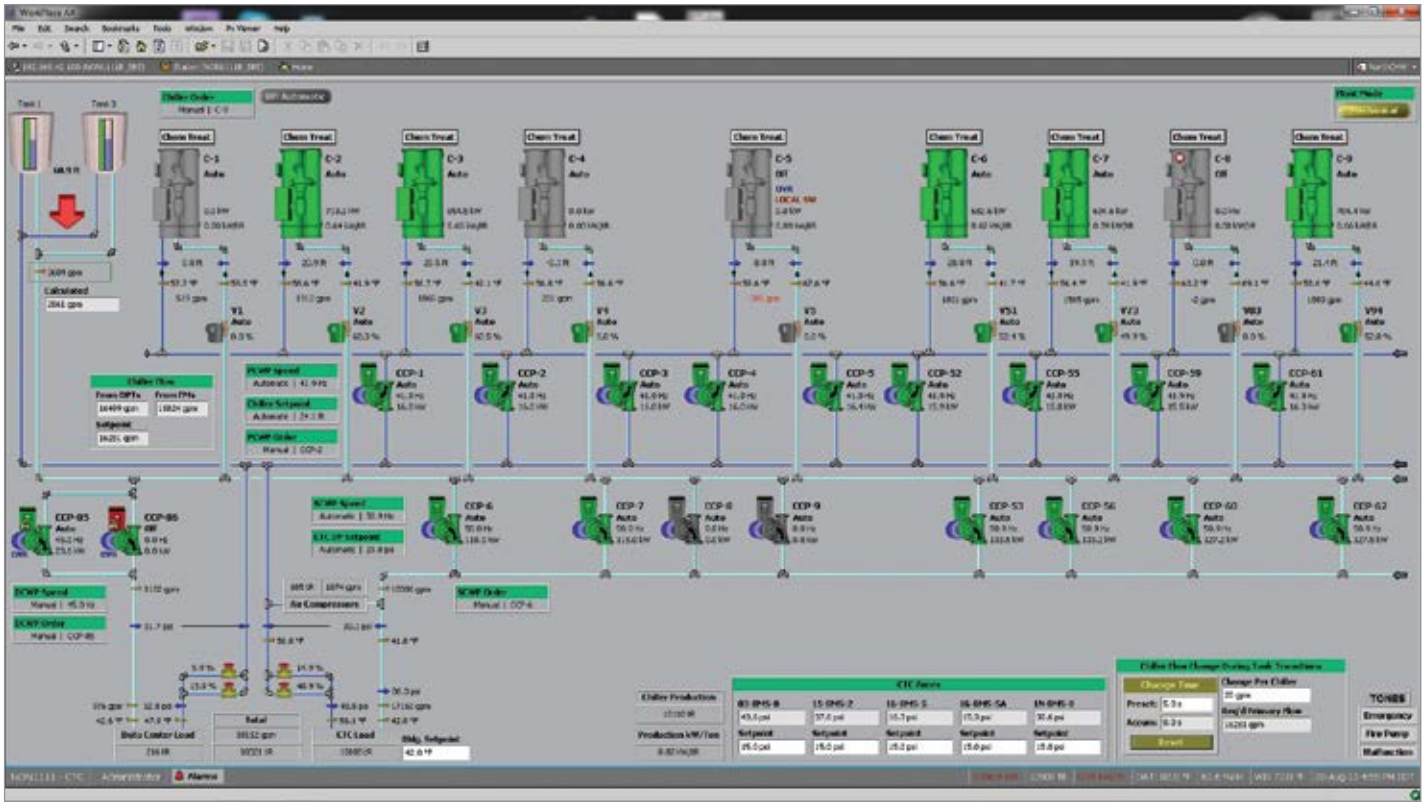
In February of 2013, Phase 1 began as the first set of equipment was modified and tested, while equipment in Groups 2 and 3 were operated manually. With Phase 1 complete and equipment in automatic operation, Phase 2 equipment modification and testing began, while Group 3 continued as a manually controlled backup. With Phase 1 and 2 complete, sufficient equipment was available in full-automatic mode to allow the third and final group of equipment to be converted. All three phases were complete in September of 2013 with a total project completion time of only seven months. Free cooling was tested in November when weather was appropriate, and the plant is now fully commissioned.

Exceeding Project Goals

As a result of tekWorx CEO® implementation, all CTC's requirements and energy goals were met:

- Average annual kW/ton was reduced by 28 percent
- There was no plant downtime
- Project payback of 1.7 years
- Major equipment remained in operation
- New control system and interface
- Remote access available for Sharkey, Fisher, Whitfield and the rest of the Chrysler team
- Project completed in only seven months

An added bonus of this project was the DTE Energy Reduction rebate check. At $200,000, it was the maximum incentive any single project could qualify for under the utility's "Energy Efficient Program for Business."



The tekWorx CEO® User Interface has provided the Chrysler Energy Team with a window into their entire cooling system. Operators are able to use an industrial Human Machine Interface (HMI) to oversee both plant operation and optimization.

ENERGY REBATE

About tekWorx

tekWorx is a leader in chilled water plant optimization. Using proven adaptive control algorithms, tekWorx solutions ensure that plant equipment is operating at its most efficient point. tekWorx cuts cooling and operating costs by 20 to 50 percent, often eliminating any need for new equipment or plant expansions. Visit us at www.tekWorx.us.

Beyond the Numbers

CTC's system now experiences much less wear and tear, and the plant is significantly quieter with less equipment in operation. The CEO® User Interface has provided the Chrysler Energy Team with better insight into their system, as the team is now able to look at equipment more closely for diagnostics and troubleshooting. In addition to the efficiencies gained in the conversion from a manual system to an automatic system, those operators are now freed up for other important tasks.

About the Author

Mike Flaherty is General Manager of tekWorx, LLC, a Cincinnati-based firm that specializes in central energy plant optimization. Prior to founding tekWorx in 2001, he was previously general manager of Parker-Hannifin's international automation business. His product experience includes control software technology for production process equipment. Mike holds a BS in Mechanical Engineering from The Ohio State University.

In addition to this project, tekWorx also completed projects at Chrysler's Dundee Engine Plant, Jefferson North Assembly Plant and Sterling Heights Assembly Plant. tekWorx expertise in hydronics and mechanical systems also extends to boilers, the next phase of optimization at CTC. BP

For more information, contact Mike Flaherty, tel: (513) 373-4287, email: mike.flaherty@tekworx.us, or visit www.tekWorx.us.

To read more about ***Cooling Controls,*** please visit www.coolingbestpractices.com/technology/cooling-controls.

Show Report: CHILLER TECHNOLOGY AT NPE2015 THE INTERNATIONAL PLASTICS SHOWCASE

SIDE is a Barcelona-based PET stretch blow molding machine manufacturer. Pictured are Josep Jimenez and Vincent Duvernois (left to right).

Negri Bossi, a leading thermoplastic injection molding machine manufacturer, had a Frigel Microgel chiller/temperature control unit and a Bauer N2IT™ Gas Assist Molding System supporting their booth equipment.

Frigel's Al Fosco and Lou Zavala (left to right) were presenting the Ecodry 3DK energy and water-saving closed loop adiabatic liquid cooler.

By Rod Smith, Compressed Air Best Practices® Magazine

➤ The NPE 2015 International Plastics Showcase was held at the Orange County Convention Center in Orlando, Florida, March 23-27. The Show attracted 2,029 exhibitors using over 1,128,000 square feet of exhibition space — both figures breaking the all-time NPE records set in 2000. Held once every three years, NPE registered attendance was 65,810 — 19% greater than the 2012 event.

Chiller & Cooling Best Practices Magazine was the only chiller magazine present at NPE, sharing both literature bin and booth space with Compressed Air Best Practices® Magazine! We had a fantastic week signing up subscribers, with the help of an excellent shoe-shine service drawing people into the booth. Visitors confirmed chillers are very high on their radar as they try to manage their water and energy consumption. One visitor was a plastics molding company CFO with four factories. He told me chillers are easily in his "top 3" of energy consumers, however, they were just now introducing a formal energy management program to truly understand the costs – and that's why he'd come to sign up his people for subscriptions!

The chiller industry was very well represented with both their own booths and also in the booths of plastic equipment OEM's. As an example SIDE, a Barcelona-based PET stretch blow molding machine manufacturer, requires and provides chillers with all their units. Export Sales Manager Josep Jimenez said, "We produce specialty bottles (like mineral water or the Lipton Ice Tea bottle) which are 1 ½ to 2 liters in size." Visit www.bottle-blowing-machines.com. I was only able to talk with a sampling of the exhibitors-my apologies go to the many I didn't meet with.

Chiller Technology Focused on Plastics

While Frigel is present in many end use markets, the company has truly specialized in process cooling for plastic injection molding, blow molding, thermoforming and extrusions. Their North American headquarters is a 40,000 square foot facility located near Chicago. The company displayed their Ecodry 3DK closed loop adiabatic liquid cooler, designed to reduce water and energy consumption. "As there is no evaporation of process water, the Ecodry 3DK can reduce water use up to 95% vs. a cooling tower," according to Frigel Global Marketing Manager Al Fosco. "An

average 100 ton system can save up to 1 million gallons of water per year." The unit features an internationally patented adiabatic chamber permitting high temperature ambient condition installation. Energy savings are achieved by the free cooling mode and by brushless, variable speed motors powering the fans. Lou Zavala, Frigel's National Sales Manager, said the market for energy and water-efficient chillers is in it's early stages and gaining momentum. "Particularly out West, we are seeing more and more demand for chiller technology able to deliver water and energy savings." Visit www.frigel.com

Mokon, founded in 1955 and based in Buffalo, NY states on their website that their origins lie in providing close temperature control for injection molding machines. To date they have sold over 50,000 machines worldwide. One of their engineers, Jim Tubinis, was kind enough to review their water-based Full Range combination chiller/heating system with me. The Full Range system is available with heating capacities up to 96 kW and up to 40 Ton chilling capacities. Tubinis explained, "Combining a Mokon water system with an Iceman chiller provides a temperature range of -20˚F to 300˚F (-29˚C to 149˚C)." In addition, Mokon can supply custom higher temperature systems up to 600˚F (315˚C). Tubinis continued, "The Free Range unit has been designed for applications requiring a wide variety of temperatures (both heating and cooling), plants with multi-zone processes and where water supplies are not accessible." Visit www.mokon.com

Multistack is a Wisconsin-based chiller manufacturer with a demonstrated track record of focusing on energy efficiency. Their product literature says they invented the modular water chiller and I've been seeing them for a number of years at the shows produced by the Association of Energy Engineers. At their booth, Regional Manager Andy Booth informed me I was looking at an innovation from Copeland, their new 15 Ton variable speed drive refrigeration compressor integrated into their new MP Series water-cooled chillers for process applications. "We are using the 15 Ton VSD with a 15 Ton fixed speed compressor allowing us to do accurate load matching," said Booth. "This 15 Ton VSD unit is the largest VSD unit Copeland has manufactured and we use it in our 30-80 ton dual circuit designs." The MP can also be ordered in a 10-40 ton single circuit design. Visit www.multistack.com

Reinforcing the Importance of Chiller Reliability and Water Quality

Advantage Engineering, based in Greenwood, Indiana, is a market-leading supplier of industrial heat transfer products including water chillers, temperature control units and evaporative cooling towers. Established in 1977, Advantage operates out of a campus of three manufacturing buildings and one warehouse with over 100,000 square

Mokon Technical Sales Engineer, Jim Tubinis, next to their water-based Full Range combination chiller/heating system.

Andy Patton, from Multistack, next to their new MP10-80 ton chiller featuring 15 Ton VSD and fixed speed refrigeration compressors.

Jon Gunderson from Advantage Engineering.

SHOW REPORT: CHILLER TECHNOLOGY AT THE 2015 NPE INTERNATIONAL PLASTICS SHOWCASE

Steve Fournier from Orival

Ecogreen® chillers feature electronically controlled variable speed drive refrigeration compressors and fan motors.

Euro Chiller from Italy

feet under roof. The company annually manufactures more than 1,000 portable chillers, 100 central chillers and 2,000 temperature control units. Their Vice President of Sales and Marketing, Jon Gunderson, told me most of their customers primarily seek out their products due to the reliability of their machines. "We can provide our clients with all the energy efficiency features they require," Gunderson said. "Their main purchasing driver, however, is reliability so their processes are always supported and optimized with the right temperatures." For some one like me so focused on energy and water conservation, it's always good to get reminded that a day or three of down-time in some plants, can wipe out a year's worth of savings! Reliability is, of course, the base point. Visit www.advantageengineering.com

Ecochillers Inc., based in Guadalajara, Mexico and with sales/warehousing in Miami and Laredo, presented their Ecogreen® compact VFDEC Series chillers. Booth representatives told me it had variable speed refrigeration compressors and fan motors allowing clients to do a better job of matching energy consumption with load profiles. The completely electronically controlled chillers are offered with rotary screw compressors and can be water-cooled or dry coolers with free cooling modules. Visit www.ecochillers.com

Plastic processing machinery requires the removal of solid particles suspended in the process cooling water before it enters their machine. You have to filter that process cooling water and Orival was there with a great cut-away of their ORV Series automatic self-cleaning water filters. The company claims this filter line can slash backwash water use by 90%. "Backwash is the water used to rinse out a filter clogged with solids," said Orival's Steve Fournier. "The ORV is designed for low flow rates of up to 27 gpm and requires only 1-2 gallons per rinse cycle." Visit www.orival.com

There were a number of other chiller and water treatment companies represented with booths I unfortunately did not have the time to meet. They included BERG, Smardt, ONI, Tekleen, Process Cooling, Kiltech and Euro Chiller. Overall, NPE is an incredible show and I would recommend it to any exhibitor or visitor. BP

For more information on NPE 2018 visit www.npe.org or for information on this article contact Rod Smith, Editor, Chiller & Cooling Best Practices Magazine, at tel: 412-980-9901 or email: rod@airbestpractices.com

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Acquiring Energy Incentives for INDUSTRIAL CHILLER SYSTEMS

By Clinton Shaffer, Editorial Associate, Chiller & Cooling Best Practices

Utility companies don't want to build more power plants — period. But as cities grow, more pressure is placed on the energy infrastructure, forcing utility companies to look for ways to reduce energy consumption. One of the methods utility companies use to reduce energy demands is to incentivize building owners to install higher efficiency machinery. By charging ratepayers a little bit of money every month, the utility company creates a fund that can provide substantial rebates to those that apply.

Acquiring those energy rebates, however, can be a complicated, dizzying endeavor — especially when it comes to industrial equipment and the sea of technical documentation that comes along with it. To get a better understanding of the process, I spoke with Panda Aumpansub, M.S.A.E., CEM, who is the Energy Solutions Leader at Havtech Inc., a supplier of HVAC and chiller systems based in Columbia, MD.

During our conversation, Panda shared insights about acquiring energy rebates by installing more efficient industrial chiller systems. As the Energy Solutions Leader at Havtech, she and her team of energy engineers have been helping companies execute incentive applications since 2010 with great results, including the acquisition of substantial utility incentives for both air-cooled and water-cooled chiller systems.

Not a Mail-In Rebate

While incentive programs provide rebate dollars, the term "rebate" can be an oversimplification of the process. You need highly technical information — about both the new chiller system and the facility's energy and load profiles — in order to acquire the incentive. "Rebate" sells the process short.

"You cannot just go get the equipment and mail something in," Panda explained. "It requires careful planning, installation and validation to achieve the energy funds."

According to Panda, there are two different types of applications used to acquire incentive funding for new chillers — prescriptive and custom. Prescriptive applications are easier, and are necessary for simple projects that involve only one chiller. Custom applications are required for multiple-chiller projects, and the process is more comprehensive and time-consuming.

Prescriptive Applications

Prescriptive applications are short and sweet. If a building owner wants to replace a chiller, there are guidelines that indicate the qualifying attributes of the new chiller, including its tonnage, energy efficiency rating (EER or kW/ton), and integrated part load value (IPLV). If the new chiller meets those specifications, the utility company will provide a specified dollar amount per ton, depending on the size and the type of the chiller.

"It's straightforward," Panda said. "You look at the technical data of the chiller, and if it meets those requirements, then you know right away the specific amount of money that they will pay you back."

Once the prescriptive application is completed and submitted, the utility company provides a pre-approval letter. The letter lets the applicant know how much funding he or she will receive with the purchase and installation of the specified chiller. After the installation, the utility company performs a post-inspection, ensuring that the chiller installed

Figure 1: Daikin Magnitude™ Magnetic Bearing Centrifugal Chiller, Size 145 to 400 Tons (© 2015 Daikin Applied)

ACQUIRING ENERGY INCENTIVES FOR INDUSTRIAL CHILLER SYSTEMS

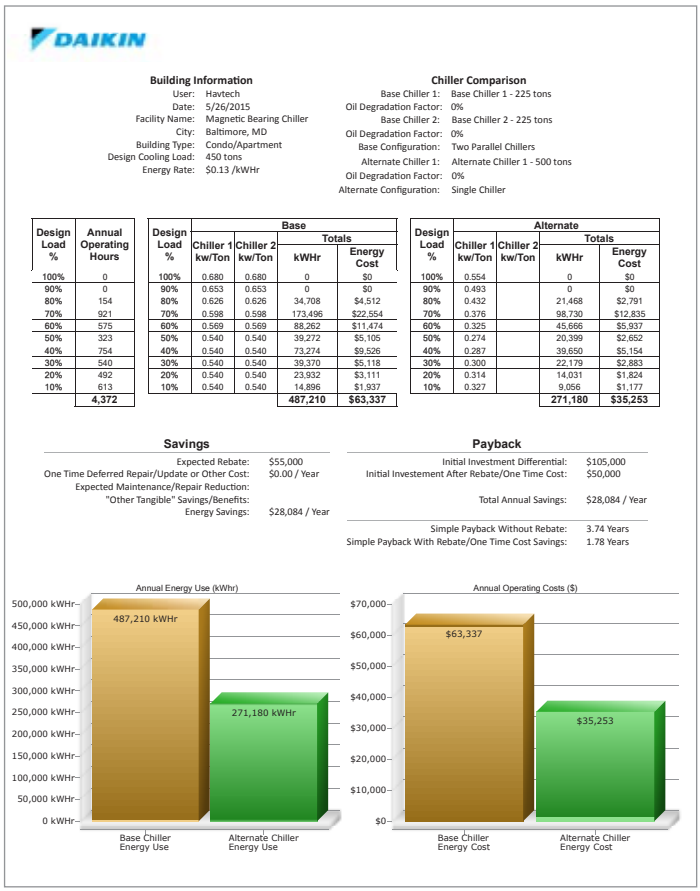
is the same that was listed on the application. If all goes well, the energy incentive check is sent.

Custom Applications

When it comes to multiple chillers running together, the application process becomes much more demanding. Since it is a complex system with many variables (control systems, mechanical systems, occupancy schedule, etc.), the corresponding application is just as complex.

"You can't just look at each chiller separately, so the utility company has created the custom application program," Panda explained. "You have to do an energy model of the whole building and apply actual chiller technical data and the sequence of operations in the model. You also need to know the plant load that the proposed chillers will serve to complete a full-year energy analysis."

In addition, the custom application includes a technical review process, where a review board from the utility company evaluates all of the technical data and does an onsite pre-inspection. Once the back-and-forth of answering questions is finished and the utility company determines that the project is qualified, it sends a pre-approval letter, designating how much money the building owner will receive for completing the project.


DAIKIN

Building Information

User:	Havtech
Date:	5/26/2015
Facility Name:	Magnetic Bearing Chiller
City:	Baltimore, MD
Building Type:	Condo/Apartment
Design Cooling Load:	450 tons
Energy Rate:	$0.13 /kWHr

Chiller Comparison

Base Chiller 1:	Base Chiller 1 - 225 tons
Oil Degradation Factor:	0%
Base Chiller 2:	Base Chiller 2 - 225 tons
Oil Degradation Factor:	0%
Base Configuration:	Two Parallel Chillers
Alternate Chiller 1:	Alternate Chiller 1 - 500 tons
Oil Degradation Factor:	0%
Alternate Configuration:	Single Chiller

Design Load %	Annual Operating Hours
100%	0
90%	0
80%	154
70%	921
60%	575
50%	323
40%	754
30%	540
20%	492
10%	613
	4,372

Design Load %	Base		Totals	
	Chiller 1 kw/Ton	Chiller 2 kw/Ton	kWHr	Energy Cost
100%	0.680	0.680	0	$0
90%	0.653	0.653	0	$0
80%	0.626	0.626	34,708	$4,512
70%	0.598	0.598	173,496	$22,554
60%	0.569	0.569	88,262	$11,474
50%	0.540	0.540	39,272	$5,105
40%	0.540	0.540	73,274	$9,526
30%	0.540	0.540	39,370	$5,118
20%	0.540	0.540	23,932	$3,111
10%	0.540	0.540	14,896	$1,937
			487,210	$63,337

Design Load %	Alternate		Totals	
	Chiller 1 kw/Ton	Chiller 2 kw/Ton	kWHr	Energy Cost
100%	0.554		0	$0
90%	0.493		0	$0
80%	0.432		21,468	$2,791
70%	0.376		98,730	$12,835
60%	0.325		45,666	$5,937
50%	0.274		20,399	$2,652
40%	0.287		39,650	$5,154
30%	0.300		22,179	$2,883
20%	0.314		14,031	$1,824
10%	0.327		9,056	$1,177
			271,180	$35,253

Savings

Expected Rebate:	$55,000
One Time Deferred Repair/Update or Other Cost:	$0.00 / Year
Expected Maintenance/Repair Reduction:	
"Other Tangible" Savings/Benefits:	
Energy Savings:	$28,084 / Year

Payback

Initial Investment Differential:	$105,000
Initial Investement After Rebate/One Time Cost:	$50,000
Total Annual Savings:	$28,084 / Year
Simple Payback Without Rebate:	3.74 Years
Simple Payback With Rebate/One Time Cost Savings:	1.78 Years

Figure 2: Energy analysis showing energy savings, rebate and simple ROI of two potential chiller systems

While the prescriptive application may take up to two weeks to receive a pre-approval letter, it takes much longer to get pre-approved through the custom application process.

"When it's a custom application, you have to go through the technical review, so it's going to take six to eight weeks to complete, and that's not including the engineering," Panda told me. "The engineering going into creating the building energy model and to collect all of the data, along with the report for the application — that's going to take two or three weeks."

Once the custom application is finished, the validation period works just like the prescriptive application. You install the chillers, get them up and running, submit the invoices, and receive the check if the requirements are satisfied. The post-project inspection usually does not take longer than three or four weeks.

Choosing the Right Chiller to Snag Incentives

Selecting the right chiller for your operation is no picnic either — particularly when you are trying to identify one that will help you acquire an energy incentive. And, as Panda told me, there is no single factor that will help you decide.

"There is not one absolute answer, or one key factor, or one single point," Panda emphasized. "That's not how it works."

As a first step, you need to develop an in-depth knowledge of your facility and its demand, or how much energy a chiller consumes in an hour. By monitoring the facility's demand, you can capture how much energy the chiller consumes in a given year. This step is key for developing an energy profile of the building.

Another important aspect of understanding the demand of your facility is determining its load profile. Since chillers are sized for 100 percent occupancy at the hottest time of the year, most chillers will run at part-load conditions for the majority of their lifecycle. To select the most energy-efficient chiller for your facility, you need to determine how many hours the chiller will run at every part-load point. The weather profile at the building location will also have a major impact on how the chiller runs at part load.

According to Panda, high-efficiency centrifugal chillers can unload down to 10 percent. Therefore, you will need to determine how many hours

the chiller will run at 10 percent load, 20 percent load, 50 percent load, etc. Only then will you have an understanding of the chiller's energy consumption. Using that information as an energy efficiency factor, you can compare different types of chillers to determine which type you want to use for a particular building.

Sample Energy Analysis for a Custom Application

To help visualize how the application process works, Panda was kind enough to provide a sample energy analysis that would accompany a custom application (Figure 2). In this case, the utility company was Baltimore Gas and Electric (BGE). The energy study provides a comprehensive look at two potential replacements for an existing, end-of-life, water-cooled centrifugal chiller. To meet the 450-ton cooling load of the high-rise apartment building, the customer has two options:

1. Replace the existing two chillers with standard efficiency chillers per ASHRAE 90.1-2010 standard
2. Replace the existing two chillers with one 500-ton magnetic bearing chiller

As you can see in Figure 2, the energy analysis provides an energy efficiency breakdown at each load, from 10 to 100 percent (To protect any proprietary information, the actual part-load values have been washed from the document). The proposed magnetic bearing chiller would save $28,084 per year in operating costs, and the approved incentive would provide an additional $55,000 in funding. Without the rebate, the simple payback would be 3.74 years. With the rebate, however, the simple payback is reduced to 1.78 years.

Evaluating the Operating Costs of Chillers

In our discussion, Panda also discussed the operating costs associated with different types of chiller systems. The two major groups of chillers are air-cooled chillers and water-cooled chillers. While air-cooled chillers are seen as less efficient than water-cooled chillers, air-cooled chillers are typically used for smaller loads, so you generally won't see them working at the same loads. Water-cooled chiller systems also require additional components, such as a cooling tower and a condenser water pump.

Because water-cooled chillers are used for larger loads, their energy efficiency numbers can be deceiving to inexperienced eyes, as Panda explained:

"When you start with standard-efficiency chillers as a baseline, for example a water-cooled chiller's kW/ton reduction at part load is 0.20 kW per ton, it looks like the number is so little in terms of energy efficiency improvement. But since it is used for such a large load, it saves a lot of energy."

One of the most energy efficient water-cooled chillers is the magnetic bearing chiller. In these machines, the compressor uses magnetic lift to spin the core of the compressor, removing the need for oil. According to Panda, the oil in the machine results in losses in efficiency:

"When you have an oil machine, you lose efficiency along the way because your oils get older and older in the machine. So your energy efficiency drops over time."

About Havtech, Inc.

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The Energy Solutions Team specializes in energy auditing services to help identify energy conservation measures (ECMs), their associated paybacks, and ROIs. Building modeling as well as rebates and incentives are conduits that are utilized to generate energy usage savings and utility expense reductions. Our experts go onsite to assess the building and its systems, and return with energy management solutions that are not only innovative, but affordable.

For more information, please visit www.havtech.com.

Figure 3: Daikin MagnitudeTM Magnetic Bearing Centrifugal Chiller, Size 500 to 700 Tons (© 2015 Daikin Applied)

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Not only does the oil-free operation eliminate losses in efficiency, it also significantly reduces maintenance costs. Oil-operated machines require an overhaul every 5 to 10 years, which can cost up to $50,000 depending on a chiller's size. Frictionless machines do not have oil in the machine, so those costs are eliminated.

Improving Chiller Performance

While there is not one specific measure that will completely fix your chiller system, Panda provided several recommendations to get you off the ground. Often times, retro-commissioning your chiller system to ensure that it is operating efficiently is a good place to start. Over Panda's career, she has seen a lot of buildings where the facility engineers have designed the system to operate a specific way, only to have the system run differently and less efficiently after several years of use.

"Sometimes, with a different set of eyes, you can see something different," Panda said. "Perhaps we shouldn't be running two chillers at full load, we should be running three at part load because it uses less energy." (This, of course, also depends on the specifics of the project.)

Additionally, Panda noted that chiller technology has improved dramatically over the past five to ten years, so facility managers with chillers that are older than 15 years should strongly consider replacing them. If you go through with the project now, while the rebates are still available, you can save a lot of money in capital equipment costs on an upgrade that may be mandatory in the near future.

"Right now, we see the core requirement [for rebates] is geared towards better, higher efficiency chillers to even get the permit," Panda explained. "At some point it is going to be mandatory — and once it's mandatory, I don't know why a utility company would incentivize."

In the end, it comes down to the building owner's preference. It becomes a balancing act between how much rebate funding that person needs to receive, how much energy savings will be generated, and what the lifecycle costs for a new chiller system will be. The overall cash flow generated by the new chiller system is a strong influence on whether an old chiller is replaced with an expensive, high-efficiency chiller or a cheaper, minimum-efficiency type of chiller. Fortunately, utility incentives are around to help with the premium costs of the higher efficiency machines. BP

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Panda Aumpansub, M.S.A.E, CEM

To read more about ***Utility Incentives,*** please visit www.coolingbestpractices.com/energy-manager/utility-incentives.

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Refrigerant: R410A (R407C available only on demand)

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Refrigerant: R134a

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