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

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October 2017

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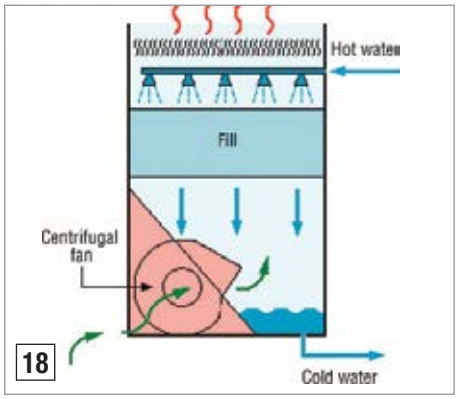

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FROM THE EDITOR

This past year I had the pleasure of meeting Mr. Bo Kuraa, an expert energy efficiency auditor based in Denmark. He's had an interesting career and currently trots the globe optimizing industrial utilities-often for UNIDO. In recent years, he has spent a lot of time on refrigeration and process cooling systems. I hope you enjoy his report on a fish processing plant in Myanmar.

Corrosion and scale are the enemy of all process cooling systems, reducing their efficiency tremendously. Michael Hunter, the Global Technical Director for APTech Group, has provided us with an interesting review of solid-form scale and corrosion inhibitors.

Air compressors are often a major "customer" of the process cooling system. The Air Technology Group, from Hitachi America, provides us with a useful article titled, "Evaluating Air Compressor Cooling Systems." The article reviews six different types of cooling systems used for air compressors.

The article also includes interesting water-use supply information including the fact U.S. Public Supply water use (driven by population growth of 230 to 301 million from 1980 to 2005) grew by 33 percent to 44 billion gallons of water per day. Domestic (home) use made up 58 percent of the total while commercial/industrial facilities (using public water) made up 42 percent of the total. This increase in water demand by the public has been offset by decreases in thermoelectric power, irrigation and self-supplied industrial use. Self-supplied industrial use was down 31 percent, over the same time period, to 31 gallons per day. It's important to note manufacturing employment, over this period, declined by almost 19 percent. Employment in several major water-using industries (primary metals, paper, petroleum) showed even larger declines. As manufacturing hopefully rebounds, in the U.S., efficient water use should continue to be a priority.

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

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CHILLER & COOLING TOWER TECHNOLOGY PICKS

SPX Cooling Technologies Announces New Recold LC Evaporative Condenser

SPX Cooling Technologies, Inc., a full-line, full-service industry leader in the design and manufacture of cooling towers, fluid coolers, evaporative condensers and air-cooled heat exchangers, announces the new Recold® LC Evaporative Condenser. Its unique design reduces refrigerant charge by up to 40 percent, and lowers fan energy consumption by up to 50 percent compared to conventional evaporative condensers.

Well-suited for condensing halogenated refrigerants in supermarket refrigeration systems, small refrigerated warehouses and modular HVAC applications, the Recold LC is an induced-draft counterflow system incorporating patent-pending heat transfer technology and single-piece installation.

With standard unit heights less than 10.5 ft., the Recold LC meets many municipal code height requirements and offers advantages for rooftop installations where low visibility is important. Benefits include single-piece installation, single-point power connection, factory-installed controls, and factory wiring and testing.

The new Recold® LC Evaporative Condenser's design reduces refrigerant charge by up to 40 percent, and lowers fan energy consumption by up to 50 percent.

It includes a bolted stainless-steel collection basin, and all parts exposed to circulating water are heavy-gauge series 300 stainless steel. For convenience, 6-10 gasketless doors per cell can easily be removed for access to interior components.

The Recold LC's copper heat transfer coils resist corrosion and offer superior thermal efficiency, allowing for a compact footprint and a long service life. The bacteriostatic, recyclable coils also weigh 30-40 percent less than galvanized steel coils, require less refrigerant charge and accommodate multiple rack systems.

The unit's high-efficiency, low-sound, electrically commutated motors with direct drive airfoil impellers, require no routine maintenance. Integral speed control eliminates the need for an external variable speed drive. The Recold LC also includes PVC drift eliminators removable for inspection.

For more information on the new Recold LC Evaporative Condenser, visit: http://spxcooling.com/products/recold-lc-evaporative-condenser.

About SPX Cooling Technologies, Inc.

SPX Cooling Technologies, Inc. is a leading global manufacturer of cooling towers, evaporative fluid coolers, evaporative condensers and air cooled heat exchangers providing full-service cooling solutions and support to customers in the power generation, petrochemical, industrial, refrigeration, and heating, ventilation and air conditioning (HVAC) markets for more than 100 years. For more information, please visit www.spxcooling.com. SPX Cooling Technologies and its product brands are part of SPX Corporation.

About SPX Corporation

SPX Corporation is a supplier of highly engineered products and technologies, holding leadership positions in the HVAC, detection and measurement, and engineered solutions markets. Based in Charlotte, North Carolina, SPX Corporation had approximately $1.5 billion in annual revenue in 2016 and more than 5,000 employees in about 15 countries. SPX Corporation is listed on the New York Stock Exchange under the ticker symbol "SPXC." For more information, please visit www.spx.com.

Aircuity Launches 2.0 Platform for Smart Commercial Buildings

Aircuity creator of measurably better environments, announced the launch of its 2.0 platform. Aircuity 2.0 is ideal for a wide variety of commercial buildings looking to significantly reduce energy costs, improve cognitive function and productivity, and achieve quantifiable results as part of a smart building strategy.

Aircuity 2.0 includes the brand new MyAircuity web and desktop apps, delivering actionable out-of-the-box insights, transparency, and accountability to building owners and facility managers implementing demand control ventilation – one of the highest total return on investment energy conservation measures available.

- The MyAircuity web app was designed with users' input, and moves beyond simple data trends to deliver deeper analytics of cost and energy savings, indoor environmental quality responses, and occupant behaviors. The redesigned user interface presents the highest priority information for each stakeholder, on demand or delivered to their inbox or mobile device.
- The MyAircuity desktop app embeds the company's two decades of experience and deep understanding of the complexity and life cycle of airside projects. From concept through

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design to start-up and turn-over, the engineering toolset ensures high quality, properly integrated and cyber-secure implementations.

Aircuity 2.0 also includes physical system upgrades. Among other initiatives, Aircuity made a significant investment to enhance the intelligence of its devices so the system can better "watch itself" and has migrated its data center to Microsoft Azure. The result is increased availability, reliability and security, increasing the return on investment for Aircuity's customers.

Aircuity will be working with their customers to migrate its entire portfolio, over 700 installations in 17 countries, to the new platform so all will benefit from the new features. Aircuity 2.0 was designed with this migration in mind, so the process takes as little as 30 minutes per system.

Since its launch in 2000, Aircuity has been the leader in demand control ventilation and indoor environmental quality solutions. It is implemented at leading institutions such as Michigan State University, Eli Lilly and Google. Aircuity 2.0 further distinguishes Aircuity as the most robust, efficient, and verifiable airside solution available, while also laying the foundation for future development, making Aircuity the smart air platform.

The MyAircuity web app moves beyond simple data trends to deliver deeper analytics of cost and energy savings, indoor environmental quality responses and occupant behaviors.

About Aircuity

Aircuity creates smart airside solutions through its intelligent building platform, significantly reducing energy costs and improving the indoor environmental quality for occupants. As the demand control solution, Aircuity optimizes ventilation rates through its patented technology. As a result, commercial, institutional and lab building owners can lower operating costs, protect occupants and verifiably reduce energy use by as much as 60 percent. Founded in 2000 and headquartered in Newton, MA, Aircuity's solutions have benefited over 400 organizations such as Google, Amazon, Eli Lilly, Masdar City, the University of Pennsylvania, and the University of California-Irvine. For additional information on the company and its solutions, please visit: www.aircuity.com.

Extech Launches New SDL700 Datalogging Pressure Meter

Extech Instruments, a world leader in test and measurement tools, announced the launch of the SDL700 Pressure Meter and Datalogger. The versatile new handheld meter is designed to measure and monitor pressure conditions in HVAC systems, as well as in process control and compressor control systems in industrial settings. The new meter offers users a rugged design with flexible programming configurations, and the convenience of datalogging readings in Excel format directly onto an SD card.

Whether diagnosing and repairing pressure-related problems or performing periodic predictive maintenance to ensure safety, accuracy and reliability, the new Extech pressure meter delivers with unrivaled flexibility to tackle every job. The SDL700 operates in three ranges: 30, 150, and 300 psi using corresponding transducers (available separately), making it easy to use across a range of systems. Plus, the pressure meter expands its measuring capabilities with a wide range of 10 measurement units including bar, psi, kg/cm², mmHg, inHg, mH_2O, inH_2O, atm, hPA, and kPA.

As part of Extech's SDL datalogging instruments family, the SDL700 records directly to a Microsoft Excel® file, eliminating error-prone file conversions or imports, and making it easy to perform data analysis or prepare reports at a later time or at another location. The large backlit display indicates real-time measurements, while data can also be saved to a 4 GB SD card (included) for easy transfer to a laptop or PC. Sampling rates can be set from once every second to nearly once every nine hours. Up to 20 million readings can be stored on one SD card. Up to 99 readings can also be recorded manually in onboard memory. A built-in tilt stand and tripod mounting point make it easy to set up the meter exactly where you need it. (TR100 mini tripod available separately)

Data functions include Min/Max, Zero (for offsetting the meter for relative measurements), and Data Hold. The configurable Auto-Power-Off can be set to save batteries or disabled for extended monitoring.

The meter offers added peace of mind with a three-year warranty from Extech and comes with 6 x AA batteries, 4 GB SD card, and a hard-carrying case. Learn more by visiting http://www.extech.com/sdl700.

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Accessories include: 30 psi Pressure Transducer (PT30); 150 psi Pressure Transducer (PT150); 300 psi Pressure Transducer (PT300); TR100 Mini Tripod and a Universal Power Adaptor (UA100-240) for extended datalogging.

About Extech Instruments

Extech Instruments, a division of FLIR Systems, Inc.'s Instruments segment, is recognized as a leader in handheld test and measurement tools worldwide. Founded in 1971, Extech is known for its depth and breadth of innovative testers and meters suited for electrical, HVAC, building/restoration, as well as a host of environmental testers for measurement of sound, light, humidity and other factors. All Extech meters are distributed worldwide through leading representatives, distributors and OEMs. The company is headquartered in Nashua, NH USA and is ISO 9001 2008 certified. For more information, please visit www.extech.com.

How to Order: Extech's SDL700 is available now from Extech distributors around the world. To find a distributor in your area, please visit our website: www.extech.com

Daikin Applied Launches Rebel Chilled Water Air Handler

Building on the innovative and award-winning Rebel® heating and cooling rooftop platform, comes Daikin Applied's Rebel rooftop air handler. Rebel offers engineers and building owners a customizable chilled water solution featuring segment-leading technologies, providing for a complete single-sourced system. Combined with either Pathfinder® or Trailblazer® air-cooled chillers, users capitalize on the 22+ IPLV performance of an air-cooled chiller for a complete system solution to match their application needs.

Energy efficiency is at the core of the Rebel's design, gaining up to 15 percent energy savings from Rebel's standard direct drive airfoil supply and ECM fans. The factory-installed energy recovery wheel captures and recycles lost energy, increasing the HVAC system efficiency and reducing the mechanical cooling capacity by as much as 30 percent to help exceed AHRI and ASHRAE 90.1-2016 standards.

In addition to the advanced, embedded technology found in the Rebel air handler, its smaller footprint improves building aesthetics. The Rebel air handler also has improved sightlines to meet architectural and municipality mandates.

The Rebel air handler gains up to 15 percent energy savings from its standard direct drive airfoil supply and ECM fans.

For more information about Daikin chillers, contact your local Daikin Applied sales office or visit www.DaikinApplied.com to find an office near you.

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Daikin Applied

Daikin Applied, a member of Daikin Industries, Ltd, designs and manufactures technologically advanced commercial HVAC systems for customers around the world. Customers turn to Daikin with confidence they will experience outstanding performance, reliability and energy efficiency. Daikin Applied equipment, solutions and services are sold through a global network of dedicated sales, service, and parts offices. For more information or the name of your local Daikin Applied representative, call 800-432-1342 or visit, www.DaikinApplied.com.

About Daikin Industries Ltd.

Daikin Industries, Ltd. is a Forbes 1000 global company with 2014 revenues of nearly $16 billion and more than 60,000 employees worldwide, making it the largest HVAC manufacturer in the world. Daikin is engaged primarily in the development, manufacture, sales and aftermarket support of heating, ventilation, air conditioning and refrigeration (HVACR) equipment, refrigerants and other chemicals, as well as oil hydraulic products. Daikin was named one of the world's most innovative companies by Forbes magazine. For more information, visit www.daikin.com.

GF Piping Systems Introduce COOL-FIT ABS Plus Piping Solution

The COOL-FIT® ABS Plus Piping System from GF Piping Systems is a fully pre-insulated plastic piping system for secondary cooling and refrigeration featuring energy-efficient, non-corroding, maintenance free performance. These features make it ideally suited for food production, process cooling, cold storage, beverage production, supermarkets, dairies, air conditioning and others.

The demand for fresh/cooled food worldwide is steadily increasing along with energy prices.

The COOL-FIT ABS Plus is designed for conveying water-based coolants with temperatures from -58˚F to 104˚F (-50˚C to +40˚C).

Cooling is now the principal consumer of energy around the world. Energy-efficient piping systems are becoming increasingly important in order to reduce operating costs. Pre-Insulated plastic piping by GF Piping Systems is an innovative system solution for consumers with special environmental care and operating cost savings in mind.

COOL-FIT ABS Plus has a core pipe made of ABS, insulated with high density polyurethane (PUR). The insulation is protected with a black, water-tight and UV resistant polyethylene jacket, making it suitable for outdoor use. In addition, the entire system is completely diffusion and vapor tight. COOL-FIT ABS Plus is designed for conveying water-based coolants with temperatures from -58˚F to 104˚F (-50˚C to +40˚C) at an operating pressure of up to 10 bar, and within diameters from ¾" to 12" (d25 to d315).

The insulation for the system has a constant thickness on both pipes and fittings, as well as thermal conductivity of 0.023 W/(m * K). The energy loss is minimized and thermal bridges are eliminated, making COOL-FIT ABS Plus the ideal system to efficiently run cooling installations.

This ready-to-install pre-insulated system maintains its original properties for its complete lifespan of 25 years. COOL-FIT ABS Plus is corrosion and incrustation proof. The nominal bore is maintained throughout the installation lifetime, and as a result, there is no increase in pressure drops, maintaining efficient low pumping energy requirements. The production of COOL-FIT ABS Plus generates a much lower CO2 footprint than any other metal production, from 40% to 60% lower depending on the type of metal.

GF Piping Systems has also launched a complementary range from 10" to 18" (d250 up to d450) of COOL-FIT PE Plus. Following the same principle of COOL FIT ABS Plus, the PE system only differs in the core pipes and fittings, manufactured in PE for this range. Consequently, the jointing technology of electrofusion pre-insulated PE sockets enable an efficient and quick assembly of the system.

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About GF Piping Systems

GF Piping Systems supplies a full range of plastic pipe, fittings, valves, actuators, fusion machines, secondary containment, heat exchangers, custom products, and sensors and instrumentation for industrial process control. For more information on the new 604/605 Valve, click here. For further information, please contact: GF Piping Systems, 9271 Jeronimo, Irvine, CA 92618-1904 USA; Toll Free (800) 854-4090, Fax (714) 731-6923; e-mail: us.ps@georgfischer.com; Web: www.gfps.com

Geoclima Achieves AHRI WCCL Certification.

Italian chiller manufacturer Geoclima is very proud to announce they earned the trusted AHRI Certified® mark, an assurance of the product's performance, for the water cooled range of products as an Original Equipment Manufacturer.

With AHRI WCCL certification customers and end-users are assured that Geoclima Water Cooled Chillers will perform in accordance with the performance values declared in the technical documentation and in the selection software Geoselectool. In fact, although it is not mandatory, AHRI certification is worldwide considered to be the major standard and the most trusted source of performance certification for heating, air conditioning, water heating and commercial refrigeration equipment. It is often a specified requirement by Consulting Engineers, Building Owners and Contractors everywhere, from Australia to the USA.

A GHH water-cooled chiller with screw refrigeration compressors.

"We are very proud to be part of the AHRI WCCL Certification Program" said Paolo Ferraris, President of Geoclima. "The AHRI WCCL Certification enables us to give our customers further and stronger assurance of performance".

On-site testing was carried out by CETIAT, an independent laboratory under contract to AHRI, at Geoclima's test centre. Tests were carried out on both small and high capacity water cooled Turbomiser and scroll chillers – as samples of the complete Geoclima water-cooled chillers range – that were tested at part load and full load capacity. To find AHRI Certified® products go to www.ahridirectory.org.

AHRI WCCL Certification represents a key milestone in Geoclima's international growth strategy. With sales offices and production in Italy, Russia, Thailand and Australia, the company is currently branching out to the USA and AHRI WCCL certification makes Geoclima a trust-worthy brand and a reliable partner for customers worldwide.

Geoclima is an Italian company with more than 20 years of experience in the HVAC sector, specialized in the design and production of non-standard chillers for applications in air conditioning and refrigeration systems, with particular attention to quality and the environment.

Established in 1994 in Italy, Geoclima has continued to expand worldwide and it is now present in Italy, Russia, Thailand and Australia and a new sales office in the USA

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is coming in 2017. Geoclima group also includes companies specialized in production of AHUs, heat exchangers and flanges. This presence in different countries and in different areas of HVAC makes it possible for Geoclima to provide complete service and turnkey solutions.

For more information, visit www.geoclima.com or send an email to info@geoclima.com

AHRI Certified® is the trusted mark of performance assurance for heating, ventilation, air conditioning, and commercial refrigeration equipment.

Technical Systems Announces Waterside Economizer Systems for Air Cooled Chillers

Technical Systems announced the availability of a range of factory built to order air cooled chiller products using integral waterside economizer systems. These waterside economizer solutions are designed for applications where cooling operations must run all year round. They are ideal for owners of data centers, manufacturing facilities, or process loads who want to benefit from partial or free cooling to decrease their utility bills and improve system reliability. They lower the total kilowatts of energy used, reducing utility costs and decreasing customers' total cost of ownership.

Fluid running through the economizer's chiller system is passed through free cooling coils before running through the evaporator. This lets the cold ambient air do the cooling, taking the load off the compressors. Instead of continuing to run compressors for cooling, the waterside economizer makes use of the cold ambient air to do the job. Unlike some other designs, the TSI economizer system is capable of both full and partial free cooling, dramatically improving the hours of free cooling available each year. It reduces the overall kilowatts of energy used compared to typical off-the-shelf commercial chiller products, requiring running compressors all year long.

Technical Systems' waterside economizer systems are integrated into a single factory built to order packaged system, with all components from a single source. Waterside economizer systems can be tailored to specific site conditions and requirements, simplifying the ordering process and saving time compared to modifying and recertifying other off-the-shelf units.

Technical Systems has had 45 years of experience manufacturing built to order refrigeration systems, and has used this expertise in developing the waterside economizer. The product has evolved to keep pace with industry standards and code requirements, while increasing efficiency and reducing energy costs for year-round cooling applications. TSI is a division of RAE Corporation.

About RAE Corporation

RAE Corporation, family-owned and headquartered in Pryor, Oklahoma, is an industry leader in the design manufacturing of custom-engineered cooling and refrigeration systems. RAE's expertise allows the company to design top-quality systems to meet the specific needs of their customers. RAE designs and manufactures products in four divisions: Century Refrigeration, RAE Coils, Refrigeration Systems and Technical Systems. For more

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information about the high-quality, made-in-the-USA cooling and refrigeration systems manufactured by all four of the company's divisions, visit www.RAECorp.com.

Asahi/America Introduces COOLSAFE Pre-Insulated Piping System

Asahi/America, Inc., the leader in thermoplastic fluid flow technologies, introduces COOLSAFE™ pre-insulated piping system for chilled media. COOLSAFE™ is a cost effective complete system consisting of a polyethylene inner layer, a polyurethane insulation core and a polyethylene outer layer. Onsite installation labor is dramatically reduced because the pipe and fittings are pre-insulated at the factory.

Asahi/America's COOLSAFE™ installs easily using conventional butt or electrofusion welding methods. The PE-inner by PE-outer design allows the system to be simultaneously butt welded, saving installation time and providing a safer installation.

COOLSAFE™ components are molded and insulated to strict tolerances to ensure easy installation, and long-term insulation of chilled media. COOLSAFE™ provides thermal conductivity better than 0.026 W/m-K (0.015 Btu-ft./h-ft2-F).

COOLSAFE™ is available in sizes 32mm–250mm (1"–10"), and is in stock now at Asahi/America. The COOLSAFE™ pre-insulated piping system includes a complete range of fittings, and is supported by Asahi/America's extensive welding equipment fleet. Asahi/America's Type-21 ball valves and Type-57 butterfly valves can be incorporated into the COOLSAFE™ system to control flow.

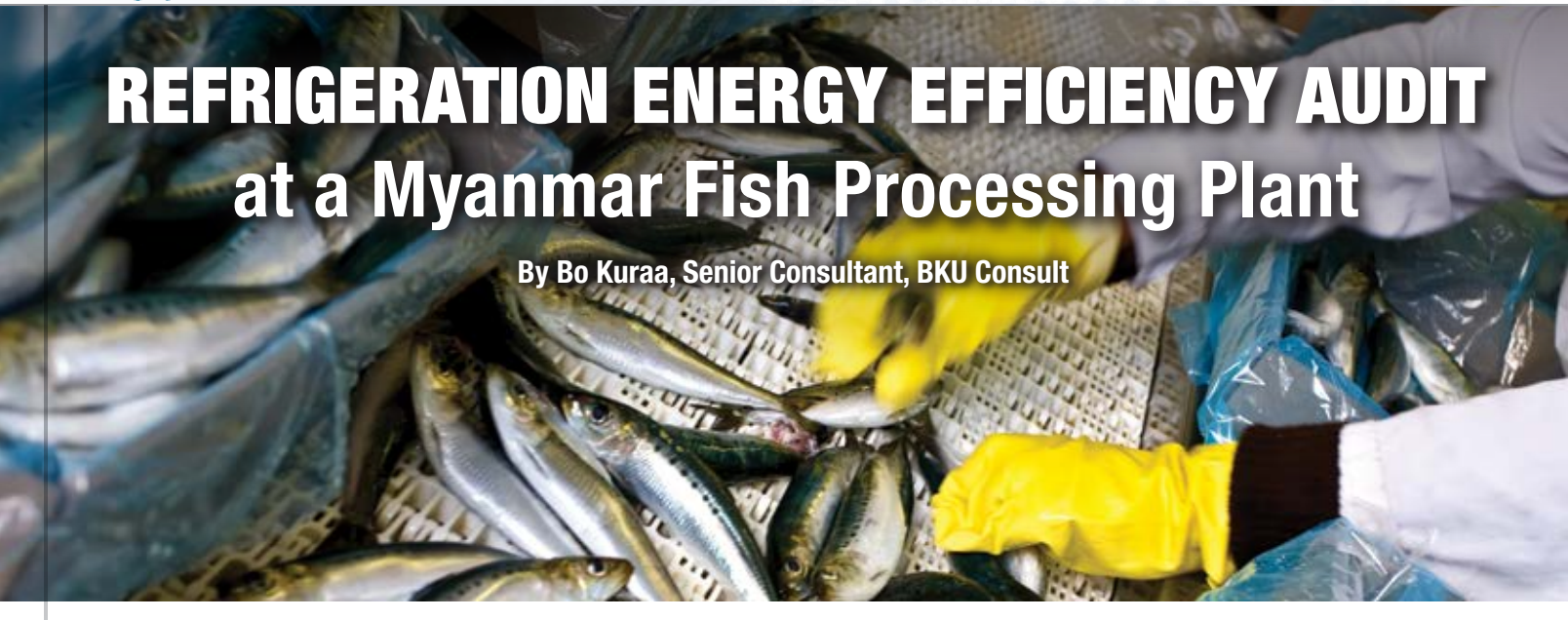
Ideal applications for Asahi/America's COOLSAFE™ piping system include commercial refrigeration, brewery and winery chilling, secondary cooling of food production, cold storage facilities and central plant HVAC systems.

About Asahi

Asahi/America, Inc. specializes in providing solutions for fluid handling systems, individualized to meet virtually any customer's need. Asahi is a leading manufacturer of corrosion resistant thermoplastic fluid handling products including valves, actuators, pipe and fittings. The company maintains an extensive custom fabrication department, and provides on-site consultation, supervision and training where required.

For more information contact: Asahi/America, Inc., 655 Andover Street Lawrence, MA 01843. Call toll free 800-343-3618 or 781-321-5409. Fax 800-426-7058. Send an email to asahi@asahi-america.com or visit Asahi online at www.asahi-america.com.

The new COOLSAFE™ provides thermal conductivity better than 0.026 W/m-K (0.015 Btu-ft/h-ft2-F).



REFRIGERATION ENERGY EFFICIENCY AUDIT at a Myanmar Fish Processing Plant

By Bo Kuraa, Senior Consultant, BKU Consult

This article contains pieces from an audit report developed for a fish processing plant located in Yangon, Myanmar. The objective is to show factories the information they may want to have gathered on their refrigeration systems and supporting cooling systems.

The fish processing plant carries out cutting and filleting of fish; imported fish as well as fish from local suppliers. In the year 2016 the production totalled 336,382 kg. The electricity consumption accounts for just under 800,000 kWh/year of which about 70% is consumed by the refrigeration plant (compressors) or energy consuming equipment (e.g. fans and pumps) related to the freezing of the final products.

The total energy saving potential is estimated to be approximately 18% of the electricity consumed by the refrigeration plant (in 2016: 543,637 kWh) divided between the following opportunities – see table 1.

It is noted that the improvements carried out on the refrigeration system in certain areas will improve the cooling performance (capacity) and do not result in energy savings. It is also noted that an optimized refrigeration system will postpone the need for additional cooling

TABLE 1

OPPORTUNITIES	ELECTRICITY SAVING [KWH/YEAR]	INVESTMENT [NO, LOW, MEDIUM OR HIGH COST]	COMMENTS
Light in cold storage and freezing rooms.	3,022 (0.6%)	Medium	Will improve the light level. Will reduce the maintenance.
Use of entrance room.	Estimated 4,000 (0.7%)	Low	A test should be carried out – can be done by the staff of the company.
Defrosting – Optimized Strategies.	16,300 (3%)	No	Improved maintenance of the defrosting system (water system) is recommended.
Insulation of piping – Refrigeration.	18,000 (3.3%)	Low	Improved maintenance of the pipe insulation is recommended.
Maintenance – Evaporative Condenser.	55,000 (>10%)	Low	The remaining service life of the condenser should be evaluated by professionals. Implementation of the project will increase the cooling capacity and save energy.
Water Treatment – Ground Water.	Not estimated	High	Energy: Will improve especially the performance of the evaporative condenser and the defrosting system. Will reduce the needed maintenance level (cost).

TABLE 2

YEAR 2016	ELECTRICITY [KWH]	PRODUCTION [KG]	CDD (REF. TEMP. = 0)	CDD (REF. TEMP. = 15)
			YANGON, MM (96.17E,16.77N)	
January	66,660	28,301.06	745	280
February	65,890	30,446.82	773	338
March	33,440	3,524.90	921	456
April	49,500	9,692.80	949	499
May	65,560	33,969.00	942	477
June	66,770	34,682.40	824	374
July	71,610	34,279.30	847	382
August	71,280	32,925.50	841	376
September	69,410	31,509.70	819	369
October	72,930	34,405.10	853	388
November	74,250	30,858.80	828	378
December	72,930	31,786.80	837	372
Total:	**780,230**	**336,382.18**		

The table shows the total production and electricity consumption compiled on a monthly basis.

capacity in the form of investment in new and larger refrigeration compressors.

The Energy Intensity Baseline for Refrigeration

The company records the production in [kg] on a daily basis. The production consists of the five following main products:

- Barr (Fillet)
- Barr CMP
- Crab (Whole)
- Barra (Maw)
- Flathead (Portion)

In the baseline calculation the total production in [kg/month] is applied as an indicator for production.

The electricity consumption accounts for just under 800,000 kWh/year – in 2016: 780,230 kWh. Note: Electricity generated at the GenSet (diesel generator) associated with power outages are not included in the calculation since the company does not record any GenSet data; e.g. hours of operation, diesel consumption or kWh's produced.

The table and the graph below (table 2 and figure 2) show the total production and electricity consumption compiled on a monthly basis.

The Refrigeration System Baseline

The refrigeration plant is a two stage, closed intercooler ammonia (R717) system consisting of three reciprocating compressors of the brand MYCOM (see Figure 2), gravity flooded evaporators and an evaporative condenser (cooling tower). The plant is estimated to be approximately 20 years old and is in an acceptable maintenance-related condition. However, the system is insufficiently instrumented, and certain essential instruments do not work or is assessed to display wrongly (not calibrated).

Piping and instrumentation diagrams/drawings (P&ID) do not exist anymore, so it was considered necessary to make the following schematic illustration (see Figure 3) of the functional relationship between piping and system components.

The cooling performance is distributed to four "consumers" – Cold Store 1, Cold Store 2, a blast freezer and a flake ice machine.

The production takes place in the period 8am-5pm on workdays, six days a week. There will be public holidays in March and April

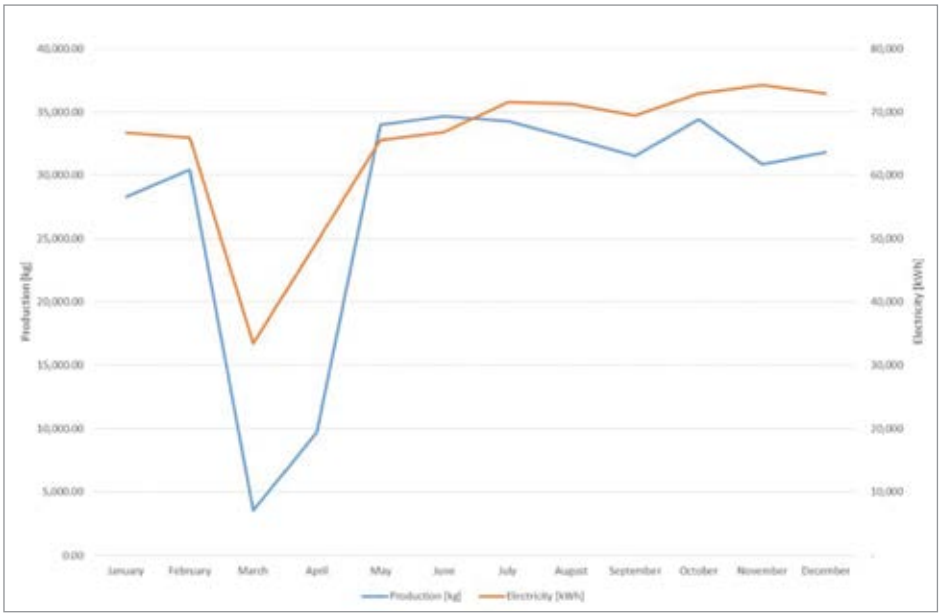


Figure 1. The graph shows the total production and electricity consumption compiled on a monthly basis.

Figure 2. The refrigeration plant is a two stage, closed intercooler ammonia (R717) system consisting of three reciprocating compressors of the brand MYCOM – first in the image C1 (50 HP), C2 (50 HP) and C3 (75 HP).

REFRIGERATION ENERGY EFFICIENCY AUDIT AT A MYANMAR FISH PROCESSING PLANT

TABLE 3. BASELINE – REFRIGERATION.

BASELINE – REFRIGERATION			POWER [KW]	NAME PLATE [KW]	LOAD FACTOR	TIME IN OPERATION FACTOR	ENERGY CONSUMPTION [KWH/YEAR]
HOURS OF OPERATION:	8,500 [H/YEAR]						
VOLTAGE (AVERAGE):	390 [V]						
	AMP	PF					
Comp. 1	42.0	0.79	22.4	37	0.61	0.80	152,409
Comp. 2	42.0	0.79	22.4	37	0.61	0.80	152,409
Comp. 3	60.0	0.79	32.0	55	0.58	0.34	92,534
Cooling Tower – Fans and pumps	23.0	0.47	7.1	?	?	0.90	54,315
Cold Store 1 – Fans	2.6	0.80	1.4	?	?	0.80	9,520
Cold Store 2 – Fans	12.1	0.74	6.6	?	?	0.80	44,880
Freezing Room – Fans (estimated)	?	?	3.0	?	?	0.34	8,670
Flake Ice (estimated)	?	?	4.0	?	?	0.85	28,900
						Total:	**543,637**
Total electricity consumption 2016 (grid):			780,230 [kWh]			**Refrig.:**	**70%**

– consequently the total production time is estimated to be approximately 2,400 hours/year.

During the workday, the finished products are prepared for freezing in the blast freezer. The blast freezer is operated during the night time – approximately from 9pm to 7am the next morning. When the blast freezer is in operation, two compressors are in operation; compressor 3 (75 HP) together with compressor 1 or 2 (50 HP). When the blast freezer is not in operation, compressors 1 and 2 are in operation.

Based on interviews of the staff of the company and a number of short-time measurements with a Fluke Power Analyzer and ACR amps and temperature loggers, a baseline has been

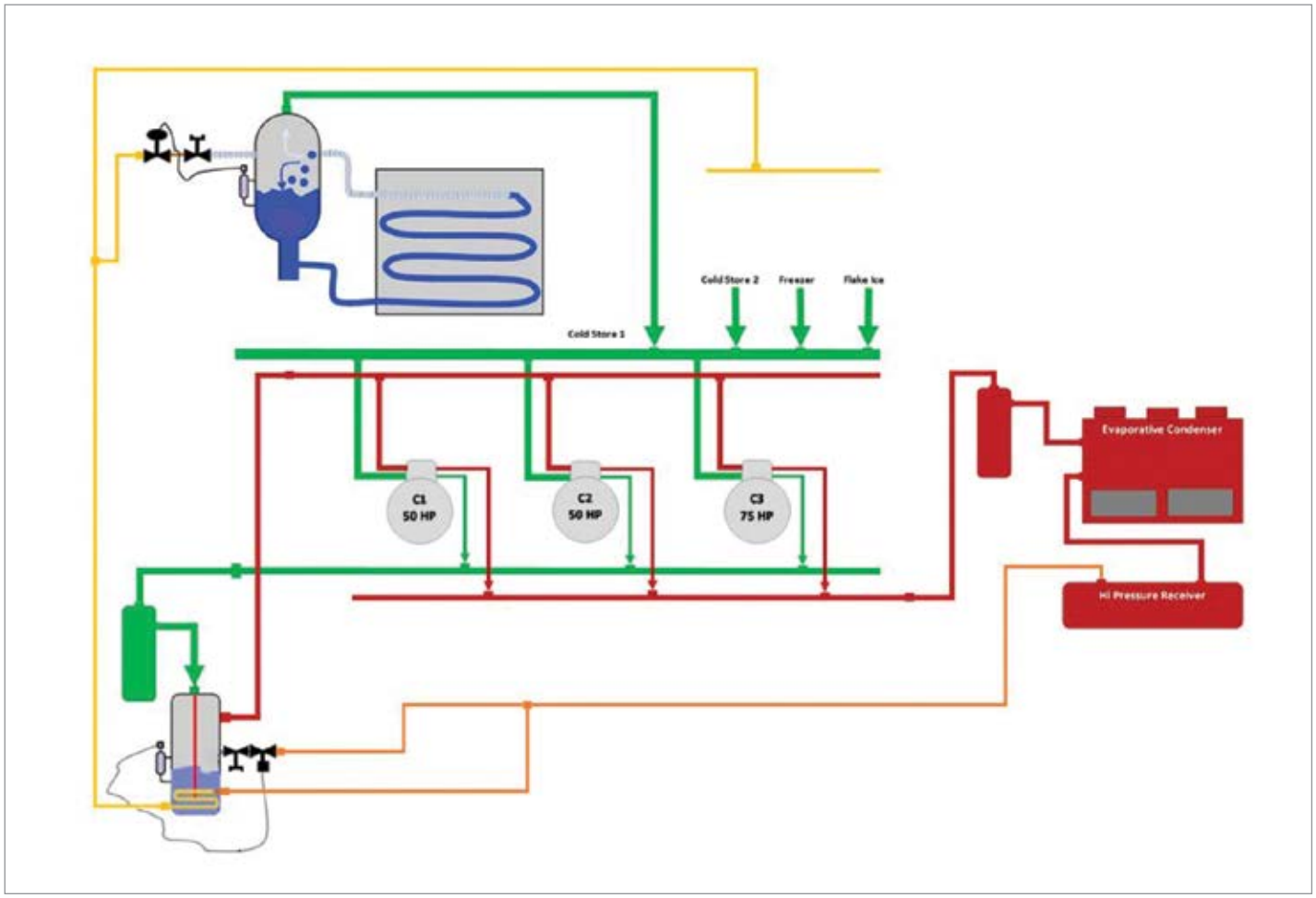


Figure 3. A schematic illustration of the functional relationship between piping and system components.

calculated concerning the electricity consumed by the refrigeration plant on an annual basis – see table 3.

It is clear from the result that the consumption of electricity for refrigeration accounts for about 70% of the total annual electricity consumption from the grid.

Insulation of Refrigeration Piping

The primary concern with refrigeration and air-conditioning pipe and ductwork is that surface condensation may occur. Condensation not only accelerates the rate of pipe corrosion but can also severely impact on the heath of building occupants. Insulation used on refrigeration and air-conditioning pipe and ductwork must prevent condensation and extend the working life of pipework whilst also restricting energy loss.

It is recommended to use jackets for insulated pipes where appropriate (incl. bends, fittings, flanges etc.) to protect against mechanical impact, sun light, birds etc. Insulation of cold systems should be made with micro-cellular cross-linked polyethylene foam with low water vapor diffusion. The insulation thickness of chilled water, refrigerant and brine systems should not be less than indicated in table 4.

During the examination, it has been estimated that approximately 8% of the total cooling capacity equivalent to 3.3% of the electricity consumed by the refrigeration system can be saved. A simple payback calculation should be made based on annual operation, electricity price and cost price of the improved/new insulation.

Maintenance – Evaporative Condenser

An evaporative condenser is a condenser cooled by ambient air combined with water sprayed through orifices and air baffles in counter flow with the air. The water evaporates and the evaporation effect of the water drops

System	Operation Temperature		Pipe Size *(inches)*				
			< 1"	1 1/4" - 2"	2 1/2" - 4"	5" - 6"	> 8"
	(°F)	(°C)	Insulation Thickness *(inches)*				
Chilled Water	40 - 55	4 - 12	0.5	0.75	1.0	1.0	1.0
Refrigerant	< 40	< 4	1.0	1.5	1.5	1.5	1.5
Brine	< 40	< 4	1.0	1.5	1.5	1.5	1.5

Table 4. The insulation thickness of chilled water, refrigerant and brine systems. Source: The Engineering ToolBox.

REFRIGERATION ENERGY EFFICIENCY AUDIT AT A MYANMAR FISH PROCESSING PLANT

adds much to the condenser capacity. Today's evaporative condensers are enclosed in a steel or plastic enclosure with axial or centrifugal fans at the bottom or at the top of the condenser.

In relation to the heat transfer (thus the efficiency), it is essential that the evaporative condenser is kept clean and that the water used is treated water, including the condenser is maintained regularly and operated correctly. The evaporative condenser, as its name implies, evaporates water in order for heat transfer to occur. However, this process leaves behind impurities. A dirty condenser will cause the condensing pressure increases – hence the compressors will consume more power.

The condenser at the plant is dirty and needs a thorough cleaning. There is a significant layer of scale on the condenser – in the magnitude of 1-3 millimeters (1/16 inches = 1.6 mm). The most common form of scale deposited on piping and heat exchangers is calcium carbonate ($CaCO_3$). Calcium hardness and carbonate alkalinity are naturally dissolved in water typically used for evaporative cooling make-up. However, the amount of calcium carbonate in a given water supply can vary widely depending on water source.

The terms "Hard Water" and "Soft Water" typically refer to the amount of calcium and magnesium found in the water. Hard water is high in calcium and/or magnesium while soft water is low in these minerals. Even minimal amounts of scale on the condensing coil surface will affect the performance of evaporative condensers.

The evaporative condenser is estimated to be the cause of a 3-5°C higher condensing temperature as compared to a clean condenser. A calculation made in the software "CoolPack" shows a reduction in compressor power consumption of more than 10% if the evaporative condenser is cleaned (condensing temperature is reduced) – Coefficient Of Performance (COP): 2.46 → 2.72.

Keeping surfaces clean within a cooling tower or evaporative condenser not only ensures that the thermal performance is optimized: it also avoids the growth of biofilm and harmful bacteria, including legionella.

Figure 4. The evaporative condenser at the plant.

Cleaning is not a substitute for water treatment but part of an overall programme for effective bacteriological control.

It is recommended that cooling towers and evaporative condensers are cleaned at least once a year or twice as per country specific legislation requirements. The company has expressed concerns in connection with a thorough cleaning of the condenser since it is assumed to be corroded in some places and may subsequently be leaking. The condenser has previously been changed due to corrosion – another argument for better water treatment as this helps to maximize the service life of the equipment.

Only a thorough cleaning does not solve the problem. A well designed water treatment program has to be implemented. Which treatment of the water is the correct, must be based on an analysis of the water – including the choice of the filtration method, e.g. a sand filter.

Blowdown

Another important issue is the "blowdown" or the "bleed rate". The concentration of total dissolved solids (TDS) will increase in the closed-loop system as the water evaporates. Bleeding off the system water by

> "A well designed and consistently implemented water treatment program will help to ensure efficient system operation while maximizing the equipment's service life."
>
> — Bo Kuraa, BKU Consult

blowdown or purging is usually necessary to prevent scale building up in cooling towers and evaporative condensers, which can impair efficiency or structurally damage the unit.

Typically, TDS concentrations in the cooling water should be no more than 2,000 – 3,000 mg/litre, but this will depend on specific operating conditions. Blowdown can be controlled manually, by timer or automatically. Automatic methods are usually based on conductivity measurement, which is proportional to TDS concentration. Using an automatically controlled system is preferable because TDS concentrations are monitored constantly, resulting in smaller volumes of water being blowdown more frequently to maintain the concentration within the desired range, minimizing the total amount of water discharged.

The amount of blowdown water required can be estimated using the make-up water TDS concentration and desired maximum TDS concentration in the cooling water.

$$\frac{\text{TDS of feed water } \left[\frac{\text{mg}}{\text{liter}}\right]}{\text{Maximum increase in concentration of TDS } \left[\frac{\text{mg}}{\text{liter}}\right]} \times 100$$

For example, for water with an average TDS concentration of 400 mg/litre and a required maximum TDS in the cooling water of 2,000 mg/litre:

$$\frac{400}{2{,}000 - 400} \times 100 = 25\% \text{ of make-up water flow}$$

Blowdown is usually discharged to drain, but there is an increasing trend to re-use this water provided that the water quality allows.

Actions:

1. Check if the blowdown water volumes are known. If not, try to measure or calculate them.
2. Determine if blowdown volumes can be reduced, possibly by improving treatment of the make-up water.
3. Investigate whether blowdown can be automated.
4. Investigate the potential for blowdown water to be re-used.

Water Treatment – Ground Water

The company uses a "second quality" of water in connection with defrosting and as make-up water to the evaporative condenser. The water is pumped up from the underground (own well) and then filtered in the reservoirs. The filter material is rice husk. At first sight, the water looks pure, but contains presumably quite a lot of minerals, e.g. calcium carbonate ($CaCO_3$) – "Hard Water". The terms "Hard Water" and "Soft Water" typically refer to the amount of calcium and magnesium found in the water. Hard water is high in calcium and/or magnesium while soft water is low in these minerals.

Scale forms on the external surfaces of a heat exchange coil because it is the hottest part of the system. Calcium carbonate has an inverse solubility in water. This means that the warmer the water becomes, the less calcium carbonate can be held in solution. The outside surface of the heat exchanger is the interface point where calcium carbonate is the least soluble and where scale tends to form first when the water becomes super-saturated with calcium carbonate.

Proper water treatment is an essential part of the maintenance required for evaporative condensers. The water related problems that occur in an evaporative condenser can be broadly classified as:

- Deposits/Scale.
- Corrosion.
- Microbiological Growth.

A well designed and consistently implemented water treatment program will help to ensure efficient system operation while maximizing the equipment's service life. The treatment of the water, which is correct, must be based on an analysis of the water – including the choice of the filtration method, e.g. a sand filter. Concentration ratios of around 3:1-5:1 are typical for many cooling tower and evaporative condenser installations, but these will depend on feed water quality and optimal TDS or specific ion (e.g. chloride) levels.

To prevent scaling and minimise blowdown, most makeup water will need some form of pre-treatment, which include:

- Softening (changing the chemical composition of some of the dissolved salts) to reduce scaling; and
- Demineralization or reverse osmosis to remove the majority of TDS.

Water treatment is a science in itself and it is outside the scope of this report to address the issue further. Note! If a chemical water treatment program is used, all chemicals selected must be compatible with the units materials of construction as well as other equipment and piping used in the system. BP

For more information contact Bo Kuraa, Senior Consultant, BKU Consult, Denmark, email: bku@aura.dk

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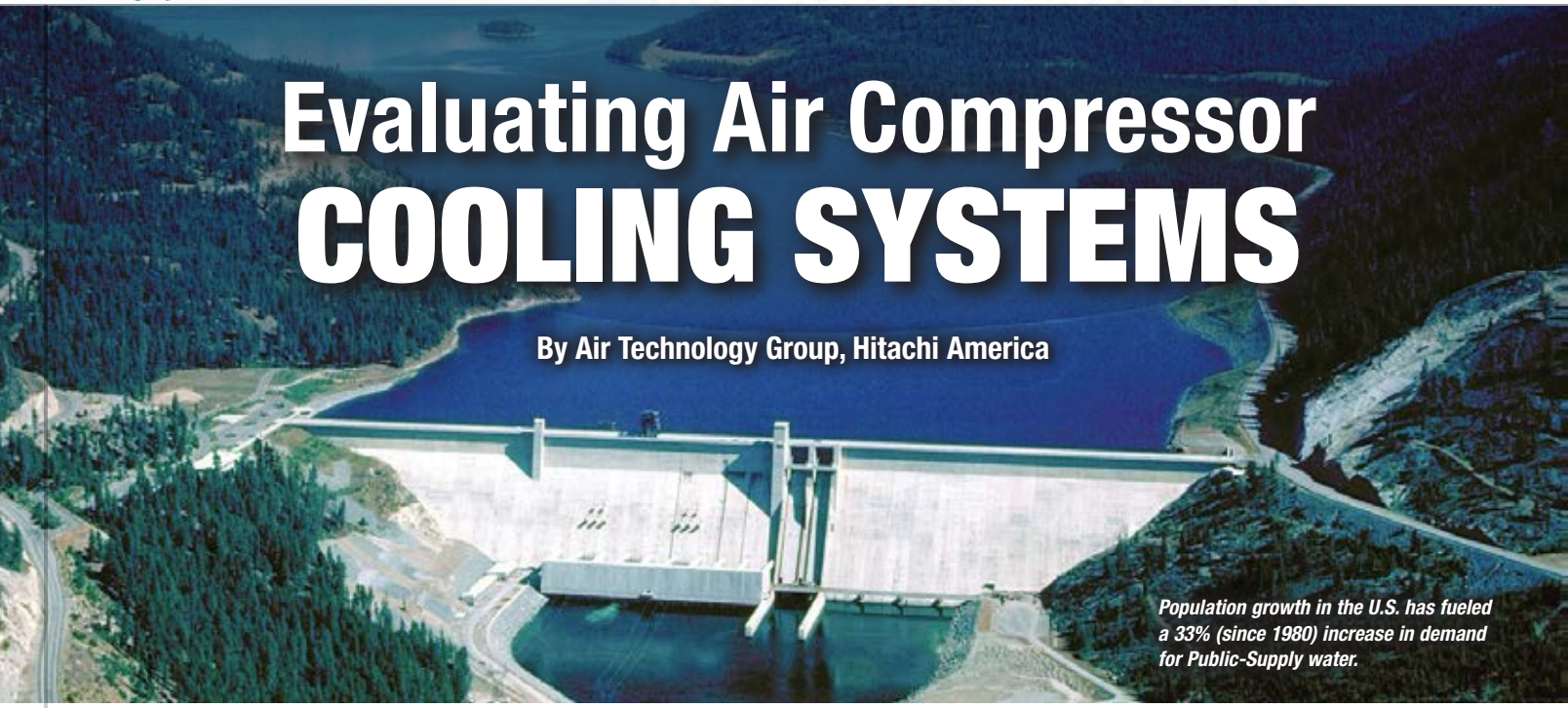
Evaluating Air Compressor COOLING SYSTEMS

By Air Technology Group, Hitachi America



Population growth in the U.S. has fueled a 33% (since 1980) increase in demand for Public-Supply water.

➤ Introduction

As the population continues to grow in the United States, industrial water use will need to continue to fall to help offset the increases in public-supply water use. Water-cooled compressed air systems provide an opportunity for sustainability managers to reduce associated cooling water consumption and costs. If switching to air-cooled air compressors is not possible, understanding the costs and the alternative types of liquid cooling systems is important.

Offsetting the Increase in Public-Supply Water Use in the U.S.

Total water use in the United States in 2005 was estimated at 410 billion gallons per day by a 2009 study conducted by the U.S. Geological Survey.[1] This study, "Estimated Use of Water in the United States", has been conducted every five years since 1950. Data for 2010 water use will first become available in 2014.

The report indicates that national water use remained roughly the same as in 2000 and that water use has declined 5 percent from the peak in 1980. This leveling off of demand has occurred despite the population growth of 31 percent from 1980 to 2005 (230 to 301 million people).[2] This population growth has led to a 33 percent increase in public supply water use over the same period. Fortunately, water use for thermoelectric power generation, irrigation, self-supplied industrial uses, and rural domestic/livestock have stabilized or decreased since 1980.

Power Generation and Irrigation Water Use Stabilizes

Thermoelectric power has been the category with the largest water withdrawals since 1965, and in 2005 made up 49 percent of total withdrawals.[3] Thermoelectric-power water withdrawals peaked in 1980 at 210 billion gallons of water per day and were measured in 2005 at 201 billion gallons per day. Partially due to sections of the Clean Water Act, that were amended in 1972, power plants have increasingly begun to use wet recirculating cooling systems (cooling towers or ponds) and/or dry recirculating cooling (air-cooled) systems instead of using once-through cooling systems. This has played a leading role in reducing demand for water in power plants.

Irrigation is the second largest category for water use and is also declining. Estimated water use in 2005 was 128 billion gallons of water

TABLE 1: TOTAL WATER USE IN THE U.S.

TOTAL WATER USE IN THE U.S.	BILLION GALLONS PER DAY IN 2005	% OF TOTAL	% CHANGE 1980-2005
Thermoelectric Power	201	49%	-4%
Irrigation	128	31%	-15%
Public Supply	44	11%	+33%
Industrial	31	8%	-31%
Rural Domestic/Livestock	6	1%	-7%
Total	410	—	-5%
Population	230 million in 1980	301 million in 2005	+31%

Source: 2009 Circular 1344, U.S. Geological Survey, "Estimated Use of Water in the United States in 2005". Note: Data for 2010 water use will first become available in 2014.

per day — down 15 percent from the peak in 1980 and representing 31 percent of total use.

- The average application rate for irrigation water has declined steadily from 3.55 acre-feet per acre in 1950 to 2.35 acre-feet per acre in 2005.
- This decline is attributed to greater use of more efficient sprinkler systems rather than flood systems.

Public Supply Water Use Increases

Public supply refers to domestic, commercial, and industrial users of public water supply systems. Public supply water use was 44.2 billion gallons of water per day in 2005 — up 33 percent from 1980. This is a reflection of the population increase over the same period of 31 percent.

- Domestic use made up 58 percent of the total while commercial/ industrial made up 42 percent.
- The commercial/industrial number is a catch-all including industrial facilities, wastewater treatment plants, firefighting, pools, parks, system losses, and all buildings with more than 15 connections.[5]

Self-Supplied Industrial Water Use Decreases

Industrial water use includes water used for such purposes as fabricating, processing, washing, diluting, cooling, or transporting a product; incorporating water into a product, or for sanitation needs within the manufacturing facility. Some industries that use large amounts of water produce such commodities as food, paper, chemicals, refined petroleum, or primary metals. Water for industrial use may be delivered from a public supplier or be self-supplied. Stricter water-quality standards for water discharges, mandated by the Clean Water Act, may have also encouraged water conservation. The data taken from this U.S. Geological Survey looks at self-supplied industrial water.[6]

- Self-supplied industrial water use was 31 billion gallons of water per day, a decrease of 31 percent from 2005 to 1980.[7]
- Significant growth in water use has been seen in the "Aquaculture" industry — the farming of fish.
- The use of water in the mining industry remained relatively flat
- This reflects a decrease in manufacturing employment of almost 19 percent from 1990-2005.
- Employment in several major water-using industries showed even larger declines:
  - Primary metal manufacturing declined 31 percent
  - Paper manufacturing and petroleum industries declined 26 percent
  - Employment in the chemical manufacturing industry declined 12 percent.

Reviewing Six Different Types of Cooling Systems for Air Compressors

Most air compressors are designed to receive cooling water, at the required flow, with a maximum inlet temperature of 100 ˚F and expect maximum discharge water temperatures of 120 ˚F to 130 ˚F. These values should be kept in mind when evaluating any compressor cooling system.

Evaluation of the cooling system for the compressor should include the after-cooler performance as it relates to the inlet temperatures it will provide to the compressed air dryer. Compressed air dryers are almost all designed to receive inlet air to be dried at 100 psig and 100 ˚F. With temperatures to the dryer above 100 ˚F (the rated inlet temperature), the moisture load per scfm to the dryer will increase significantly reducing the flow rating drying capability. For proper application, be aware of the inlet air temperature to the dryer and the design approach temperature to the incoming cooling media temperature — air or water.

With the exception of large water-cooled reciprocating compressors, most rotaries and centrifugal air compressors have relatively high

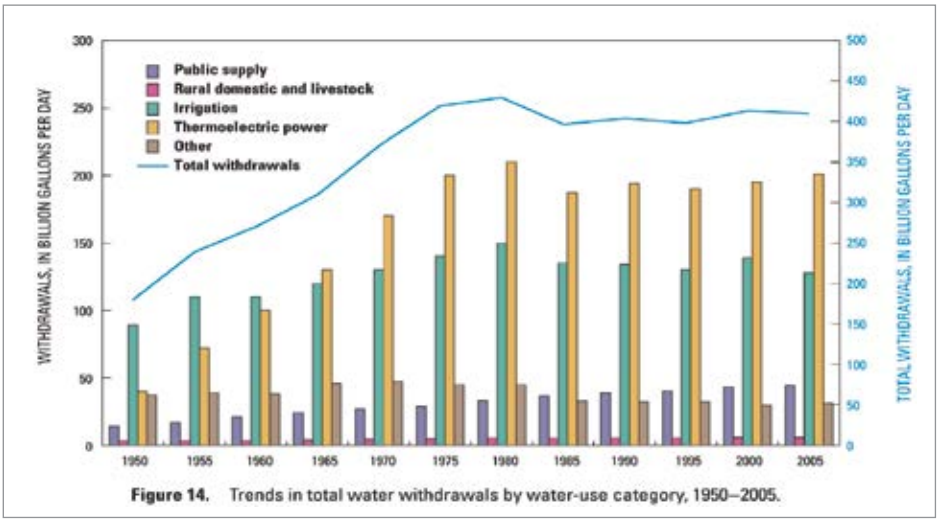


Figure 14. Trends in total water withdrawals by water-use category, 1950–2005.

Table 2: Trends in Total Water Withdrawals by Water-Use Category (U.S. Geological Survey)

Source: 2009 Circular 1344, U.S. Geological Survey, "Estimated Use of Water in the United States in 2005". Note: Data for 2010 water use will first become available in 2014.

EVALUATING AIR COMPRESSOR COOLING SYSTEMS

pressure losses through them when compared to many others commonly fluid- cooled industrial pieces of equipment. Whenever possible, each compressor (or group of compressors) should be on their own system to avoid other pressure losses affecting the flow to the air compressors.

An effective trim cooler should be well controlled to effectively modulate the flow and manage the power use. Often these trim coolers are sized to be able to handle 100% of the load and keep the equipment running in the case of an emergency.

The energy use of the circulation pumps is a function of the flow volume and the head. Poor fluid piping, sizing and configuration can add pressure loss and head. Installing the cooler farther away from the compressors or on the building roof will also usually increase the cooling fluid "head" and require larger pumps.

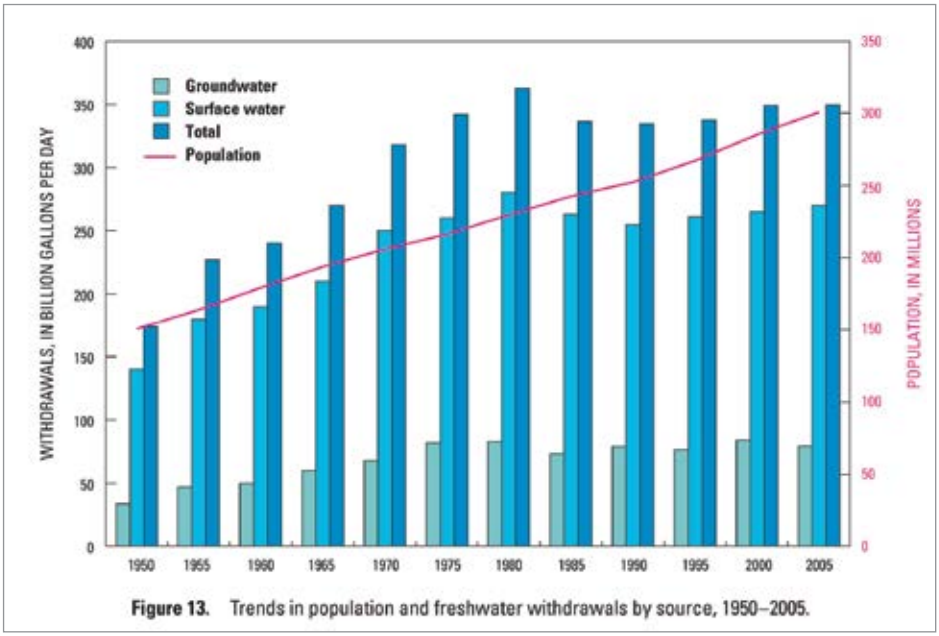


Figure 13. Trends in population and freshwater withdrawals by source, 1950–2005.

Table 3: Trends in Population and Freshwater Use by Source (U.S. Geological Survey)

Source: 2009 Circular 1344, U.S. Geological Survey, "Estimated Use of Water in the United States in 2005". Note: Data for 2010 water use will first become available in 2014.

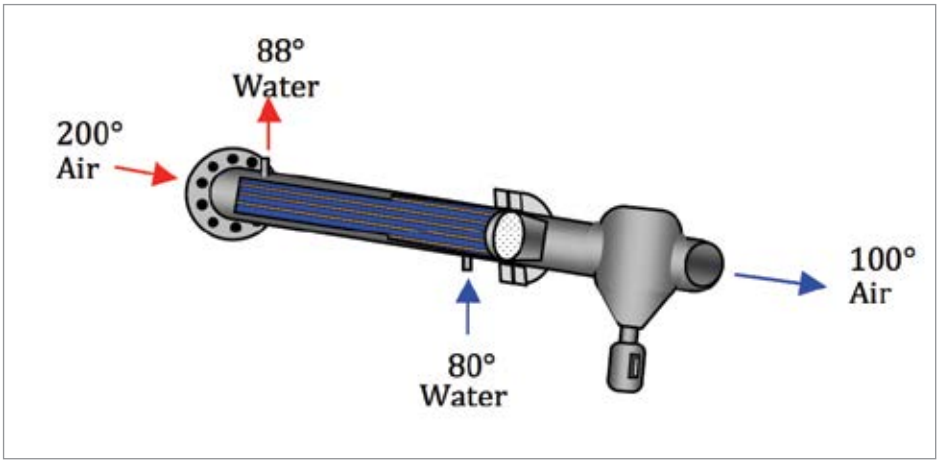


Figure: A water-to-air trim cooler

Cooling System #1: Recirculation Ponds

Recirculation cooling water ponds are an option for a locally controlled cooling water system supply. As long as the pond is large enough to handle the heat load under the worst condition and maintain an acceptable temperature, it can be very effective, particularly in large installations. They do have some inherent limitations:

- Significant water loss due to ambient evaporation
- Continued buildup of silt in the pond may significantly reduce heat absorption capability and not remain usable
- Water treatment is still necessary
- Makeup water is usually with some kind of expense — i.e. well pump, etc.
- A pumping station is still required to circulate the cooling water

Cooling System #2: Trim Coolers

A trim cooler is a smaller heat exchanger to be used only in times of excess or peak heat loads. They are installed to complement a larger system designed to handle all cooling need 85-90% of the time. A trim cooler can allow a facility to go with a lower water consumption system by being there as an emergency back-up during high heat load periods. A trim cooler might be a shell and tube heat exchanger or a cabinet-enclosed chiller.

Cooling System #3: Dry Air Cooling — No Water Required

These coolers are closed loop cooling systems usually using an appropriate water (60%) and polyglycol (40%) mix (one-time fill) passing through finned tubes. The coolers are in modules — each with a small fan for air-cooling. As the heat load is reduced, the

Typical Dry-Air Fluid Cooling System — Usually uses an appropriate water/glycol mix

fans are shut-off individually as required and brought back on when needed. Dry air cooling systems are usually available from 160,000 btu/year rating at 250 cfm class to 4,000,000 btu/hr rating at 6,000 cfm class — with special sizes for other levels.

The air-cooled heat exchangers can be manufactured to deliver a 2 ˚F approach temperature but economics usually dictate a 5 ˚F approach. This means in parts of the country they may be able to handle a reciprocating compressor's cooling needs with little or no trim cooling. Dry air cooling systems, when combined with a trim cooler, can provide factories with a very low-cost and reliable alternative to water-cooled machines.

Cooling System #4: Open Evaporative Cooling Tower

The cooling water system requiring the lowest capital costs is the *open tower type.* In this system, the heated return water flows down a controlled open path where it is cooled by continual evaporation by moving ambient air from a fan and pulling an evaporating water percentage into the ambient air. These towers will have a smaller circulating pump to move the water through the cooling area and a large horsepower electric motor fan to move ambient air over and through the cooling water to optimize the evaporation cooling. There is also a flushing or blow out system using water.

TABLE 3: DIRECT COOLING WATER/FLUID COMPARISON OF A 600 HP, 3-STAGE CENTRIFUGAL COMPRESSOR, 2,750 SCFM AT 100 PSIG AT 290 BHP

COMPRESSOR COOLING		1,000 BTU/HR	GPM
AFTER-COOLER	1,000 BTU/HR	1,547	—
	GPM AT 85 ˚F	—	124
OIL-COOLER	1,000 BTU/HR	145	—
	GPM AT 85 ˚F	—	29
TOTAL	1,000 BTU/HR/GPM	1,692	153

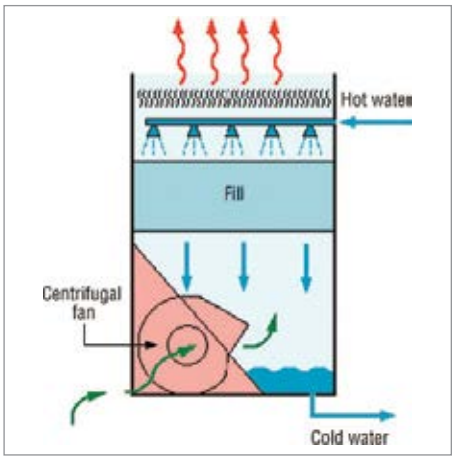
	ONCE – THROUGH MUNICIPAL WATER	OPEN EVAPORATIVE WATER	CLOSED LOOP EVAPORATIVE TOWER	DRY COOLER WITH TRIM
Water cooled for compressor cooling – gpm/$yr.	153 $236,844	Recirculated	Recirculated	N/A
Total gallon/year at $3.00/1,000 gallons	78,948,000	N/A	N/A	N/A
Spray circulation pump motor at $.06 kW/8,600 hrs/y–r.	N/A	kW/100% $516	kW/30% $155	
Main cooling system fan driver motor kW/yr. at $.06/8,600 hrs/yr.	N/A	75 hp 60 kW $30,960/yr.	11 hp 10 kW $5,160/yr.	(12) 1.5 hp 18 hp at 50% use 9 kW $4,644/yr.
Evaporative make up water – gpm $/year gallons/year	N/A	3.4 gpm $5,264/yr. 1,754,400	1.2 gpm $1,858/yr. 619,200	N/A
Flushing blow out water – gpm ($3.00/1,000 gallons) $/year gallons/year	N/A	45.9 $71,052/yr. 23,684,400	1.7 $2,632/yr. 877,200	N/A
Total Gallons of Water for Water Treatment	78,948,000	25,438,400	1,496,400	N/A
Water treatment costs at 42 grains hardness, 10 alkalinity, with biocide treatment at $1.20 per 1,000 gallons	$94,737	$30,526	$1,795	N/A
Trim cooler costs to operate during extreme hot weather; chiller cooler kW/% time at $.06 kWh/8,600 hrs/yr.	N/A	N/A	N/A	30% utilization 9 kW $1,393/yr.
Pump station electric motor kW – based on 160 gpm, 100 ft of head specific gravity 1.0 100% of time at $.06 kWh/8,600 hrs/yr.	7 kW $3,612	7 kW $3,612	7 kW $3,612	7 kW $3,612
Total Operating Cost Water $/yr.	$335,039/yr.	$136,666/yr.	$13,350/yr.	$9,649/yr.

The primary benefit of this type of system is that as the ambient temperatures increase, generally so does the evaporation rate which means, in most North American locations, they will deliver about 85 ˚F temperature cooling water when operating properly within their design limits.

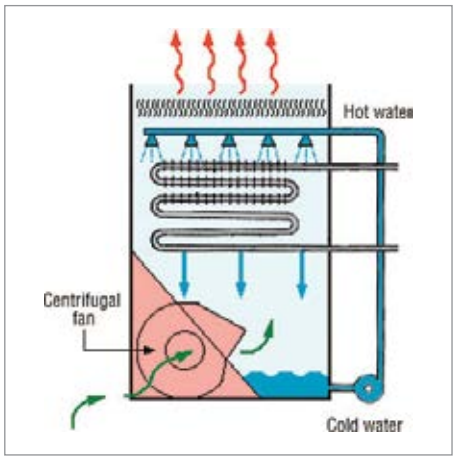
Open tower coolers are very prevalent throughout industry and are often known affectionately as very effective "air washers" meaning they remove the dirt and impurities from the ambient air, generating a continual cleaning of the tower.

The contamination factor, along with the high level of make-up water required, makes proper and diligent water treatment and condition monitoring a prerequisite for a successful installation. Open towers also inject oxygen into the process water system which may or may not create corrosion or other maintenance issues.

EVALUATING AIR COMPRESSOR COOLING SYSTEMS



Typical Evaporation Open Tower with Counter Flow



Typical Closed Circuit Cooling Fluid Tower with Evaporator

Cooling System #5: Closed Circuit Cooling Tower with a Auxiliary Evaporation Cooling Assist for Hot Weather

In this type system the primary coolant is sealed in a closed loop system — unexposed to ambient air, it may be water — but it more often is a glycol water mix appropriate to the local ambient cold temperature limitations. This is very good for the equipment being cooled since it runs for a significantly long time without significant water treatment requirement or replenishment.

The cooling system is equipped with a motor driven spray pump and spray header which delivers a spray over the air cooled heat exchangers during hot weather and creates evaporation auxiliary cooling similar to the open tower described earlier.

Cooling System #6: Closed Loop Cooling with Evaporation

Closed Loop Cooling with Evaporation systems experience additional water use, the magnitude very much dictated by the ambient conditions. There is also a motor driven coolant circulation pump and motor drive main cooling air fan similar to the open tower. The standard pumping station is also required. Some flushing or blow may also be required.

Depending on design and operating conditions, this type of cooling towers use parallel flow or cross flow or counter flow. Compared to an open tower with evaporative cooling, the closed circuit cooling system has a higher initial cost but also some advantages which may be significant when the operating conditions dictate.

In a compressed air system the process water must be capable of full capacity throughout the year. This means maintaining a clean, reliable cooling fluid loop is critical. To do this in an open tower requires proper and diligent water treatment and maintenance. The closed loop system is basically isolating the compressor cooling fluid from all air ambient out borne contaminants:

- This reduces the frequency of the need to shut down the cooling system for cleaning.
- This type cooler has a lower volume of recirculating water requiring water treatment filtration
- The compressor cooling fluid usually requires minimal treatment
- During periods of dry operation (cooler weather) the need for spray evaporation and therefore makeup water is eliminated
- These units, like many central cooling water systems, are set up with either another cooling water source or chiller cooler. These trim coolers cool the fluid from the primary cooler when required by too high a temperature.

Conclusion

As the population continues to grow in the United States, industrial use will need to continue to fall to help offset the increases in Public-Supply water use. Compressed air systems provide an opportunity for energy managers to reduce associated cooling water consumption and costs. Understanding the costs and the alternative types of cooling systems is an important first step.

All options are preferable to "once through" municipal water. The ever-growing regulations and controls will just further increase these costs. The true cost of the open evaporative tower and the closed loop evaporative tower can be driven much higher with more significant water treatment cost, water disposal regulations, sewer costs and surcharges. If a facility can't simply convert a water-cooled air compressor to an air-cooled air unit, a dryer-cooler system (with trim) has the lowest costs and very predictable results. BP

For more information, please visit www.hitachi-america.us/airtech

To read similar ***Cooling System*** articles, visit www.airbestpractices.com/sustainability-projects/cooling-systems

Endnotes

1 Estimated Use of Water in the United States in 2005, Joan F. Kenny, Nancy L. Barber, Susan S. Hutson, Kristin S. Linsey, John K. Lovelace, and Molly A. Maupin, U.S. Department of the Interior, U.S. Geological Survey, Reston, Virginia, 2009, Circular 1344, page

2 Ibid, Table 14, Trends in estimated water use in the U.S. page 43

3 Ibid, page 42

4 Ibid, page 45

5 Ibid, page 16

6 Ibid, page 32

7 Ibid, page 1

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Typical Dry-Air Fluid Cooling System — Usually uses an appropriate water/glycol mix

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A Review of Solid-Form SCALE AND CORROSION INHIBITORS

By Michael Hunter, Global Technical Director, APTech Group, Inc.

➤ Introduction / History of Solid Water Treatment

Cooling towers and chillers operate by running water through them in order to cool buildings or for "process" purposes in industrial settings. Since water comes into contact with the metal in this equipment, as well as heat exchangers, there is the ongoing opportunity for scale build up and corrosion depending on the water quality in the systems.

During the last 40 years of the 20th century, the standard method for treating the water that runs through cooling towers and systems was to use blended liquid water treatment chemicals. Generally these liquid products were delivered by tanker truck or common carrier trucks. The liquid chemicals were fed into the cooling systems by a variety of pumps to protect the systems from potential corrosion, scale build up, and microbiological fouling.

This method of treating cooling systems was generally effective when managed correctly. However, liquid water treatment chemicals had a variety of issues and concerns associated with their application. Many of these products were (and are) labeled as corrosive owing to the pH (acidic or caustic) of the ingredients. Potential issues with liquid products include the following:

Issue	Result
Potential for spills during shipment	Environmental hazard, potential for injury reduced or eliminated
Shipping costs	Water is more than 80% of the product in liquid formulations; requires truck shipping, meaning increased expense
Handling liquid containers	Time consuming, potential for injury
Container storage	Space and containment requirements, eye wash stations
Dealing with empty containers	Triple-rinsing required, time consuming, wastes water, storage of empty containers, plastic disposal (ie: land fill)

Around the most recent "turn of the century", in answer to the challenges associated with liquid chemicals, solid-form chemical products for cooling towers (as well as boilers and closed loop systems), along with dispensing systems to reconstitute the solid products back to liquid form on-site, began to be developed and introduced to the market by multiple companies.

How Solid Chemical Water Treatment Products Work

Manufacturing Process

Most solid-form water treatment products are produced by combining raw materials of proven chemical combinations producing a finished product which is best described as a water soluble wax-like, hard putty. A range of cooling system water treatment chemical products is available in solid form from a number of manufacturers, ranging from scale and corrosion inhibitors to specialty products and biocides. Additionally, there are a couple of solid-form products available for smaller applications that require less control. These include tablets of inhibitors covered with a coating and housed in a membrane for system delivery, as well as an inhibitors and dispersant package compressed into a 2" puck.

Solid Chemistry Product Forms

Many solid product formulations, similar to their liquid counterparts, are available in the market. These solid products are utilized by professional water treatment personnel when treating and maintaining cooling systems for their customers. Product packaging configurations include:

- **Recyclable Plastic Bottles –** 1 gallon in size, weighing 11 pounds per bottle, packaged 4 bottles to a case
- **Discs –** 6" in diameter by 3" tall, weighing 5 pounds each, packaged in disposable plastic
- **Sticks –** 5" long, 2" inch wide, generally .8 pounds each, packaged in PVA materials which dissolve during use
- **Encapsulated Tablets –** Small (approximately 1/2" in diameter) of scale and corrosion inhibitors. 10 – 2.5 pounds of product in mesh bags per case
- **Pucks –** 2" in diameter, 6 to a package with a hook to hang in the system

Each of these solid product forms is designed for individual, specific applications. The bottles are the most commonly used solid product form. The water treater removes the cap and places the bottle in the dissolving unit and changes the bottle when empty. Empty bottles can be rinsed and recycled.

The discs are most useful for larger systems or when the water treater is unable to visit the customer site frequently enough to change bottles. Up to 4 discs (20 pounds) may be stacked in a dissolving unit at one time – equivalent to 30 of conventional liquid inhibitor. For larger systems, bespoke dissolving equipment is available.

Stick versions of these solid products provide a, convenient method for rapidly achieving correct maintenance dosing level. They are designed as a fast dissolving product, so it is possible to introduce the product rapidly to the system. The Stick products also can be used for initial dosing to a system prior to start-up, after any event that resulted in water treatment chemicals not being administered to the system, or after a large amount of make-up water is added to the system. Stick products can also be utilized in systems that are too small to require feed and control equipment as part of their standard set-up and operation.

Encapsulated, timed release products use a coating and membrane system to control the release of the scale and corrosion inhibitors. Designed for use in smaller cooling towers (500 tons or less) that don't require controllers or pumps, the inhibitors are released over a 30 day period.

Pucks or tablets are a 2 inch diameter "sandwich" of scale and corrosion inhibitors with a dispersant in the center. The puck has an embedded plastic hook to enable hanging the product in the tower wherever water flows over it. Pucks are for very small (under 25 tons) cooling towers and last about 30 days.

Solid-Form Product Dissolving Alternatives

Since solid water treatment products are shipped in concentrated form, the chemicals are dissolved on site at the point of application using make-up or city water and dissolving boards or feeder units (or in the case of Sticks or Pucks; directly in an open portion of the system). For Bottle or Disc products, the dissolving units are available in a number of configurations, with or without a reservoir, and electrically powered or gravimetric/magnetic. The unit is attached to a wall and connected to an incoming city water line. An outgoing line is connected from the dissolving unit to existing chemical feed equipment (typically a pump or educator) and if electrically powered, plugged into a 110 volt outlet. (For safety, the voltage is reduced to 24 volts.)

The plastic bottle or disc is then positioned in the receiving well of the dissolving board (upside down in the case of the bottle). For units with reservoirs, as the water treatment system controller "calls" for chemicals, a solenoid valve opens and incoming water is sprayed through a specially configured and calibrated spray nozzle up into the bottle or onto the surface of the lowest positioned disc. This action dissolves a portion of the chemical and mixes it with the spray water in the reservoir. The reservoir empties as the chemical pump serves the now liquid product, into the cooling system to protect the system components. These activities continue based on the demands of the system and the settings in the controller.

For the encapsulated solid products, the gray feeder units are mounted to the floor and attached to a wall or mounting frame. These units don't require a chemical pump as chemical is dissolved whenever recirc water is flowing.

Building facility management professionals or water treatment specialists monitor the system and change bottles or add discs as necessary to enable ongoing chemical feeding. In the case of encapsulated products, they are replaced at 30 day intervals. Periodic system monitoring by way of traditional water treatment testing procedures, such as Molybdate, Phosphonate, etc., assists in keeping the system treatment at correct and necessary levels for proper system protection against corrosion, scale and biologic contamination.

Comparing Solids to Liquid Water Treatment Chemicals

Liquid and solid water treatment products have a number of common traits. They are both produced by blending chemical combinations that are historically proven to combat the issues that can shorten the useful lives of cooling towers and chillers. Different polymers and azoles are combined in both liquids and solids to deal specifically with water that is either scale forming or corrosive in nature and also to manage and control suspended matter that may be entrained in the system

An installation of the AP Tech solid cleaner.

A REVIEW OF SOLID-FORM SCALE AND CORROSION INHIBITORS

water. Both forms of chemistry are ultimately served into the systems they maintain via pumps or eductors and are regulated or managed by sophisticated computer-based Controllers.

Monitoring of system chemistry for solid water treatment products is the same as for the liquid formulations currently available. Typical monitoring or testing methods for both forms include testing for levels for Molybdate, Phosophonate and Tolyltriazole in the cooling system water.

There are also a number of differences between these two forms of water treatment products. When initially manufactured or produced, most liquids have some amount of additional caustic in the products to maintain the other ingredients in solution. Since solid products are reconstituted to a liquid onsite in the reservoir of the dissolving board, at the time of delivery to the system, dangerous caustic is not required as an ingredient, unless it is necessary to treat a specific water condition. (The dissolved chemical in the reservoir is stable without any added caustic due to a relatively low concentration level.) Even with the addition of caustic, liquid products generally contain up to 80% or more of water in the products.

These two "ingredients" (added caustic and water) mean that shipping liquid water treatment chemicals in 55 gallon drums weighing 500 pounds each, is both costly and in many cases, dangerous. It also means that they must be shipped as "hazardous product", since they include caustic. Solid products, on the other hand, weigh less than 50 pounds per case. Most solids, with the exception of biocides can be shipped by UPS or FedEx, meaning quicker delivery and lower shipping costs. Biocides, whether in solid or liquid form are considered hazardous, from a shipping perspective and must be shipped by common carrier (or by UPS if the shipper or the recipient has a "hazardous shipping contract".)

RESULTS OF CORROSION RATE TESTING:

	LIQUID WATER TREATMENT		SOLID-FORM WATER TREATMENT	
MONTHS OF 2013	VALUES OBTAINED	RATING	VALUES OBTAINED	RATING
April	1.9 mpy	◆◆◆◆◆		
May	2.2 mpy	◆◆◆◆◆		
June	2.0 mpy	◆◆◆◆◆		
July			2.1 mpy	◆◆◆◆◆
August			1.8 mpy	◆◆◆◆◆
September			2.2 mpy	◆◆◆◆◆
Total Average	**2.03 mpy**	◆◆◆◆◆	**2.03 mpy**	◆◆◆◆◆

RESULTS OF DEPOSITS RATE TESTING:

	LIQUID WATER TREATMENT		SOLID-FORM WATER TREATMENT	
MONTHS OF 2013	VALUES OBTAINED	RATING	VALUES OBTAINED	RATING
April	27.2 mg/m^2.d	◆◆◆◆◆		
May	28.1 mg/m^2.d	◆◆◆◆◆		
June	26.5 mg/m^2.d	◆◆◆◆◆		
July			32.6 mg/m^2.d	◆◆◆◆◆
August			33.8 mg/m^2.d	◆◆◆◆◆
September			39.6 mg/m^2.d	◆◆◆◆◆
Total Average	**27.26 mg/m^2.d**	◆◆◆◆◆	**35.3 mg/m^2.d**	◆◆◆◆◆

Solid water treatment chemicals have number of other advantages over their liquid counterparts. A case of product in "bottles" weighs 44 pounds. A case of 10 mesh bags of encapsulated product weighs 25 pounds. Both of these types of solid water treatment products are easily carried through customer buildings and stored in (often) small mechanical rooms. Additionally, since solids do not require caustic to be added to keep the product the product in solution, expensive containment areas or eye wash stations are not necessary.

Like liquid products, solid form chemicals are useful in a wide array of commercial applications ranging from commercial buildings to government facilities and light industrial applications. For very large applications such as cooling towers in large industrial applications, liquid products in totes may remain the most efficient treatment method. However, due to their increased sustainability traits, including reduced fuel used in shipping, reduced spill concerns, reduced potential for injury, reduce carbon footprint and the optimization of space utilization in mechanical rooms solids are especially attractive to facilities such as hospitals, universities, primary and secondary school systems and office buildings. Senior management of these kinds of organizations and facilities are increasingly placing an amplified emphasis on such considerations across their entire entities – not just in the facility management arena. Solid water treatment chemicals are becoming a common component in the overall sustainability game plan of these types of institutions. In fact, for these reasons, mechanical engineers are increasingly being asked to specify solid water treatment chemical configurations in new buildings or renovations.

The following example is emblematic of the sustainability benefits of solid water treatment chemicals: A Cooling Tower on a 20 story office building which produces 1,000 tons refrigeration requires this amount of annual liquid chemistry, in 55 gallon drums, to treat the water in this Cooling Tower:

- 12 barrels of scale/corrosion chemistry
- 4 barrels of micro biological chemistry
- 4 barrels of cleaners

In this example, the twenty 55 gallon barrels of liquid chemistry are shipped 600 miles to the office building via trucks using diesel fuel. Based on this data, utilizing solid form water treatment products to treat this 1,000 ton Cooling Tower instead of liquids would generate the following Carbon Dioxide (CO_2) reductions (also known as Carbon Footprint savings):

Transport fuel savings	826 lbs of CO_2 per year
Sodium Hydroxide (NaOH) savings	1,776 lbs of CO_2 per year
Plastic used reduced	1,084 lbs of CO_2 per year
Total Savings	**3,686 lbs of CO_2 per year**

These savings are comparable to an individual leaving his/her car in the garage for 173 days and walking or taking public transportation (based on a vehicle that averages 10,000 miles / year @ 25mpg).

Performance of Solid Water Treatment Products

Solid water treatment products have generally been found to protect equipment as effectively as traditional liquid chemical products, when correctly implemented. In addition, results have shown that solids can help a facility become more sustainable, as these two case histories show. The first case study is a description of the benefits the new system provided – both technically and from a sustainability perspective for a very large shopping comfort cooling program. The second case study describes the results of a solids system implementation in a large government office building which had severe scaling problems.

Large Shopping Center

A very large shopping center had been using liquid water treatment for many years in its cooling system. The technical results had always been acceptable. In recent years, however, the management team of the shopping center had become more and more focused on environmental issues. The management team worked with the water treatment partner to add sustainability areas of interest to the traditional water treatment and maintenance objectives to form a comprehensive, multi-directional series of goals for the new program:

- Control of Corrosion
- Control of Deposits
- Control of Fouling
- Microbiological Control
- Net Loss of Water
- Rate and Cycles of Concentration
- Analytical Results
- Consumption of Chemicals
- Dosing Systems
- Control Systems and Monitoring
- Storage Space for Chemicals Containers
- Storage Space for Empty Containers
- Need to Build Containment Basins
- Occupational Safety
- Operating Facilities
- Environment
- Heat Exchange Efficiency
- Specific Energy Consumption

In addition to establishing these categories of objectives, the facility management team developed a simple 5-star rating system to translate the technical water treatment data to a form more easily understood by the shopping center upper management. Not all of these categories of data are completely impacted by the solid-form water treatment. But they are included to show the degree to which the customer was focusing on a holistic solution.

To address these topics of interest, the facility management team worked with their water treater partner to implement a solid-form water treatment system in place for their five cooling tower and chillers, each with 1,000 tons of refrigeration, with slightly soft municipal water for make-up.

With the solids implementation, it was decided to increase the cycles of concentration from 5 to 10, which enabled significant water savings and reduced chemical usage. Additionally, PLC controllers were installed to allow for automatic, ongoing corrosion measurement without the need for corrosion coupons and automatic control of the number of

CHEMISTRY OF WATER EXPRESSED IN RYZNER INDEX:

	LIQUID WATER TREATMENT		SOLID-FORM WATER TREATMENT	
MONTHS OF 2013	VALUES OBTAINED	RATING	VALUES OBTAINED	RATING
April	6.2	◆◆◆◆◆		
May	6.3	◆◆◆◆◆		
June	6.4	◆◆◆◆◆		
July			5.4	◆◆◆◆◆
August			5.3	◆◆◆◆◆
September			5.2	◆◆◆◆◆
Total Average	**6.3**	◆◆◆◆◆	**5.3**	◆◆◆◆◆

RESULTS OF MICROBIOLOGICAL CONTROL (DIP SLIDE ANALYSIS):

	LIQUID WATER TREATMENT		SOLID-FORM WATER TREATMENT	
MONTHS OF 2013	VALUES OBTAINED	RATING	VALUES OBTAINED	RATING
April	0.8 x 10^{-3} CFU	◆◆◆◆◆		
May	0.9 x 10^{-3} CFU	◆◆◆◆◆		
June	0.7 x 10^{-3} CFU	◆◆◆◆◆		
July			1.6 x 10^{-3} CFU	◆◆◆◆◆
August			1.8 x 10^{-3} CFU	◆◆◆◆◆
September			1.8 x 10^{-3} CFU	◆◆◆◆◆
Total Average	**0.8 x 10^{-3} CFU**	◆◆◆◆◆	**1.7 x 10^{-3} CFU**	◆◆◆◆◆

RESULTS OF THE EVALUATION OF THE CYCLES OF CONCENTRATION:

	LIQUID WATER TREATMENT		SOLID-FORM WATER TREATMENT	
MONTHS OF 2013	VALUES OBTAINED	RATING	VALUES OBTAINED	RATING
April	5.3 / 5.25	◆◆◆◆		
May	5.4 / 5.26	◆◆◆◆		
June	5.5 / 5.44	◆◆◆◆		
July			9.0 / 9.15	◆◆◆◆◆
August			8.9 / 8.99	◆◆◆◆◆
September			9.5 / 9.62	◆◆◆◆◆
Total Average	**5.4 / 5.31**	◆◆◆◆	**9.1 / 9.25**	◆◆◆◆◆

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operating chillers needed at any one time. The system uses "bleed and feed" methods to feed the water treatment chemistry.

As shown in the following charts, the new solid chemical system provided as good or better system protection as the previous liquid chemical system.

In addition to maintaining effective system protection, the solid-form water treatment system helped address many of the environmental concerns of importance to the shopping center management team:

PERFORMANCE RATIOS	LIQUID PROGRAM	SOLID PROGRAM
1 – Control of Corrosion	◆◆◆◆◆	◆◆◆◆◆
2 – Control of Deposits	◆◆◆◆◆	◆◆◆◆◆
3 – Control of Fouling	◆◆◆◆◆	◆◆◆◆◆
4 – Microbiological Control	◆◆◆◆◆	◆◆◆◆◆
5 – Net Loss of Water	◆◆◆◆	◆◆◆◆◆
6 – Rate and Cycles of Concentration	◆◆◆◆	◆◆◆◆◆
7 – Analytical Results of Corrosion Preventive Agents	◆◆◆◆◆	◆◆◆◆◆
8 – Consumption of Chemicals	◆◆◆◆	◆◆◆◆◆
9 – Dosing Systems	◆◆◆	◆◆◆◆◆
10 – Control Systems and Monitoring	◆◆◆	◆◆◆◆◆
11 – Storage Space for Chemical Containers	◆◆	◆◆◆◆◆
12 – Storage Space for Empty Containers	◆◆	◆◆◆◆◆
13 – Need to Build Containment Basins	◆◆	◆◆◆◆◆
14 – Occupational Safety	◆◆◆	◆◆◆◆◆
15 – Operating Facilities	◆◆◆	◆◆◆◆◆
16 – Environment	◆◆	◆◆◆◆◆
17 – Heat Exchange Efficiency	◆◆◆◆◆	◆◆◆◆◆
18 – Specific Energy Consumption	◆◆◆◆◆	◆◆◆◆◆
19 – Cost of Water Treatment	◆◆◆◆◆	◆◆◆◆
20 – Return on Investment	◆◆◆◆	◆◆◆◆
Total Average	◆◆◆	◆◆◆◆◆

Governmental Office Building

In mid-2007, the facility management team at this Federal Building had just replaced two 800 ton chillers and one 300 ton chiller with two new 900 ton chillers and a 400 ton chiller. They also replaced the cooling towers with new stainless steel Marley cooling towers. After only six months of operation, the cooling tower fill had accumulated 1/4" of scale in some areas.

So much scale had built-up inside the fill that it began to crumble and stack up at the bottom near the basin due to the weight. The basin of the tower, below the water line, and the cooling tower hot distribution decks were also very scaled.

The building's facility management team decided to transition their water treatment to a solid water treatment chemicals solution in December 2007.

The contracted water treater began treating the building systems in January, 2008 using the Stick form of a solid online cleaner product initially and over time, switched to a solid-form online cleaner in gallon bottles from a dissolver/feeder unit.

Positive results were visible almost immediately. Within a couple of months, the scale inside the fill was markedly thinner. After approximately 5 months, the scale that had formed on the cooling tower basin had also started to become thin and began flaking from the basin. After a little over one year, the cooling tower fill was almost completely clean and the basin scale had gone from 1/4" in thickness to eggshell-thin and was flaking away.

The chillers were opened for annual inspection and routine maintenance in 2008. Although it was evident that the scale deposits were being removed, the two 900 ton chillers did still contain scale. These two chillers alternate, so they are not always running. The 400 ton chiller is the most active. It is loaded almost constantly and is even used as the after-hours chiller. When opened for maintenance, it was completely clean of all scale. By it running more than the other two chillers the solid-form online cleaner water treatment was able to clean it up most optimally.

The building facility management team was extremely impressed with these results. The solid-form water treatment distributor has since been awarded 14 additional buildings due largely in part to the success cleaning up this building's Towers and Chillers.

Summary

When introduced about 15 years ago, solid water treatment chemicals were viewed by many water treaters as a product that simply would not work to treat cooling water systems. Now, with thousands of successful installations worldwide in cooling towers (as well as boilers and closed loop systems), solid-form water treatment solutions are considered to be the legitimate future of water treatment and exists in hundreds of water treaters' "tool belts".

These water treatment professionals understand that if applied correctly, solid-form products can be just as effective of a method to protect cooling and heating systems from corrosion and scale as their liquid counterparts. And with the additional sustainability, safety, ease of use, and shipping cost benefits of solids, hundreds of facilities are transitioning to these products each year world-wide. BP

For more information contact APTech Group, tel: 513-761-8111, www.aptechgroup.com

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INDUSTRIAL COOLING SYSTEM INDUSTRY NEWS

Health Care Facility Patients at Risk for Legionnaires' Disease

More than 76 percent of Legionnaires' disease cases acquired from Legionella exposure in health care facilities can be particularly harsh. This includes possible fatal risks to patients, according to a report released from the CDC.

Legionnaires' disease is a serious type of pneumonia caused by bacteria, called Legionella, living in water. Legionella can make people sick when they inhale contaminated water from building water systems not adequately maintained.

The report's findings –a part of the CDC's monthly *Vital Signs* publication – are based upon exposure data from 20 states and New York City. According to the CDC, the analysis was limited to these 21 jurisdictions because they reported exposure details for most of their cases, allowing the CDC to determine how Legionnaires' disease was associated with health care facilities.

About 3 percent of Legionnaires' disease cases were determined to be "definitely associated with a health care facility," with 17 percent of cases listed as "possibly associated with a health care facility."

"Determining Legionnaire's disease causation is not simple since the mere presence of Legionella in a water system or device is not sufficient to cause disease. The bacteria must ultimately be inhaled or aspirated into the lungs of a susceptible person to cause disease," says Michael Patton, member of ASHRAE Committee SSPC 188. "Since people with conditions that have reduced their ability to fight off infections are especially susceptible, it is not a surprise the report found patients in health care facilities to be at risk. It's vitally important all buildings incorporate good design, operations and maintenance procedures that prevent growth and spread of Legionella as these are regarded as the best methods of preventing disease."

The incorporation of a Water Management Plan will reduce the chance of heavy colonization, amplification and dissemination to people. With this in mind, ASHRAE developed ASHRAE Standard 188: *Legionellosis: Risk Management for Building Water Systems* to assist designers and building operators in developing a Water Management Plan including practices specific to the systems existing in a particular building, campus or health care facility. To date, more than 5,000 copies of ASHRAE Standard 188 have been purchased. It can be previewed at no cost at https://www.ashrae.org/Standard188.

Based upon this ASHRAE standard, the CDC developed a toolkit entitled "Developing a Water Management Program to Reduce Legionella Growth and Spread in Buildings: A Practical Guide to Implementing Industry Standards." The document provides a checklist for building owners and managers to help identify if a water management program is needed, examples to help identify where Legionella could grow and spread in a building, and ways to reduce risk the of contamination.

About ASHRAE

ASHRAE, founded in 1894, is a global society advancing human well-being through sustainable technology for the built environment. The Society and its more than 57,000 members worldwide focus on building systems, energy efficiency, indoor air quality, refrigeration and sustainability. Through research, standards writing, publishing, certification and continuing education, ASHRAE shapes tomorrow's built environment today. More information can be found at www.ashrae.org.

For more information on Legionella, Legionnaires' disease and the toolkit, visit www.cdc.gov/legionella.

Ingersoll Rand Acquires Thermocold Costruzioni

Ingersoll-Rand plc, a world leader in creating comfortable, sustainable and efficient environments, announced it has completed the acquisition of Thermocold Costruzioni S.r.l. The transaction closed on April 1, 2017.

The acquisition strengthens the company's comprehensive portfolio of energy efficient, climate-friendly heating, ventilating and air-conditioning (HVAC) products for buildings in Europe with opportunities to extend Thermocold technologies to other parts of the world. Thermocold operates from one location in Bari, Italy, and has a wide European distribution network.

"The completion of this acquisition marks another milestone in providing breakthrough solutions for building owners to achieve operating and sustainability goals," said Dave Regnery, president of the Commercial HVAC North America, Europe, Middle East and Africa strategic business unit (SBU) of Ingersoll Rand. "We have been jointly innovating and serving customers, and this is the next step in our relationship. This is an exciting day for employees and distribution partners; we look forward to the growth potential we have together."

One of the signature Thermocold solutions is a multi-pipe HVAC system for high efficiency, simultaneous heating and cooling. This system repurposes rejected energy, or uses renewable energy, for heating the facility, delivering a more sustainable solution that reduces the amount of investment costs, use of floor space and total operating expenses. The multi-pipe system further contributes to lower the environmental footprint of a building due to significant lower energy use.

The company did not disclose the cost of the acquisition and indicated the transaction would not have a material impact on the company's cash flow or earnings in 2017.

About Ingersoll Rand

Ingersoll Rand (NYSE:IR) advances the quality of life by creating comfortable, sustainable and efficient environments. Our people and our family of brands— including Club Car®, Ingersoll Rand®, Thermo King® and Trane® —work together to enhance the quality and comfort of air in homes and buildings; transport and protect food and perishables; and increase industrial productivity and efficiency. We are a global business committed to a world of sustainable progress and enduring results.

For more information, visit www.ingersollrand.com.

Daikin and Harrison Energy Partners Join Forces

On its journey to become the number one HVAC leader, Daikin Applied is forming a relationship with Harrison Energy Partners to strengthen its HVAC solutions capabilities in Central, Northwest and Western Arkansas, as well as Eastern Oklahoma. Harrison Energy Partners will become the factory sales and parts representative in the region. Harrison Energy Partners will also become a factory authorized Service Alliance Partner for Daikin Applied in Northwest and Western Arkansas, as well as the bordering counties of Eastern Oklahoma.

Harrison Energy Partners is the largest commercial and industrial HVAC firm in Arkansas. With strengths in HVAC applications and owner sales, system service, controls and energy services, Harrison Energy Partners helps customers efficiently maintain comfort in their buildings. Their considerable breadth of solutions and energy expertise significantly expands Daikin's ability to serve its customers in the territory.

For Harrison Energy Partners' CEO, Bill Harrison, the move furthers his organization's goal to provide the greatest advantages to their customers. "Our mission has been and continues to be to deliver commercial HVAC excellence at a superior value so we are always our client's first choice. Joining forces with Daikin, with their culture of innovation and product development, positions us to do that both now and in the future."

Harrison cited Daikin Applied's plans for growth, innovation pipeline and partnerships with independent representatives as factors in the deal. "We respect their forward-looking philosophy, which includes understanding the importance of independent representation. We're well-aligned strategically."

Daikin Applied's EVP of Sales, Marketing and Aftermarket, Kirk Thorne, believes this change will continue to fuel Daikin's competitive advantage in the market. "Daikin values our independent representatives' customer focus and entrepreneurial culture," Thorne stated. "Our Reps are the best in the industry, and our appointment of Harrison Energy Partners makes us an unmatchable force in HVAC systems and solutions." Thorne added, "Daikin also values the diverse line card developed by Harrison Energy Partners over the years. It is the strength of Daikin and Harrison Energy Partners' other valued brands and capabilities that allow us to successfully serve the overall needs of the marketplace together."

Thorne emphasized Daikin Applied's strategies are market based. "This joint effort is well suited to the market conditions and capabilities of Harrison Energy Partners in Central and Western Arkansas and Eastern Oklahoma. Every market is different and Daikin continually evaluates each of its markets individually to ensure we have the right structure and relationships to serve our customers. Our end goal is to create the best outcomes for our customers, by investing in top talent to build the strongest organization in the marketplace."

Daikin Applied would like to thank Airetech Corporation, its previous equipment representative in the territory, for its contribution to Daikin Applied during its tenure as the Daikin Applied representative. Likewise, Harrison Energy Partners expressed appreciation for their long, distinguished history with Trane. Both Daikin and Harrison Energy Partners are committed to supporting their existing customers and projects in the marketplace throughout the transition.

About Daikin Applied

Daikin Applied, a member of Daikin Industries, Ltd., designs and manufactures technologically advanced commercial HVAC systems for customers around the world. Customers turn to Daikin with confidence they will experience outstanding performance, reliability and energy efficiency. Daikin Applied equipment, solutions and services are sold through a global network of dedicated sales, service, and parts offices. For more information or the name of your local Daikin Applied representative, call 800- 432-1342 or visit, www.DaikinApplied.com.

About Harrison Energy Partners

Harrison Energy Partners (HEP), founded in 1983 by CEO, Bill Harrison, provides commercial HVAC excellence through new systems, controls, energy services and system maintenance and repairs. Headquartered in Little Rock, AR, HEP has been named "One of the Best Places to Work in Arkansas" by Best Companies Group in 2013 and 2016. For more information, call (501) 661-0621 or visit harrisonenergy.com.

ASHRAE Announces New President for 2017-2018

ASHRAE introduced its 2017-2018 president, executive committee officers and directors during its Annual Conference in Long Beach, CA.

ASHRAE's new president is Bjarne W. Olesen, Ph.D., Fellow ASHRAE. At his inaugural presidential address, Olesen announced his term's theme will be "Extending Our Community." Through this theme, Olesen will focus his time as the Society's leader on extending ASHRAE's global community, technological horizons and overall value to the Society's members.

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"The tremendous amount of volunteer work that occurs within ASHRAE is unique compared to other societies," says Olesen. "The time ASHRAE volunteers dedicate to the Society is incredible, and the dedication of our 2017-2018 officers will strengthen our Society's knowledge base, community reach and ability to shape a more sustainable world. I look forward to working with my fellow ASHRAE officers and members this year to extend our global community, adapt to new technologies and embrace our shared needs and objectives."

In addition to serving as the Society's president, Olesen will continue to serve as a professor at the Technical University of Denmark. During his term, he will also serve as chair of ASHRAE's Board of Directors and Executive Committee.

Elected officers who will serve one-year terms are as follows:

- President-Elect: Sheila J. Hayter, P.E., Fellow ASHRAE, group manager, National Renewable Energy Laboratory, Golden, CO
- Treasurer: Darryl K. Boyce, P.Eng., Fellow ASHRAE, assistant vice president, facilities management and planning, Carleton University, Ottawa, ON Canada
- Vice President: Michael Schwedler, Fellow ASHRAE; principal and senior applications manager, Trane Co., La Crosse, WI
- Vice President: Ginger Scoggins, P.E., president, Engineered Designs, Raleigh, NC
- Vice President: Edward Tsui, managing director, Intelligent Technologies Ltd., Hong Kong
- Vice President: Julia A. Keen, Ph.D., P.E., BEAP, HBDP, associate professor, architectural engineering and construction sciences, Kansas State University

ASHRAE also introduced its newest directors who will serve three-year terms from 2017-20:

- Region VII Director and Regional Chair: Michael P. Cooper., P.E., senior vice president, Bernhard MCC, Metairie, LA
- Region VIII Director and Regional Chair: Jonathan I. Symko, president, QSC Consultants LLC, Sugar Land, TX
- Region IX Director and Regional Chair: Trenton S. Hunt, systems engineer/account manager, Mechanical Products Intermountain, Midvale, UT
- Region X Director and Regional Chair: Marites Dagulo Calad, vice president, Norman S. Wright Mechanical, Waipahu, HI
- Region XIV Director and Regional Chair: Constantinos A. Balaras, Ph.D., P.Eng., Fellow ASHRAE, research/development engineer, National Observatory of Athens, Greece
- Region-at-Large Director and Regional Chair: Farooq Mehboob, P.E., Fellow ASHRAE, owner, S. Mehboob & Company, Consulting Engineers, Karachi, Pakistan
- Director-at-Large: Van D. Baxter, P.E., Fellow ASHRAE, senior research/development engineer, Oak Ridge National Laboratory, Oak Ridge, TN
- Director-at-Large: Donald L. Brandt: BEAP, sales engineer, Trane Co., Phoenix, AZ

About ASHRAE

ASHRAE, founded in 1894, is a global society advancing human well-being through sustainable technology for the built environment. The Society and its more than 56,000 members worldwide focus on building systems, energy efficiency, indoor air quality, refrigeration and sustainability. Through research, standards writing, publishing, certification and continuing education, ASHRAE shapes tomorrow's built environment today. More information can be found at www.ashrae.org.

CALMAC Celebrates 70th Anniversary

Founded in 1947, Calvin 'Cal' MacCracken started the company to pursue his love of inventing. Prior to founding CALMAC, Cal designed and throttled the first jet engine ever built by GE. During his 50 years with CALMAC, he created over 250 inventions and had 80 patents. Some of his most widely known to the public include a hotdog cooker called Roll-A-Grill, and the award-winning Alumazorb low emissivity ceiling, saving hundreds of millions of kWhs for ice rinks around the world. In addition to being a prolific inventor, Cal was an industry icon who was honored by ASHRAE and inducted into the ASHRAE Hall of Fame for his pioneering work in energy conservation through energy storage and ice rinks. Cal was so far head of his time, when he was on a "futuristic" 1953 T.V show entitled *2000 A.D.,* Cal correctly predicted, in detail, the coming of the Solar Age.

CALMAC was the originator of the IceMat® Ice Rink Floor, creating perfectly uniform ice with dramatic reduction in pumping power. IceMat rolls out like a carpet and connects to a refrigeration unit for quick installation at both temporary and permanent ice rinks. This flexible design has since become the industry standard for ice rinks.

CALMAC's most widely applied product is, IceBank® energy storage functions like an affordable, simple and reliable battery for a building's air-conditioning system. IceBank® saves dramatically on the cost to cool buildings by reducing a building's on-peak use of electricity. The IceBank ice battery system uses standard cooling equipment plus an energy storage tank to shift all or a portion of a building's cooling needs to off-peak, nighttime hours. During off-peak hours, ice is made and stored inside IceBank energy storage tanks. The stored ice is then used to cool the building the next day. IceBank® offers a critical service to grid, since air-conditioning is the main culprit behind spikes in peak electrical demand. This on-peak reduction decreases the need to build new power plants or turn on expensive "peaker" power plants. The award-winning product has received many accolades including

the Buildings Money-Saving Products Award and Building Operating Management Top Products Award.

Used by over 4,000 businesses in 60 countries, CALMAC has over 1GW of energy storage worldwide and has built a prestigious list of customers including Credit Suisse, Goldman Sachs, Google, Kohl's, IBM, IKEA, McDonald's, Morgan Stanley, Nordstrom, Rockefeller Center, Wal-Mart and more. The company's customers range from school districts, universities and places of worship to government buildings, retailers and medical centers. One customer, for example, St. Lucie County School District has reduced utility costs by $5 million a year thanks to CALMAC.

"As a school district located in South Florida, consistently hot temperatures and high humidity rates makes cooling 6.5 million square feet of buildings and 40,000 students one of our biggest priorities and biggest expenses," said Marty Sander, St. Lucie County School District's executive director of growth management, land acquisition, inter-governmental relations, facilities and maintenance. "We pair high efficiency chillers with CALMAC's energy storage technology for hybrid cooling system that shaves peak demand and reduces our utility bill. Before working with CALMAC, we ranked 60th out of 67 school districts statewide for energy use per student. Now, we have moved to 16th in the state and have reduced our energy costs from $12 million to $7 million per year. Not only are we saving money, but now we can budget for an extra 100 teachers."

As changes in business and the energy landscape occur, CALMAC's ice based energy products continue to meet the challenges of today's energy and facility managers. IceMat ice rinks are growing as a major player in retrofit markets with flexible, affordable engineered solutions for indoor and outdoor rinks. IceBank energy storage remains a leading thermal storage solution.

Although storing energy in ice has been applied for over 40 years, there have been a number of internal and external factors leading to a renewed interest in ice storage in the past decade. Materials of construction and manufacturing practices have increased the durability and life of the IceBank product, while growth of renewable energy and the green building market has turned the spotlight on the energy storage marketplace.

"In the mid-1970s, I joined the company because of its focus on solar energy," said Mark MacCracken, son of Cal MacCracken and now CALMAC's CEO. "CALMAC's development of IceBank became the top priority in the 1980s. In the 1990s, Demand Side Management was critical to the electric utilities and ice storage became a common tool to lower customer costs and decrease peak demand. As popularity for renewable energy rose following the development of LEED in the 2000s, the need for demand flexibility of energy storage became even more paramount. I went to Phoenix in 2009 to attend the GreenBuild Expo and was elected to be Chairman of the Board of Directors of US Green Building Council – ironically in the same city where my father

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attended the first Solar Energy Convention in 1955. It was an honor to be elected to run the most impactful non-profit organization in the sustainable marketplace in the same location my father launched CALMAC into it 54 years prior. He was truly ahead of his time."

In April 2017, Mark MacCracken was also recognized by City and State New York as an honoree of the Corporate Social Responsibility Award for Sustainability and Environmental Impact for his success in promoting sustainability initiatives in the energy sector as well as devoting his time to creating a positive environmental impact.

For more information on CALMAC, visit www.calmac.com.

About CALMAC

Since 1947, CALMAC Corp. has been a leading U.S. manufacturer of cool energy related technologies. CALMAC is most known for its IceBank energy storage systems strengthening the smart grid by storing critical energy sources - including renewables like wind power - for later use. IceBank energy storage tanks are installed at over 4,000 locations in 60 countries and last over 40 years. CALMAC's IceMat and Alumazorb products are found in hundreds of rinks worldwide. Customers trust CALMAC for the best ice skating surfaces under any conditions — and lower construction and operating costs. Widely recognized for promoting peak energy conservation and energy cost savings, CALMAC Corp is a member of the Ice Skating Institute, U.S. Green Building Council (USGBC) and the New Buildings Institute.

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