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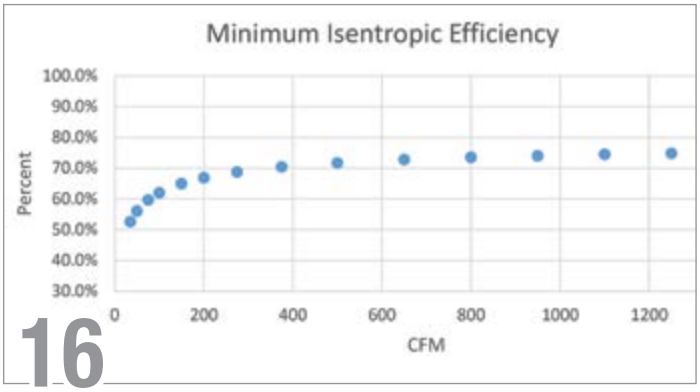
COMPRESSED AIR SYSTEM FEATURES



COOLING SYSTEM FEATURES

EVERY ISSUE

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FROM THE EDITOR

New Content in 2025!

With the new year, our magazine is introducing changes I hope you'll enjoy.

Starting this month, all our issues combine *Compressed Air Best Practices* and *Chiller & Cooling Best Practices*. We're excited to bring a fuller range of on-site utilities to every issue.

Department of Energy isentropic efficiency regulations for oil-flooded rotary air compressors take effect January 10, 2025. Our feature from Bruce McFee, President, Sullivan-Palatek, has information manufacturers need to know. When we saw the strong interest in McFee's talk on the subject at the Best Practices 2024 EXPO & Conference, we knew we needed an article.

Midwest Machinery of St. Louis, MO, replaced a cooling tower for Bayer Crop Science, and the project held a variety of unique challenges, including an accelerated schedule. Thanks to Spencer Kaufman, Sales Engineer, and Ryan Miller, General Manager, for sharing great work from Midwest Machinery, the first Marley rep firm.

When a manufacturing plant's compressed air dry tank is suddenly full of water, how should the maintenance team uncover the problem? Work backwards and check off potential trouble spots one at a time. That's the lesson from Facility Maintenance, our new column from John Bilsky, Facilities Specialist, Gentex Corporation.

(I hope to add other columns in future issues, perhaps one from a facilities engineer.)

Toyota is reducing Scope 1 and 2 emissions, CalPortland is lowering CO_2 output and PepsiCo is using water more efficiently. For manufacturing plants focused on decarbonization and water conservation, it's helpful to see what other plants are achieving. We're bringing back our sustainability-focused news section as Industrial Energy & Water Conservation News, and hope it provides inspiration.

You'll also find features on Oak Ridge National Laboratory's Compressed Air Scoping Tool, evaluating process cooling supply temperatures (thanks to Clayton Penhallegon Jr.) and air compressor sizing for spray finishing (thanks to C.H. Reed).

This issue is rich with strong writing, and I can't wait for you to dive in. Please send me your feedback on the new content.

TROY DREIER
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Subscribers From Around the World

We salute all Best Practices Magazine Subscribers from around the world who own, operate, maintain, engineer and provide expertise for the on-site utilities (compressed air, nitrogen generation, vacuum, blowers, chillers, cooling towers and pumps) powering modern plant automation. This subscriber-driven monthly column hopes to build community and recognize all subscribers!

The Best Practices 2024 EXPO & Conference was pleased to welcome many attendees from manufacturing plants, including Will Wernsing, Utility Tech, and Chris Rohman, Utility Building Maintenance Tech, Bio Products, Archer Daniels Midland (left to right). ADM is known for having one of the largest compressed air installations in industry, one comprised entirely of centrifugal air compressors. Visit https://www.adm.com.

Another manufacturing plant attendee at the Best Practices 2024 EXPO & Conference was Jesse Scott, Facilities Engineer, Magna International. "The Best Practices conference shows a lot of different innovative products," Scott said. "I've found many energy and sustainability items I'll be pursuing to implement in our plant operations." Visit https://www.magna.com.

Submission Guidelines

We invite our subscribers to send in pictures so we can see the people who read our Best Practices magazines! Those holding a recent magazine issue will receive first consideration. Please send a high-resolution picture as a JPG with a note describing the team and company to Troy Dreier at troy@airbestpractices.com.

One of the standout events at the Best Practices 2024 EXPO & Conference was the annual in-person meeting of the Women in Compressed Air, Vacuum & Cooling Networking Group. This year, it included a catered breakfast sponsored by Ingersoll Rand and Hitachi Global Air Power. Subscribers in attendance included Brieana-Marie Dionne, Human Resources Generalist, ELGi; Ketsiya Rejoice Mundoga, Reliability Engineer, GoGo SqueeZ; Tiffane Champion, National Sales Manager, Control Devices and Gina Castro, Product Line Manager, Control Devices (left to right). Visit https://www.elgi.com/us, https://gogosqueez.com and https://www.cdivalve.com.

Also at the breakfast event were Loretta English, Inside Sales Coordinator, Ultrachem; Pam Tetterton, Regional Sales Manager, BOGE; Marlene Quintero-Ortega, Inside Sales Account Representative, BOGE; Kristin Anderson, Mechanical Design Engineer, Haskell; Jalene Fritz, Vice Chair, Cooling Technology Institute and Irma Magdaleno, Sales, Rovivsa (left to right). Visit https://www.ultracheminc.com, https://www.boge.com, https://www.haskell.com, https://www.cti.org and https://www.rovivsa.com.mx.

Compressed Air Industry & Technology News

Hitachi Global Air Power US Announces Andy Fayyad as Vice President, Overseeing Operations Transformation

Hitachi Global Air Power US announced Andy Fayyad has joined the company as Vice President Operations. Fayyad is responsible for continuing the company's operations transformation at the Sullair air compressor manufacturing facility in Michigan City, IN.

"Andy's extensive experience and commitment to operational excellence make him an ideal fit for our team," said John Randall, President and CEO, Hitachi Global Air Power. "With his deep expertise in quality assurance and strategic planning, Andy is well-equipped to support our growth strategy and strengthen our commitment to world-class quality and manufacturing."

Fayyad brings more than 34 years of experience in the industrial manufacturing space. He's a seasoned expert in lean manufacturing with international management experience leading teams in China, South Korea, Germany, France, India and the U.S.

"I am joining Hitachi Global Air Power at an exciting time – the company has been boldly modernizing their manufacturing operations to world-class levels," said Fayyad. "I look forward to continuing the transformation journey with this capable and dedicated team." For more information, visit https://www.hitachiglobalairpower.com.

Andy Fayyad, Vice President Operations, Hitachi Global Air Power

DENSO Completes $4.4M Compressed Air System Project with ESG and Support from Consumers Energy

DENSO, a leading mobility supplier, has completed a $4.4 million project with Energy Systems Group (ESG) to update and replace compressed air systems at its thermal manufacturing facility in Battle Creek, MI. Consumers Energy contributed more than $493,000 to the initiative, collaborating with DENSO to protect the planet.

DENSO's Battle Creek, MI, thermal manufacturing facility. Photo courtesy of DENSO.

The project represents DENSO's largest green investment in its North American operations this year to date.

The updates will allow the location – DENSO's first manufacturing site in the U.S. – to reduce its carbon output by 3,110 metric tons per year, equivalent to the amount of electricity used in more than 700 homes annually.

"To create a greener future, it requires the collaboration of many," said Todd Greer, Vice President of Manufacturing at DENSO's Battle Creek facility. "That's why we are so appreciative of ESG and Consumers Energy's support. Together, we were able to harness our collective know-how for maximum sustainability impact. Activities like this are what drive us closer to our goal of becoming carbon neutral by 2035." For more information, visit https://www.denso.com/us-ca/en.

Gryphon Investors Acquires RapidAir, Establishes Platform for Branded Downstream Compressed Air Solutions

Gryphon Investors announced it has acquired RapidAir from Pfingsten Partners. RapidAir will serve as a platform for future investments in compressed air solutions. This represents the sixth platform deal closed by Gryphon's Heritage Group, the firm's small-cap fund strategy.

Founded in 2003 and headquartered in Auburndale, WI, RapidAir is a provider of downstream compressed air solutions, including fittings, accessories, aluminum piping and filtration products. CEO Mark LeMire, along with the company's management team, will remain with RapidAir and retain an ownership stake.

"We are excited to partner with Mark and the RapidAir team to grow the business and further position the company as a market leader. RapidAir has built a strong reputation as the go-to-provider of downstream compressed air solutions for a variety of applications given its top-tier products, best-in-class customer service and technical support, comprehensive design capabilities and superior lead times," said Jeff Pembroke, Gryphon Operating Partner. For more information, visit https://www.rapidairproducts.com.

Hertz Kompressoren Expands IMPETUS VSD Series in U.S. Market

Hertz® Kompressoren has introduced into the U.S. market its IMPETUS two-stage, variable speed, low-horsepower (hp) series of air compressors ranging from 22kW (30-hp) to 75kW (100-hp), both air and water cooled. The low horsepower series complements the higher horsepower two-stage, variable speed machines ranging from 90kW (125-hp) to 315kW (430-hp), which has been in the U.S. market for several years.

The Hertz low horsepower, two-stage machines offer excellent isentropic efficiencies, higher than 80% and as high as 86%. The reason for this high efficiency is that these two-stage machines run cooler, have an air flow path that reduces pressure loss, have oversized separators, are oil-cooled, have a permanent magnetic motors and large intake chambers.

"This Hertz two-stage IMPETUS, low horsepower, variable speed series of compressors is the best and most efficient rotary screw compressor in the market today. The future is two-stage machines because of the tremendous energy savings realized with these compressors," said Mert Alpagut, Vice President, Hertz Kompressoren U.S. For more information, visit https://www.hertz-kompressoren.com/en-us.

The IMPETUS VSD

Atlas Copco Group Acquires Compressed Air Distributor Pennine Pneumatic Services Based in England

Pennine Pneumatic Services (PPS), a compressed air distributor in Yorkshire, UK, has become part of Atlas Copco Group.

PPS is based in Brighouse in Yorkshire, England, and was founded in 1991, but also has branches in Sheffield, Hull, Leigh and Alfreton. The company has 84 employees across the five locations.

PPS offers energy-saving advice and solutions to manufacturers and other industries with applications that rely on compressed air and related systems and services. This includes compressors, gas generators, chillers, pneumatics, pipework, ducting and assembly tools. Customers are found in all types of manufacturing industries, such as automotive and rail, chemical, construction and engineering, as well as food & beverages.

"PPS showcases strong sales and service presence in the North of England, which will open additional opportunities for us going forward," said Philippe Ernens, Business Area President Compressor Technique.

The purchase price is not disclosed. PPS has become part of the Service division within the Compressor Technique business area. For more information, visit https://www.atlascopcogroup.com.

Compressed Air Industry & Technology News

South-Tek Systems Launches N2GEN-FLEX Nitrogen Generator, Delivering Savings in Energy and Service Costs

South-Tek Systems announced the launch of the N2GEN-FLEX Nitrogen Generator.

"We're excited to introduce the N2GEN-FLEX to the market," said Jens Bolleyer, CEO, South-Tek Systems. "Our customers are looking for efficient, cost-effective and flexible solutions. The N2GEN-FLEX delivers on our promise to provide our customers with the right solution for their applications. It reduces operational costs, lowers service maintenance and provides reliable high-purity nitrogen whenever it's needed, revolutionizing how companies handle their nitrogen requirements. This line of products represents the future of nitrogen generation."

The N2GEN-FLEX uses Pressure Swing Absorption (PSA) technology to deliver the most efficient air-to-nitrogen ratio in the industry, which is significantly more efficient than competing systems. This advanced technology reduces energy consumption by 20% or more when compared to traditional nitrogen generators, ensuring lower operational costs and a longer lifespan. The N2GEN-FLEX is engineered to provide superior performance, flexibility and cost-effectiveness for operations requiring nitrogen from 95% to 99.999% purity and flow rates from 400 to over 2,200 scfh. For more information, visit https://www.southteksystems.com.

New modular design delivers exceptional cost savings, energy efficiency and maximum operational flexibility for industrial applications.

Emerson Energy Manager Simplifies Industrial Electricity Monitoring, Reduces Energy Costs and Carbon Emissions

Emerson has launched its new Energy Manager solution, a pre-engineered hardware and software offering designed to simplify industrial electricity monitoring with quick setup and intuitive operation. Ready out of the box, the Energy Manager solution monitors asset energy use in real time, allowing manufacturers to gain deeper insight into energy consumption and operating costs, lowering carbon dioxide (CO_2) emissions and maximize energy and operational efficiency.

Emerson's Energy Manager solution allows plant managers to quickly view detailed values and see savings opportunities, such as idle consumption and peak loads. The software's easy-to-use dashboard provides asset-specific energy use, associated costs and CO_2 emissions for up to 10 end points (expandable to 50 endpoints with a license).

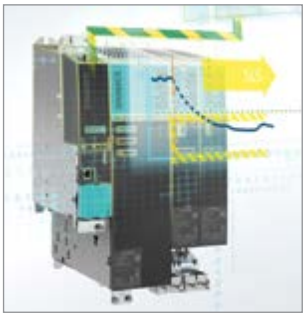
Emerson introduces its new Energy Manager solution, a plug-and-play system that streamlines industrial electricity monitoring, helping manufacturers optimize energy use, reduce CO_2 emissions and boost operational efficiency.

"Reliable, accurate monitoring of energy costs and emissions is becoming invaluable to organizations," said Eugenio Silva, Intelligent Automation Product Manager with Emerson's discrete automation business. "Our new Energy Manager solution gives operators, facility managers and corporate sustainability teams greater visibility and deeper understanding of energy consumption and operating costs at all times. This can better position companies to track and reach targets, comply with regulations and reliably reduce environmental impact." For more information, visit https://www.emerson.com.

Siemens Supports Machine Builders with Guided Safety Acceptance Test for SINAMICS Variable Frequency Drives

With its SINAMICS Startdrive commissioning software, Siemens is supporting machine builders in the validation of safety functions for SINAMICS variable frequency drives with a guided acceptance test. With SINAMICS Startdrive, Siemens offers a tool for the integration of drive hardware into the TIA Portal engineering framework. This integrated guided acceptance test for safety functions is available for SINAMICS G- and S-series drives and complies with EN ISO 13849-2 and IEC 62061.

The safety acceptance test is extremely user-friendly. A wizard guides the user step-by-step through the acceptance process and checks whether safety functions have been parameterized and executed correctly in the relevant application. For documentation purposes, a standard-compliant acceptance report is then created automatically. With the safety acceptance test integrated into SINAMICS Startdrive, Siemens helps machine builders carry out the legally required validation of safety functions easily and safely. For more information, visit https://www.siemens.com.



With SINAMICS Startdrive, Siemens supports machine builders in the validation of safety functions for SINAMICS variable frequency drives with a guided acceptance test.

ELGi North America Introduces Next-Generation EG Series Air Compressors for Superior Efficiency

ELGi North America has upgraded its EG Series portfolio with the introduction of the EG Super Premium (EG SP) 90-110 range of oil-lubricated, screw air compressors and the EG PM 11-45kW Permanent Magnet Synchronous Motor (PMSM) compressor.

"Over 80% of a compressor's total lifecycle cost is attributed to energy usage," said Scott Avey, Vice President – Industrial Business, ELGi North America. "With these new ranges, we're helping our customers in energy-intensive industries meet their sustainability goals, reduce operational costs and stay competitive in a demanding market."

The EG SP 90-110

The EG SP 90-110 achieves improved energy efficiency through its two-stage airends with the proven η-V profile. This configuration distributes operational load evenly across each stage, increasing component lifespan and achieving up to 15% energy savings compared to prior models. Additionally, Nema Premium Efficiency Motors, directly coupled with the airends, optimize energy efficiency and ensure reliable operation in harsh conditions.

Optional built-in ELGi Variable Frequency Drives further enhance this range's efficiency by matching air compressor output with demand with varying motor speeds. For more information, visit https://www.elgi.com/us.

Chiller & Cooling Industry & Technology News

Midwest Machinery Saint Louis Named Sales Agent for Johnson Controls

Johnson Controls Equipment North America and Midwest Machinery are pleased to announce Midwest is now the equipment sales agent serving the St. Louis, MO, markets including Southern Illinois and Eastern Missouri. This strategic alignment gives Midwest the ability to provide best-in-class York-branded equipment. The York products complement the company's other marquee brands including Marley, Cleaver-Brooks, Armstrong, ClimateMaster and Danfoss.

"This expanded relationship with Johnson Controls and their local direct branch marks an important milestone for us. By offering the full range of York-branded equipment, we are better positioned to serve our clients with cutting-edge solutions while maintaining the exceptional customer service that's been a hallmark of Midwest Machinery for over a century. Never have we been more equipped to deliver on our mission of striving to be our customers' most trusted and valued partner in their pursuit of designing and constructing better buildings and mechanical systems," said Troy Gladstone, President, Midwest Machinery. For more information, visit https://midwestmachinery.net. For more information, visit https://www.johnsoncontrols.com.

Midwest Machinery has been named the official equipment sales agent for York-branded HVAC equipment by Johnson Controls, serving the St. Louis, MO, Southern Illinois and Eastern Missouri markets.

Danfoss Turbocor® President Ricardo Schneider Announces Retirement, Rogerio Federici Succeeds Him

Danfoss has announced Rogerio Federici will succeed Ricardo Schneider as the new Head of Danfoss Turbocor® Compressors. Schneider, a recognized leader in the HVAC industry, will start a transition to retirement after 32 years with Danfoss.

Rogerio Federici will succeed Ricardo Schneider as the new Head of Danfoss Turbocor, effective Jan. 1, 2025.

Federici, currently Head of Sales & Marketing for Danfoss Turbocor, will step into the role after two years of successfully leading Turbocor's commercial efforts. He brings 28 years of experience at Danfoss and a deep understanding of the market to his new position.

"Rogerio's appointment reflects our commitment to ensuring seamless leadership transitions and continued growth," said Kristian Strand, President, Commercial Compressors, Danfoss. "His expertise will be invaluable as we continue developing and delivering game-changing oil-free technology to the HVAC industry."

"I am honored to lead Danfoss Turbocor into this next chapter of innovation and growth," said Federici. "We have a talented team and a powerful vision to further advance our technology and deliver even greater value to our customers." For more information, visit https://www.danfoss.com.

CAREL Appoints New Group Chief Technology Officer, Reflecting Its Commitment to Developing its Technical Areas

Paolo Faraldi has joined CAREL as the new Group Chief Technology Officer. This strategic appointment reflects the Group's commitment to strengthening the scope and development of its technical areas, with the aim of increasing the integration and coordination of its technological processes.

Faraldi brings to the Group more than 20 years' experience acquired at leading international companies, such as Fiat, Indesit, Philips and Electrolux, both in Italy and abroad. He will be responsible for overseeing and coordinating CAREL's technical and digital projects, with the aim of fostering synergy and innovation across all areas of development. This appointment is a key part of CAREL's strategy, which has always been centered around research, innovation and technology – constant analysis and adoption of new technologies are in fact part of the Group's research and development process.

Paolo Faraldi, Group Chief Technology Officer

Giandomenico Lombello, CAREL Group Managing Director, said, "We are thrilled to welcome Paolo Faraldi. His experience and vision will be fundamental in guiding CAREL in facing new technological challenges and maintaining our leadership on the market." For more information, visit https://www.carel.com.

Daikin Applied Announces Magnitude® WME-D Centrifugal Chiller

Daikin Applied has introduced the Magnitude® WME-D, a next-generation, water-cooled centrifugal chiller featuring a two-stage, oil-free compressor and low-global warming potential (GWP) R-515B refrigerant. With an optimized compressor-refrigerant combination, the WME-D improves performance for up to 40% more energy savings than traditional fixed-speed compressors. The combination of a low-GWP refrigerant and enhanced efficiency allows building owners and operators to accelerate their decarbonization efforts while experiencing the best performance in the market compared to similar chillers.

"We are consistently working to provide sustainable, high-performance solutions," said Jim Macosko, Vice President of Product and Sustainability Solutions, Daikin Applied. "With the introduction of the Magnitude WME-D, customers can continue to experience unparalleled reliability and efficiency while reducing the environmental impact of their building and HVAC systems."

The WME-D chiller offers impressive cooling and heating capabilities, providing 250-450 tons (900-1,600 kW) of cooling and 3600-5300 MBH (1,000-1,550 kW) of heating. This dual capability eliminates the need for separate heating equipment.

The WME-D chiller is designed with low-GWP R-515B refrigerant, aligning with Daikin's commitment to providing sustainable solutions without compromising performance. The chiller boasts the best performance in the market relative to other chillers using R-515B refrigerant, excelling in both full-load efficiency and integrated part-load efficiency. For more information, visit https://www.daikinapplied.com.

As customers look to reduce carbon emissions, Daikin delivers energy-efficient and industry-leading performance with the Magnitude® WME-D.

Industrial Energy & Water Conservation News

Toyota Releases 2024 North American Sustainability Report, Shares Insights on Environmental Strategy

Toyota Motor North America published its 2024 North American Environmental Sustainability Report.

"Building on Toyota's foundational principle of continuous improvement, Toyota aims to achieve our environmental sustainability goals – not just becoming carbon neutral – but also the continued collaboration, cooperation and data management activities as they become standardized for all team members," said Kevin Butt, Regional Environmental Sustainability Director, Toyota Motor North America.

The report outlines Toyota's environmental strategy and highlights progress toward contributions to the UN Sustainable Development Goals. Highlights include:

- 14% reduction in Scope 1 & 2 (operations-related) greenhouse gas (GHG) emissions vs. FY2019.
- Achieved a 6.8% decrease in the current year for the number of gallons of water withdrawn per vehicle manufactured when compared to FY2021.

Toyota is steadfast in its global commitment to achieving the Toyota Environmental Challenge 2050 through a phased approach that emphasizes collaboration and innovation. For more information about Toyota, visit https://www.toyota.com.

Toyota has released its 2024 North American Environmental Sustainability Report.

Philip Morris International Receives Fourth Consecutive CDP "Triple-A" Rating for Climate, Forest and Water

For the fourth consecutive year, Philip Morris International has received a "triple-A" rating from Carbon Disclosure Project (CDP) for its disclosures on climate change, forests and water security – placing PMI among the world's leading companies in environmental transparency and action.

Philip Morris International received a "triple-A" rating from Carbon Disclosure Project for the fourth consecutive year.

PMI has maintained a position on CDP's Climate A List for the past 10 years, reflecting its commitment to transparency and performance as the company progresses toward achieving its science-based targets, as well as carbon neutrality for Scope 1 and 2 by 2025, and net zero by 2040 for Scope 1, 2 and 3. P

This is the fifth year that PMI has been featured on CDP's Water A List as the company works toward its water optimization targets, which include optimization of 10 million cubic meters of water in its tobacco growing areas by 2030.

"We recognize the urgency to address climate change and protect biodiversity, and this is why our decarbonization strategy and progress are closely tied to preserving natural ecosystems," said Jennifer Motles, Chief Sustainability Officer, PMI. "We are proud to be an early adopter of the TNFD framework and will be reporting on it in 2025, which builds on the work we have already done to incorporate climate-related risk and opportunities into our overall business strategy and disclosure efforts, following the Taskforce on Climate-related Financial Disclosures (TCFD) recommendations." For more information, visit https://www.pmi.com.

ABB Recognized with "A" Score from Carbon Disclosure Project for Transparency on Climate Change

ABB has been recognized for leadership in corporate transparency and performance on climate change by global environmental non-profit Carbon Disclosure Project (CDP), securing a place on its annual "A List."

"ABB is taking a rigorous science-based net-zero targets approach in line with the Net-Zero Standard of the Science Based Targets initiative (SBTi). Inclusion in CDP's A List is an important recognition of our approach to sustainability and our commitment to setting ambitious and meaningful sustainability targets," said Anke Hampel, Group Head of Sustainability, ABB.

The company has submitted its new targets to SBTi with validation expected in 2024. These include 1.5°C-aligned Scope 1 and 2 targets aiming at a CO_2e emissions reduction of 80% by 2030 and 100% by 2050 versus a 2019 baseline. On a 12-month rolling average, as of Q3 2023, ABB achieved a 72% reduction in Scopes 1 and 2 CO_2e emissions versus 2019.

Additionally, the company has set new Scope 3 CO_2e emissions targets aiming at a reduction of 25% by 2030 and 90% by 2050 versus a 2022 baseline.

Following the latest WBCSD avoided emissions guidance, ABB has also updated its ambition in this area and aims to enable its customers to avoid 600 megatons of CO_2e emissions through products sold from 2022 to 2030. ABB helped its customers avoid 70 Mt of CO_2e in 2022, across industry, transportation, buildings, data centers and more. For more information, visit https://global.abb.

ABB secured a spot on Carbon Disclosure Project's annual "A List."

PepsiCo Releases 2023 Environmental, Social and Governance Summary Highlighting PepsiCo Positive Results

PepsiCo published its 2023 progress report on Environmental, Social and Governance (ESG) results. Through a wide range of innovation, strategic investment, ground-breaking partnerships and the multitude of actions pursued by its 318,000 global associates, the company:

PepsiCo released its 2023 ESG Summary highlighting PepsiCo Positive (pep+) results.

- Reduced Scope 1 and 2 emissions by 13% and total Scope 1, 2 and 3 emissions by 5% year over year[1]
- Recorded a 25% improvement in water-use efficiency at high water-risk company-owned locations when compared to a 2015 baseline – reaching this goal two years ahead of schedule[2]

"Three years into our pep+ journey, it's clear the focus we have driven throughout the business is working in many areas. Our use of virgin plastics is down year-over-year and our total Scope 1, 2 and 3 emissions are down compared to 2022, as well as versus our 2015 baseline. This is all to be celebrated. However, the road ahead will continue to present challenges," said Jim Andrew, Chief Sustainability Officer, PepsiCo. "We continue assessing where to devote time and resources to deliver meaningful impact and ensure we are focusing our efforts. Building strong and strategic partnerships with other scale players and adopting and scaling breakthrough technologies are central to our strategy." For more information, visit https://www.pepsico.com.

1. Reduced Scope 1 and 2 emissions by 33% and total Scope 1, 2 and 3 emissions by 4% measured versus a 2015 baseline.

2. Measured versus a 2015 baseline. Goal reflects the exclusion of third-party facilities. Between 2006–2015, water-use efficiency improved by 26% in global legacy operations at the date of target setting.

New DOE Air Compressor Regulations

Rotary air compressor isentropic efficiency regulations place a new requirement on manufacturers

By Bruce McFee, President, Sullivan-Palatek

➤ January 10, 2025, is the day the U.S. Department of Energy (DOE) begins efficiency regulation of oil-flooded rotary air compressors. This has the potential to cause the biggest change in the history of the air compressor industry, as models from 35-1,250 cfm with pressures ranging from 75-200 psi (5.2-13.8 bar) will need to meet a minimum isentropic efficiency. Also, models produced on or after Jan. 10 for sale in the U.S. will need to be registered with the DOE.

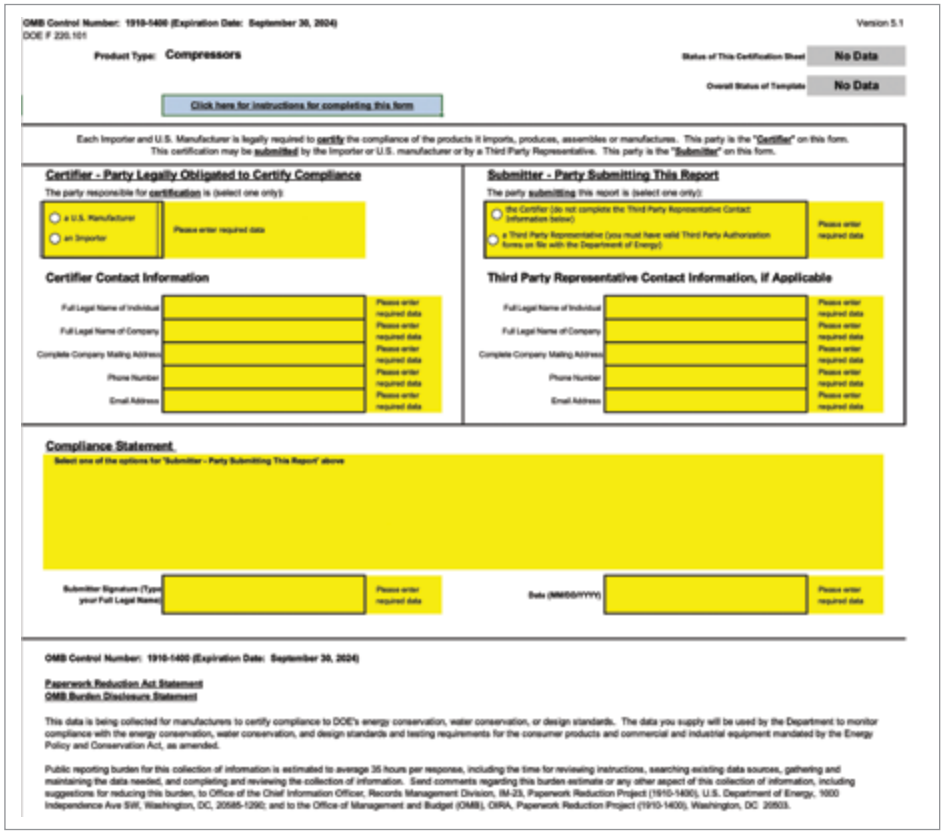
According to the standards document, the DOE estimates the energy savings over a 30-year period would be 0.16 quadrillion British thermal units, or a 6/10 of one percent improvement compared to not having a federal energy efficiency standard on air compressors.

How the DOE Regulations Were Created

Isentropic efficiency measures the ratio of ideal isentropic power to actual power consumed during air compression. Losses in efficiency occur for many reasons including heat from air compression, air slippage, friction with moving parts, pressure losses as air moves through system components and many other items. As a result, the actual measured energy is always higher than the theoretical ideal energy.

The DOE developed performance standards by comparing hundreds of data sheets from manufacturers and correlating the data to the amount of air flow. The data showed air compressors become more efficient as their capacity increases. A minimum standard was established for an air-cooled, oil-flooded, fixed-speed rotary air compressor using a math formula identifying a range

Above: The Sullivan-Palatek SP11 rotary screw air compressor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Full Legal Name of Company
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Phone Number
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The opening page of the DOE's rotary air compressor certification template.

of 53% isentropic efficiency for the smallest covered air compressors to 75% in larger air compressors. Products offered for sale in the U.S. below this minimum standard will either need to be redesigned or taken out of the U.S. market.

The DOE identified four different equipment classes. In addition to the air-cooled fixed-speed air rotary compressor, there is an air-cooled variable speed rotary air compressor, water-cooled fixed-speed rotary air compressor and water-cooled variable speed rotary air compressor class. Each equipment class has a different math formula to establish the minimum performance isentropic efficiency standard at a specific air flow.

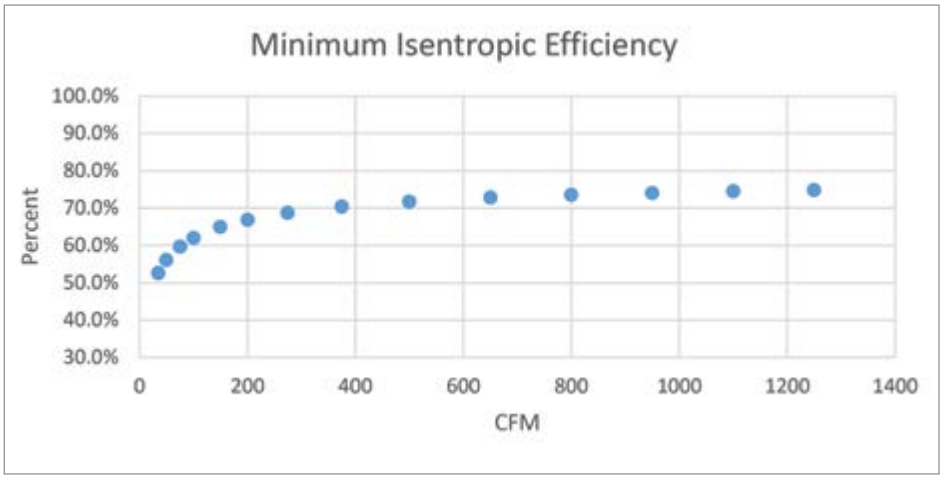
The measurement of variable speed (VS) air compressors is different than fixed speed models, which are rated only at 100% load. A VS compressor has three data points, 100% load is applied a 25% rating, 70% load gets a 50% rating and 40% load gets a 25% rating. As a result, a VS air compressor might have a different optimal airend than a fixed speed model with the same maximum flow rating, because the DOE rating is average at 70% flow for VS models.

Air Compressor Testing for DOE Approval

While air compressor manufacturers belonging to the Compressed Air and Gas Institute (CAGI) have provided data on energy usage for many years, the DOE is making some changes to the historical procedure. The CAGI verification program has provided customers confidence in manufacturer's data sheets by using a third-party test program to validate the data supplied by participating manufacturers.

However, the ISO 1217 standard used by both CAGI and the DOE allows a 4-7% tolerance on flow and 5-8% tolerance on energy consumption. The range is dependent on published air flow capacities. Likewise, the CAGI program does not specify how manufacturers would calculate their performance numbers. The DOE program requires one of two methods to develop the data: actual testing or use of an alternative efficiency data method (AEDM.)

The testing method requires selecting a basic machine and running at least two tests using the prescribed DOE test method, which is similar to ISO 1217, but with some minor variations. The performance numbers are stated as the mean without any consideration for the



The minimum isentropic efficiency standard increases as compressed air flow increases.

New DOE Air Compressor Regulations

downside tolerance. In addition, the DOE test involves a 95% one-tailed confidence limit test that may further reduce the final performance numbers. It becomes what the DOE refers to as the represented value.

AEDM is the usage of a mathematical method to project performance using data from a similar model to the one tested, assisting manufacturers that might need to provide a slightly customized product produced in small volumes. Manufacturers may not use the AEDM to overstate efficiency and are required to keep records of any AEDM calculation.

The result of any test data combined with its lower confidence limit test, or use of AEDM results in a represented value, must be reported to the DOE for each model placed into the U.S. market. DOE regulations also require manufacturer's CAGI data sheets and literature contain performance data identical to data submitted to the DOE. As a result, manufacturers will need to review their CAGI data sheets to make sure their data reflects the changes the DOE has made to the definition of a represented value.

New Challenges for Air Compressor Manufacturers

The DOE recently supplied the data template manufacturers need to submit for any products planned for future distribution in the U.S. The template requests many details, including the basic model number, the product equipment class, the flow in cfm, isentropic efficiency, maximum operating pressure and method of rating (testing or AEDM). If test method is used, the number of tests must be included. If the model includes ancillary equipment, manufacturers must list the brand and model number of the equipment, its voltage and motor phase, as well as size and types of connections.

Given that a variation of the basic model occurs any time an air compressor's flow, pressure or equipment class changes, there are likely to be a high number of products requiring submission to the DOE by any manufacturer. In addition, custom specialty products changing a component – such as an explosion-proof motor or stainless-steel cooler – would need separate registration. As a result, there will be administrative and engineering burdens in producing the extra testing or AEDM calculations for one-off models.

Testing facilities may reside at a manufacturer's location, however, the instruments must be capable of measuring temperature, flow, humidity and pressure within narrow ranges of tolerance. The guideline also requires periodic calibration of instruments to make sure they remain in compliance. While there is no requirement a test facility reside in the U.S., it is the importer's responsibility to ensure covered machines have been properly tested, meet the minimum isentropic efficiency standard and are registered as imported compressors with the DOE.

The DOE standard is expected to be more difficult for specialty air compressors because they are often manufactured in small quantities and may require operating features preventing the most efficient design. In its final rule, the DOE analyzed several specialty applications including corrosive environments, hazardous environments, extreme temperatures, marine environments, weather-protected environments and mining environments. Air compressor products in these applications often require special class electric motors, higher ambient cooling fans, environment-protected coolers and piping, smaller footprints than ideal and other unique designs that may not be the most energy efficient. Likewise, higher pressure air compressors are less likely to meet the minimum standard and therefore more of these models could be taken off the market.

Despite the change coming January 10, the industry is expected to continue supplying enough air compressors to meet demand. The DOE provided a five-year notice of its rule during a time when the industry was already working on energy efficiency improvements. For more information on DOE air compressor standards, visit https://www.energy.gov/eere/buildings/commercial-and-industrial-air-compressors. BP

About the Author

Bruce McFee has been active in the air compressor industry for almost four decades. He serves as President at both Saylor-Beall Manufacturing Company and Sullivan-Palatek, Inc. McFee has been a member of the CAGI Board of Directors since 2018. He previously served as Chairperson of the Reciprocating Air Compressor Section and the Portable Air Compressor Section, and he is the current Chairperson of the Rotary Positive Air Compressor Section.

About Sullivan-Palatek

Sullivan-Palatek Inc. was founded over 35 years ago in Michigan City, IN. The company began as an engineering service provider and transformed into manufacturing rugged and dependable rotatory screw air compressors. Sullivan-Palatek focuses on continuous improvement, allowing its customers to meet a variety of compressed air demands. Sullivan-Palatek supports American jobs by assembling its air compressors in Northwest Indiana with a local workforce. For more information, visit https://www.sullivan-palatek.com.

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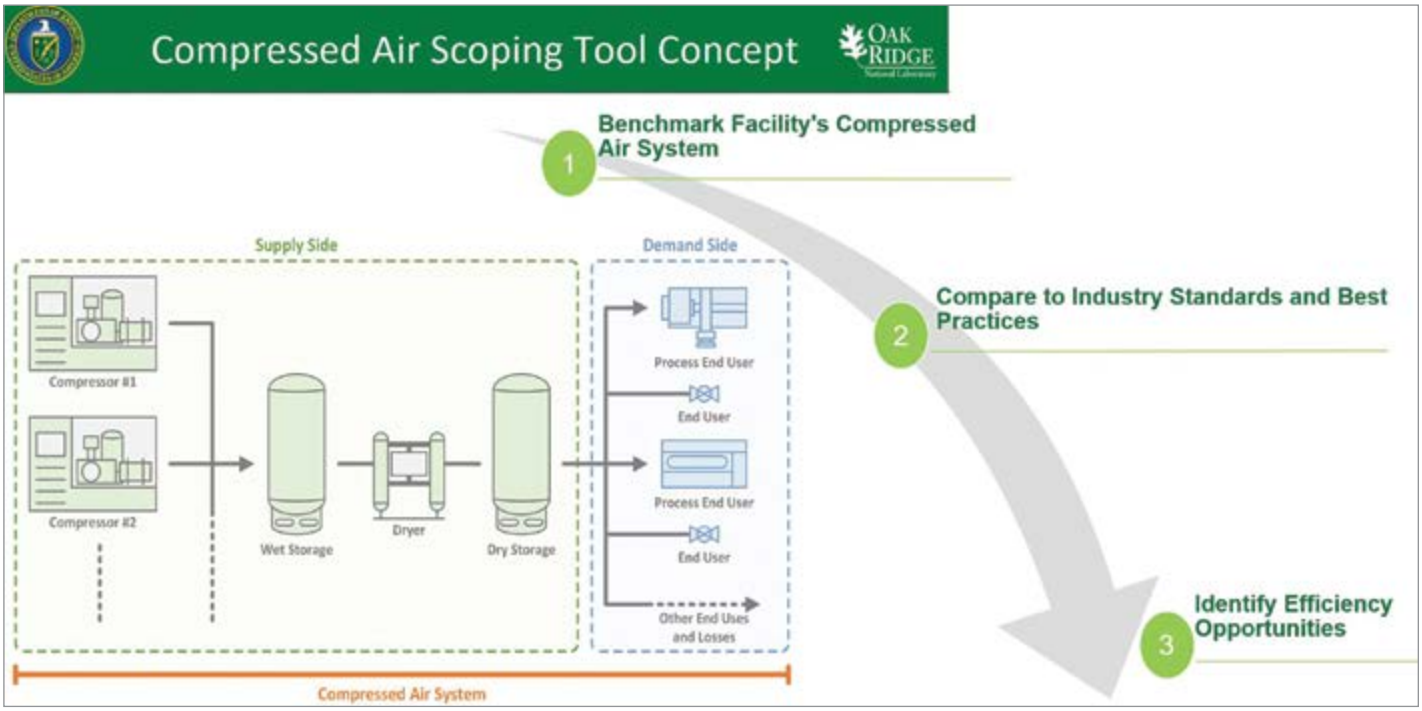
Compressed Air Scoping Tool Teaches Energy Efficiency Best Practices

Created by the Oak Ridge National Laboratory and the DOE, the tool provides a simple way to measure and improve compressed air system performance

By Alex Botts, R&D Associate, Oak Ridge National Laboratory

Standards and practices around compressed air systems are evolving as previous golden rules become outdated and unhelpful. One of the most referenced guidelines gives us the perfect example: The previous rule of thumb for compressed air storage – 1-3 gal/cfm[1,2] – is now accepted to be 3-5 gal/cfm. This change in recommended storage is only one of many in the industry, resulting in industrial users lost in a sea of contradictory best practices.

Above: Oak Ridge National Laboratory in Oak Ridge, TN (Image courtesy of ORNL/U.S. Department of Energy)



The CA Scoping Tool provides a simple way to benchmark compressed air systems and learn from the most current best practices.

To help combat confusion and poor information sharing, a collaborative effort between Oak Ridge National Laboratory (ORNL) and the Department of Energy's (DOE's) Better Plants program created the Compressed Air (CA) Scoping Tool with the most up-to-date best practices in the industry (as of 2023). It can be used as a nonbiased, one-stop shop for best practice recommendations. The Excel-based tool is designed to be an initial step in understanding the operation of a compressed air system, a baselining tool enabling users to comprehend various aspects of a facility's system from the production of compressed air to its application by end users.

Overview of the CA Scoping Tool

The CA Scoping Tool should be seen as a first step in analyzing and understanding a compressed air system. It does not replace an assessment, but should be used as a learning, training and benchmarking tool. After completing the questions, users will gain a better understanding of their compressed air systems and get recommendations to save energy and money. The tool is designed to identify areas in need of improvement, but can also be used to identify best practices. Results can be used to brainstorm improvements or indicate when an outside expert should be consulted. After the analysis is complete and the system is improved, the user is encouraged to revisit the tool to conduct a comparison to their baseline and continue the improvement cycle.

In the Excel-based CA Scoping Tool, users are asked questions about their operational practices. They select responses from drop-down menus, ranging from yes/no options to time ranges or frequencies. Each question receives a score based on the provided answer, contributing to the overall system evaluation. Some of the questions include multiple options, with higher scores assigned to answers representing better operational practices. At the end, scores are gathered and a report card with recommendations is generated. Hence, the CA Scoping Tool serves as the initial step for industrial manufacturing plants to benchmark and enhance their compressed air systems.

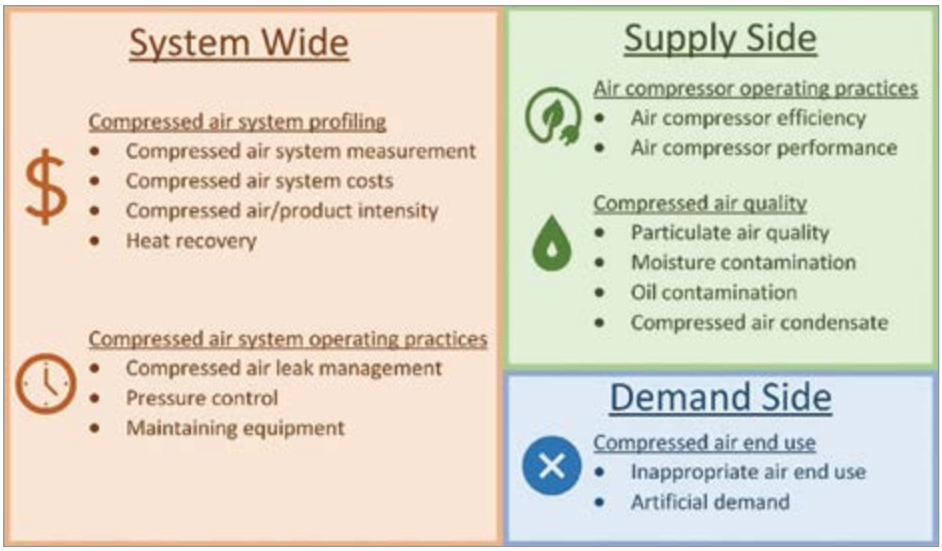
Table 1. CA Scoping Tool organization

1. Instructions	• Instructions on how to fill out the data collection sheets	
2. Plant Information	• Equipment description • Resource consumption (air compressor inputs)	• Facility set points (air compressor outputs) • Production uses • Annual costs
3. System Profiler	• Compressed air system measurements • Compressed air system cost analysis	• Compressed air intensity • Heat recovery
4. Compressed Air System Operating Practices	• Air leak management • Pressure control	• Maintaining effective compressed air system operations
5. Air Compressor Operating Practices	• Air compressor efficiency	• Air compressor performance
6. Compressed Air Quality ISO 8573.1	• Particulate content • Moisture content	• Oil content
7. Compressed Air System Operating Practices: Distribution, End Use, Recovery	• Inappropriate uses	• Artificial demand
8. Results	• The final scores for each section	
9. Energy Saving Opportunities	• Possible recommendations based on the user's inputs	

As shown in Table 1, the tool consists of nine tabs, six of which are part of the graded portion. The table displays the types of data collected, the corresponding results and the identified energy-savings opportunities.

Compressed Air Scoping Tool Teaches Energy Efficiency Best Practices

The tool breaks down the scoping process into three distinct steps: benchmarking the current compressed air system, comparing operating procedures against current best practices and identifying energy efficiency opportunities based on user responses.



Groupings of question areas within the CA Scoping Tool

Compare a Facility with Industry Standards and Best Practices

After some fundamental benchmarking questions, the second step in the CA Scoping Tool compares the facility's operational characteristics with industry-accepted standards and best practices. These 97 questions comprise best practices widely accepted in academia and the compressed air auditing industry, and have been reviewed by members of both communities. The questions range from rules of thumb to International Organization for Standardization (ISO) standards for compressed air systems. The questions cover supply side, demand side and system-wide topics.

Results and Identified Efficiency Opportunities

After completing the questionnaire, the user is provided the scores from the comparison step. This area of the tool summarizes scores for each topic. The user then receives their report card and a comprehensive list of possible energy-savings opportunities based on their scores. These opportunities are directly linked to the answers given in the comparison steps of the tool, and should be seen as entry points to start investigating recommendations for the facility.

Partner Plant Case Study

As part of the testing of the CA Scoping Tool, a Better Plants partner was asked to review and use the tool. The partner used the tool at one of its sites and received a list of recommendations to improve its compressed air system. The following sections provide an overview of its experience and use of the tool.

Table 2. Summary of the plant's compressed air system

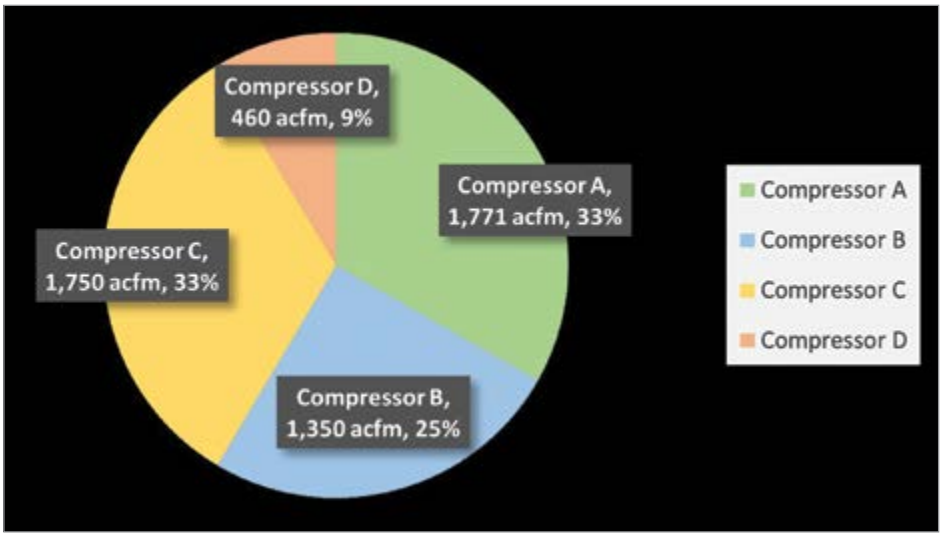
Air Compressor Name	Rated Power (hp)	Annual Operating Hours (Hrs/year)	Rated Flow Capacity (acfm)
Compressor A	400	6,000	1,771
Compressor B	300	3,744	1,350
Compressor C	400	8,400	1,750
Compressor D	100	6,000	460
System Total	**1,200**	**—**	**5,331**

Partner Plant Information

The partner had four air compressors: two 400-horsepower (hp), one 300-hp and one 100-hp. Through discussions with plant personnel, the partner discovered the operating times for each compressor differed slightly and none of them ran 24/7 (this was discovered through the benchmarking exercise). Finally, using the nameplate values, the partner defined the total potential air flow for the air compressors. A summary of the air compressors is shown in Table 2. The pie chart reflects the proportional rated flows for the air compressors in the system.

The partner reported an annual electric consumption of 4,454,218 kWh/year to operate the compressed air system, with no cooling

Compressed Air Scoping Tool Teaches Energy Efficiency Best Practices



Summary of air flow capacity by air compressor

water consumed and no compressed air purchased off-site. After reviewing compressed air production data, the partner reported an average compressed air production of 1,720 acfm during production hours, with a peak compressed air demand of 2,315 acfm and a pressure set point of 104 psig (7 barg). Based on results from the plant information tab using a marginal cost of $0.04/kWh, the facility found the estimated cost of the compressed air system was $338,168/year, roughly equivalent to $0.343/100 cubic feet of compressed air.

Results from the Partner Plant Questionnaire

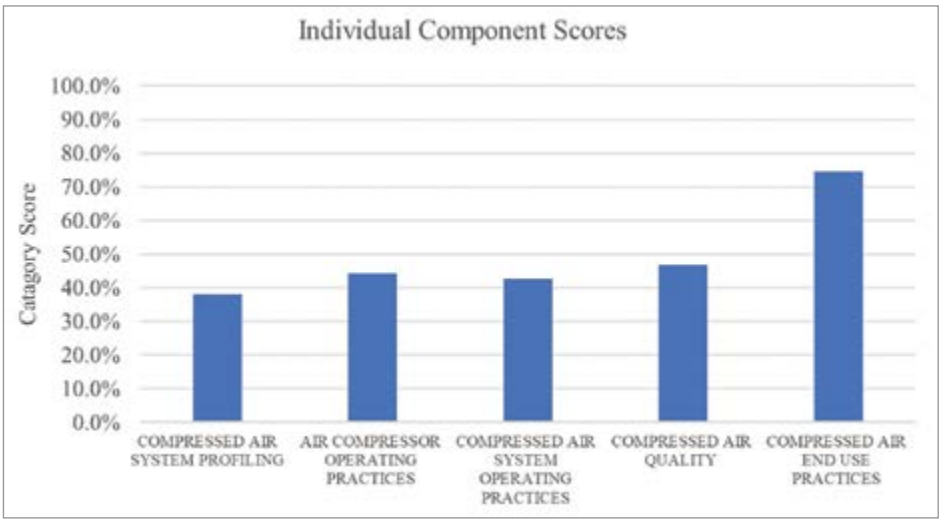
After completing the questionnaire, the partner received an overall score of 47% (scoring 529 of the available 1,126 points). The final tally for each section indicated room for improvement across the entire system, with the lowest score in the compressed air system profiling section. The results showed the strongest part of its system is its end users. Table 3 and the bar chart reflect the partner's score for each section. The partner intends to reassess its compressed air system after improvements are made. The partner would also like to compare similar facilities to gather and replicate best practices within its own company.

Partner Plant Energy-Saving Opportunities

Based on the partner's answers, the CA Scoping Tool curated a list of 44 possible recommendations that should be investigated.

Table 3. Summary of the partner plant's overall score

	Possible Score	Plant Score	%
Compressed air system profiling	268	102	38.10%
Air compressor operating practices	253	108	42.70%
Compressed air system operating practices	165	73	44.20%
Compressed air quality	295	138	46.80%
Compressed air end-use practices	145	108	74.50%
Total scoping tool questionnaire score	**1,126**	**529**	**47.00%**



Individual component scores for the test system

A full list of the partner's recommendations can be found in the corresponding journal article or the example data file that comes with the tool[3]. For its lowest-scoring section, "Compressed air system profiling," the energy-saving opportunities are as follows:

Compressed Air System Costs

1-5. Increase the frequency of the following tasks:

- The volume of compressed air is calculated and reviewed.
- The electricity cost for the air compressors and compressed air dryers is calculated and reviewed.
- Maintenance costs (parts, labor, outside services) for the compressed air system are tracked and reviewed.
- Capital costs and the depreciated value of the compressed air system are tracked and reviewed.

- The fully loaded cost to generate compressed air is calculated and reviewed.

6. Use the fully loaded cost data to determine where to make improvements to the compressed air system.

Compressed Air/Product Intensity

1. Increase the frequency in which the air intensity (compressed air divided by product volume) is measured and trended in terms of cubic feet of compressed air needed per unit of product produced.

Heat Recovery

1. Recover heat for room conditioning.
2. Recover heat for hot process water.

Compressed Air System Measurements

1. Improve data measuring, recording and trending for critical compressed air system parameters.
2. Improve metering for supply-side compressed air flows.
3. Increase metering for demand-side compressed air flows.

Ultimately, the CA Scoping Tool will become part of DOE's MEASUR tool suite after additional testing and review[4]. The beta version of the tool and sample data can be found on the DOE's Industrial Efficiency & Decarbonization Office's resources website for the CA Scoping Tool.[5] BP

Endnotes

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4. G. Accawi, et al. 2022. "MEASUR - Manufacturing Energy Assessment Software for Utility Reduction." DOE Office of Energy Efficiency and Renewable Energy, Energy Efficiency Office, Advanced Manufacturing Office.
5. Industrial Efficiency and Decarbonization Office, "Compressed Air Scoping Tool—Excel, Beta Version (CA Scoping Tool Beta v1.0)," n.d. [Online]. Available: https://www.energy.gov/eere/iedo/compressed-air-scoping-tool-excel-beta-version-ca-scoping-tool-beta-v10.

About the Author

Alex Botts is an R&D Associate at Oak Ridge National Laboratory, serving as a Technical Account Manager for the DOE's Better Plants Program. She supports industry partners with data analysis, Energy Treasure Hunts and software, guiding them to achieve significant energy savings and developing training programs. Her contributions include incorporating the legacy software AirMaster+ into the DOE's MEASUR software and producing various technical publications, all aimed at advancing energy efficiency and decarbonization in manufacturing.

About the Better Plants Program

The Better Plants Program works with leading U.S. manufacturers and wastewater treatment agencies to set ambitious energy, water, waste and carbon reduction goals. By partnering with industry, the Better Plants program aims to help leading manufacturers boost efficiency, increase resilience, strengthen economic competitiveness and reduce their carbon footprint. Visit https://betterbuildingssolutioncenter.energy.gov/better-plants.

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Midwest Machinery Replaces a Cooling Tower for Bayer Crop Science

Loaded with extras, this cooling tower was built to last

By Troy Dreier, Senior Editor, Chiller & Cooling Best Practices Magazine

➤ Midwest Machinery, a rep firm based in St. Louis, MO, was the first manufacturer's representative for Marley cooling towers beginning in 1923 (see sidebar), with a territory covering Eastern Missouri and Southern Illinois. In 2011, it became the Marley rep for Kansas and Western Missouri, as well, which is when it began working with Bayer Crop Science in Kansas City, MO.

Bayer Crop Science runs a 240-acre fertilizer production facility with areas for active ingredient and chemical intermediate production, as well as a high-active herbicide production unit. Among the multiple cooling towers at the facility was a 40-year-old field-erected, three-cell, wooden, crossflow Marley cooling tower used for rejecting heat and providing cooling for multiple processes. Bayer occasionally called upon Midwest Machinery to inspect and service the aging cooling tower.

The cooling tower's condition worsened over time, and by 2022, Bayer Crop Science decided replacing the cooling tower made better financial sense than repairing it. That's when Bayer contacted Midwest Machinery to see if it would like to bid on providing the materials for the replacement tower.

For Spencer Kaufman, Sales Engineer, Midwest Machinery, this became his favorite project at the company. It wasn't the biggest project he worked on, but it held a variety of unique challenges.

Old Requirements, New Materials

Midwest Machinery would help design the spec and provide engineering advice for the replacement, a three-cell, double-stack, dual air inlet, crossflow, factory-assembled Marley cooling tower capable of 2,625 gpm per cell, for a total 7,875 gpm. The tower is able to expel 3,937 tons with a hot water temperature of 100°F (38°C) and a return temperature of 85°F (29°C). The tower is entirely stainless steel. It includes a motor-mounted outside airstream with a motor services platform, internal mechanical access platforms, fan deck davits, air inlet screens, a free-standing fiberglass stairway and fan deck catwalks. The full tower is 23-feet wide, 60-feet long and 24-feet tall.

Above: Midwest Machinery's St. Louis, MO, headquarters

Kaufman took several calls with Bayer during the discovery phase to fully understand the company's technical requirements. He reviewed the early specification and offered feedback so the company would get responses from bidders it could easily compare.

Because the original cooling tower had been supplied by a Marley rep, Midwest Machinery was able to access it and view the requirements. Bayer Crop Science was satisfied with the cooling tower's performance duty, and didn't request any changes in temperature, process flows or horsepower (hp). The design wet bulb temperature stayed the same at 77°F (25°C). The new cooling tower, like the old, needed to provide round-the-clock performance.

Crossflow towers are easier to maintain, Kaufman said, providing easier access. They provide more favorable water distribution, and their gravity-fed distribution is easier to maintain than a counterflow's pressurized distribution. For these reasons, he prefers working with crossflow cooling towers in most applications. This cooling tower kept the same footprint and electrical infrastructure



Bayer Crop Science decided it made more sense to replace its 40-year-old cooling tower than repair it.

Midwest Machinery Replaces a Cooling Tower for Bayer Crop Science

as the original, as Bayer declined to make any changes.

Replacement discussions started in April 2022, and Midwest Machinery submitted its bid in November 2022. At least two other companies made bids, Kaufman believes. While he doesn't think his company was the low bidder, it was the one selected. Bayer saw the value Midwest Machinery's cooling tower experience could bring.

Moving Ahead Before the Design Is Complete

Midwest Machinery was awarded the project, and then the real work began. Bayer Crop Science had requirements making the installation an unusual challenge. The new cooling tower had to be erected on the exact foundation poured for the old cooling tower. No new concrete could be poured. There was a railroad nearby, and any project moving dirt needed an easement from the Army Corps of Engineers. While getting an easement was possible, doing so would cost the project time and money. Bayer wanted the project completed over the winter, when it could shut down one or two cooling cells without impacting its processes. Also, Bayer needed to spend the money on this project during a set budget window.

As this cooling tower was planned and built during the later Covid years, slow supply chains made it important to get parts ordered early, by July 2023. The fast schedule meant the initial request went in before the installation's design was fully completed. In a typical project, the design is solidified first, the equipment ordered and small problems inevitably arise needing to be fixed. With the inverted schedule, larger problems cropped up for Kaufman and Bayer's engineering team to solve. Citing safety concerns, Bayer requested additional grading and access paths to keep technicians safe. Bayer also requested changes to make future maintenance easy, such as putting davits on the fan deck in case of a motor failure. Doing so makes removing the motor easier for future technicians. Because of the late additions, Kaufman had to put in multiple change orders




Midwest Machinery engineered a three-cell, double-stack, dual air inlet, crossflow, factory-assembled Marley cooling tower on the old cooling tower's foundation.

Midwest Machinery, Since 1923

Headquartered in St. Louis, MO, Midwest Machinery has four offices covering territory from Illinois to Oklahoma and a bit of Texas and Arkansas. The company represents Marley cooling towers and many other well-respected manufacturers. Formed in 1923 by Leon T. Mart, Bernard G. Proetz and Merit Stone, it became the first Marley rep soon after (Mart had co-founded what would become the Marley Cooling Tower Company with Chester Smiley the previous year). The Gladstone family purchased Midwest Machinery in the 1980s. Troy Gladstone, President, is the second generation of Gladstones to run the company.

"Being the first Marley rep, we bleed Marley blue," said Ryan Miller, General Manager, Midwest Machinery. "It's close to our hearts. Here in Kansas City, more than half of our staff at one point worked under the Marley roof. We know the people, we know the inner workings of the company and we've got a lot of close personal relationships there. For us as an organization and as individuals, there's a close emotional tie to Marley.

"Beyond that, Marley's always had a reputation as a high-quality manufacturer. It's a rigid, solid industrial product with lots of hours of engineering and testing behind it. Marley owns the design of the entirety of its products. It may outsource some of the manufacturing, but it owns the gearbox designs, it owns the fan designs and it pours a ton of money into research and development to optimize products and invent new ones.

"Marley is always coming out with new products. It's great to be able to boast we represent the number one cooling tower manufacturer – both by size and reputation – in the world.

"Some cooling tower manufacturers specialize in one particular type of tower, but Marley manufactures all types. No matter how you want to slice and dice the evaporative cooling category, whether you're talking field-erected or factory-assembled towers, counterflow or crossflow, open-cooling towers or closed fluid coolers, Marley does it all.

"As a rep, it allows us to be 100% consultative to anybody in the market, whether we're talking to engineers about how a tower's going to fit into their particular application or contractors who are going to have to install it. No matter what we're talking about, we have an entire tool belt of all the things that might work for the application. Instead of trying to put a round peg in a square hole, we can ask the questions, find out all the needs of the project and then have the right product to go into that application." BP

For more information, visit https://midwestmachinery.net and https://spxcooling.com.

Midwest Machinery Replaces a Cooling Tower for Bayer Crop Science

to add or change equipment. The tower shipped in October 2023. Kaufman credits the in-house Bayer engineering team with coordinating all the details.

"I was concerned things weren't going to fit or the orientation would be off, just because it was all going in a different process than normal, but we worked diligently with the Bayer engineers to ensure it all worked out," Kaufman said.

Adding All the Bells and Whistles

For Bayer Crop Science, safety and longevity were paramount in creating the cooling tower. Kaufman is used to offering clients tiers of options for maintenance features – a good, better, best selection. For this project, Bayer always chose the best tier. The fiberglass stair tower between two of the cells is an expensive selection, Kaufman noted. A more economical option would have been adding a ladder with a safety cage around it. But Bayer said no, it didn't want its technicians to have to climb up ladders, as it was a safety issue for the company.

Likewise, when it came time for material selection, Bayer Crop Science went with an all-stainless steel construction, rather than an all-galvanized cooling tower, or one part-stainless and part-galvanized. An all-stainless construction offers better longevity, and Bayer wanted this tower to last.

Adjustments and Additions During Construction

Once construction began, new challenges emerged. The original concrete basin had been poured 40 years prior. Getting the tower built required on-the-spot fine-tuning.

"Until you get in there and do inspections when the tower isn't operating, you don't really know what you're dealing with," Kaufman said. "We were changing how we were going to set the

Spencer Kaufman, Sales Engineer, Midwest Machinery

towers, what the anchorage would look like. We were changing elevations of the towers so we could get other components to set right, like the piping or the fiberglass stair tower."

Local mechanical contractor Cerris Systems handled the cooling tower demolition and construction. Having Cerris Systems involved was a critical part of the operation, Kaufman said, as the company's history with cooling towers made the installation seamless.

A Boost in Energy Efficiency

The older cooling tower had a variable frequency drive (VFD) that wasn't part of its original construction. The new cooling tower, likewise, has a VFD. During partial load conditions or when the weather is cooler, Bayer can use the VFD to reduce fan speed and save money.

Besides helping with the project specification and design, Midwest Machinery offered Bayer Crop Science's operations team advice on the best way to run its cooling tower. The optimal way is running all three cells, Kaufman says, and ramping all three up or down together with the VFD. That delivers the greatest energy efficiency. If Bayer has only one-third of the load, for example, it's more energy efficient to run all three fans at 33% rather than shutting off two and running the third at full capacity.

While gaining efficiency wasn't the driving force behind this installation, Kaufman notes Bayer Crop Science's new cooling tower is more energy efficient. It has more cooling capacity than the previous, even though it has the same footprint and hp rating.

"It's a more efficient cooling tower, and you combine that with using VFDs so they don't have to run the towers as hard in the wintertime. They're doing it in about as efficient a manner as they can with the footprint they have allowed," Kaufman said. "There was an increase in efficiency, probably in the 5-10% range."

The challenge this cooling tower offered, the opportunity to work with an unusual process and getting to add a full slate of bells and whistles combined to make this Kaufman's favorite project. The results – as shown in the pictures here – speak for themselves.

"It was a good challenge, but it was also extremely rewarding," Kaufman said. For more information, visit https://midwestmachinery.net and https://spxcooling.com.

All images courtesy of Midwest Machinery and SPX Cooling Tech.

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Evaluating Process Cooling Supply Temperatures

Selecting the optimal cooling temperature can lead to significant energy and water savings

By Clayton Penhallegon, Jr., P.E., President, Integrated Services Group

Chilled water (CHW) systems are common in plants where process cooling is needed. These systems, which use refrigeration cycle machines to provide cool water commonly around 45-60°F (7-16°C), are vital to proper manufacturing facility operation. In many plants, the cooling equipment is one of the largest categories of energy use, which makes the efficiency of these systems critically important.

Depending on the process environmental requirements, CHW may also be used for air handlers providing spot cooling to workers or for complete room cooling. This may occur, for example, where dehumidification is needed to prevent plastic part molds from "sweating," or condensing moisture from the air onto the molds which can result in off-spec parts.

However, many process cooling applications do not require the cool temperatures typically provided from CHW systems. One common application in plastics, printing and other processes is the use of "temperature control units" (TCUs), which are packaged devices with a pump, mixing valve and/or heat exchanger, and sometimes heaters to provide relatively precise temperature control of specific process loops at temperatures and/or pressures above the main cooling water supply system. TCUs are often set to temperatures well above the CHW supply temperature. Integrated Services Group has observed many systems running from 70°F up to 120°F (21 to 49°C) depending on the process and the specific application.

We have observed many industrial process cooling applications run well at temperatures from 70°F to 120°F (21 to 49°C).

This article will make plants aware of the energy and water use differential between CHW systems providing chilled water in a 45-60°F (7-16°C) range, and process cooling solutions at 70°F up to 120°F (21 to 49°C). The article will examine cooling resource evaluation criteria and supply water temperature specifications, then describe and compare process cooling options.

A Note on Glycol Systems

This article will refer to water as the cooling systems' working fluid. Depending on geographic location (i.e. freeze risk) and working temperatures, some cooling systems use glycol blends rather than plain water. The concepts presented here apply equally to glycol

Above: A dry fluid cooler

systems although some adjustment in terms of potential approach temperatures and the cost of heat exchangers may be needed in the various details to account for the distinctions between glycol blends and pure water. One key point: Glycol can't be used directly in any open-loop cooling tower systems.

Cooling Resource Evaluation Criteria

When process cooling is required, there are two primary factors that typically influence the choice of cooling method used:

1. Basic adequacy of the cooling approach: Does it cool the process?
2. Cost of the cooling approach: How much will it cost?

There are multiple facets to each of these, some of which are widely and routinely recognized and some of which are not.

Adequacy of the Cooling Approach

A given cooling approach is typically considered satisfactory if it meets the machine manufacturer's stated cooling requirements or other plant owner-developed cooling parameters. These are commonly understood and evaluated in the following terms:

1. Supply temperature: Will it meet the stated supply temperature?
2. Supply pressure: Will it meet the required supply pressure?
3. Cooling flow: Is the system capable of providing the required flow?

Somewhat less frequently considered, but nevertheless critically important, are the following:

1. Stability/Precision: Can the cooling system provide the required temperatures and pressures at sufficiently precise and stable conditions?
2. Reliability: Is the proposed design reliable in terms of redundancy and operation for minimal failures?

First Costs and Operating Costs of the Cooling Approach

Cooling system costs are most often evaluated like many other industrial systems where first cost is virtually paramount. More foresighted industrial systems operators will also consider the following:

1. Energy operating costs
2. Maintenance costs for routine service to equipment
3. Other associated operating costs such as chemical water treatment, replacement filter media and water consumption

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4. Repair costs such as replacing heat exchangers scaled with minerals
5. Capital costs for periodic renovation and/or replacement of major system components

These operating cost items are important because they can become substantial cost penalties to plants. Given the long life of process cooling systems, in many cases 20 to 30 years or more, choosing a system purely on lowest first cost can be expensive. Poor decisions here can burden a business with higher operating costs for many years.

What Process Cooling Supply Temperature Is Really Required?

As noted above, supply temperature is the first and foremost process cooling condition that must be satisfied. However, there may be alternatives capable of providing entirely satisfactory cooling with warmer temperature water. These may be accomplished by flowing more gallons per minute (GPM) through the process, using larger heat exchangers or combinations of these or other methods.

The critical question is what is the required temperature on the process side? If a machine requires 120°F (49°C) oil supply to a gear box, it can be provided with a non-CHW resource, even if the manufacturer specified CHW for the cooling function. As noted previously, this may require changing the heat exchanger and increasing the GPM. In any case, it must be done carefully and intentionally.

Air-cooled chillers provide chilled water with minimal water use, but at moderately higher energy cost.

Process Cooling Alternatives

Table 1 lists process cooling water options as well as the reference CHW methods (water- and air-cooled systems). The alternatives are listed based on design conditions: what the specific technique would be capable of providing on a year-round basis, assuming the system is in good working order (reasonably clean heat exchangers, adequate pump flows).

To provide the most options for energy efficiency, some of the approaches are also listed with seasonal application opportunities and the available hour range for typical locations where they could be considered. These are listed as "Seasonal" applications rather than "Design" for the year-round usages.

In addition to the tabular data, efficiency, water consumption and design supply temperatures are presented graphically in two charts. This makes it easier to relate the supply temperature and water consumption of the different options to their respective energy efficiency.

Table 1. Cooling Methods Sorted by Supply Temperature (High to Low)

Approach	Time Frame	Typical Supply	System Average kW/Ton†	Ann. Avg. GPM Per 100 Tons	Appx Inst. Cost Per Ton*
Dry Cooling	Design @ 95°F (35°C) dry bulb	105-115°F (41-46°C)	0.25-0.3	0	$600-700
Adiabatic	Design @ 78°F (26°C) wet bulb	95-105°F (35-41°C)	0.3-0.35	0.3-0.5	$700-900
Dry Cooling or Adiabatic	Seasonal 3,000-5,000 hrs/yr	70-95°F (21-35°C)	0.2-0.3	0	$600-700 DC $700-900 Adiabatic
Closed-Loop Fluid Cooler Cooling Tower	Design	87-88°F (31°C)	0.15-0.3	2.9	$400-500
Closed-Loop Fluid Cooler Cooling Tower	Seasonal 3,000-5,500 hrs/yr	55-75°F (13-24°C)	0.15-0.3	2.9	$400-500
Open-Loop Cooling Tower	Design	85°F (29°C)	0.1-0.25	2.8	$300-400
Free Cooling from Open-Loop Cooling Tower	Seasonal 2,500-4,500 hrs/yr	40 - 60°F (4-16°C)	0.15-0.3	2.9	$1,100-1,300
CHW: Air-Cooled Chiller	Design	40-60°F (4-16°C)	0.9-1.2	0	$1,200-1,500
CHW: Water-Cooled Chiller	Design	40-60°F (4-16°C)	0.7-1.0	3.4	$1,000-1,200

†Tons in this table are refrigeration tons of 12,000 BTUs per hour removed from the heat load. Tower loads for CHW systems include the chiller refrigerant compressor heat rejection and may be expressed in other situations in 15,000 BTU per hour tower tons.

*Cost per ton for cooling system equipment and installation only. Does not include building and space costs, distribution piping or drops to equipment.

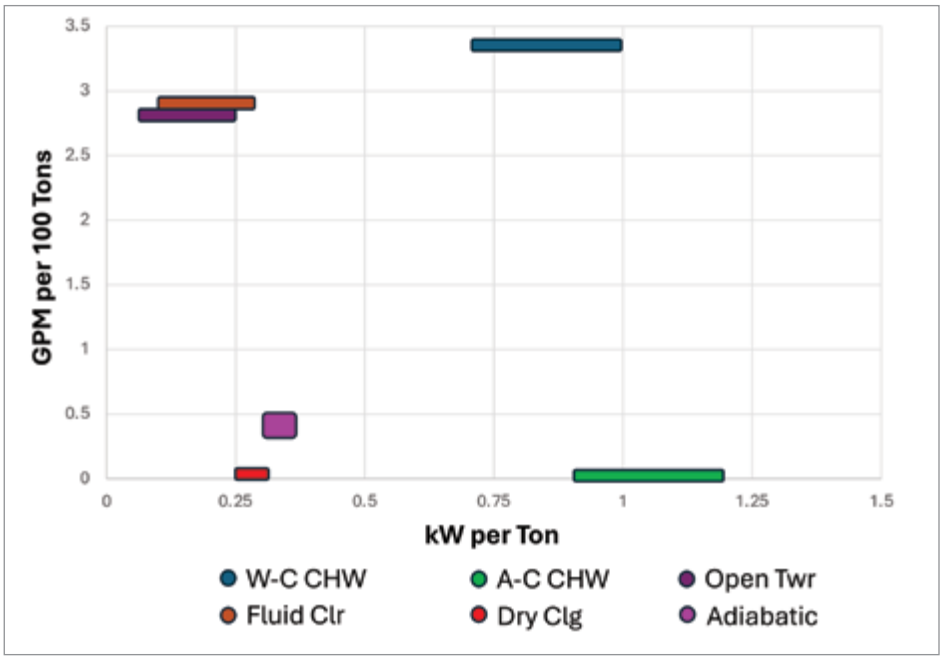
Chilled Water Cooling

Chilled water is the default cooling system in many cases due to its ability to meet essentially all the cooling requirements in a plant, whether directly or via supplemental conditioning through TCUs. (Note: This article does not address low temperature applications such as ice tank thermal storage or other below-freezing cooling requirements.) In many plants, there is only a single distribution piping system and in such cases the water temperature must meet all cooling needs.

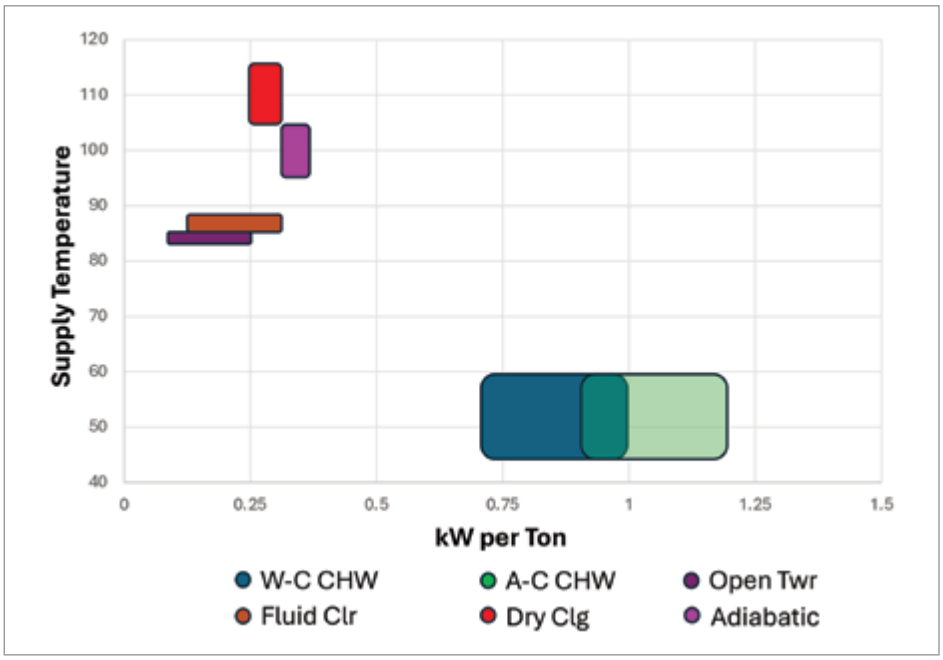
Chilled water can be supplied by either air- or water-cooled chillers with the resulting energy and water consumption shown in the accompanying table. The selection of one or the other depends heavily on energy and water costs and availability.

Air-cooled systems are often advantageous in smaller systems due to their simplicity (no open cooling towers, low water consumption, fewer system components) while water-cooled systems become compelling in larger systems where energy savings are significant and capital costs benefit from scale economies. This is especially true in cases where cooling towers are already planned due to air compressor or other machine cooling requirements.

The selection between air- and water-cooled chillers was covered as part of the November 9, 2023, webinar "Chiller Selections for Central Plants: Lowest Overall Costs for Process Cooling," which is available on the webinar archives page of the *Chiller & Cooling Best Practices* website.



Cooling method efficiency and water use



Cooling method efficiency and design supply temperature

Free Cooling Chilled Water

Refrigerant cycle-based CHW is essential for year-round "design" process cooling requiring cooler temperatures. However, CHW can be provided for many hours a year at significant savings from cooling tower systems. By definition, this is a seasonal approach, which is not capable of providing design conditions throughout the year. Nevertheless, the high efficiency makes it an attractive supplement to systems already including cooling towers.

Typically, these are implemented through carefully sized plate heat exchangers to provide both loop isolation (so the "dirty" tower water is not mixed with the "clean" closed-loop CHW) as well as close approach temperatures between the leaving CHW and the entering tower water (usually 2-3°F or 1.1-1.7°C). This maximizes system operating hours for the greatest benefit from the investment.

Open-Loop Cooling Tower

Cooling towers are direct contact heat exchangers enabling the closest possible approach between the cooling water temperature and the ambient wet bulb temperature. For much of North America, the ASHRAE design wet bulb temperature is 78°F (26°C) with a common leaving water temperature target of 85°F (29°C). This just

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so happens to be the AHRI standard design entering condenser water temperature for water-cooled chillers (what a coincidence!). This 7°F (3.9°C) approach temperature difference (85-78°F; 29-26°C) can be reduced by selecting larger cooling towers, but it is difficult to cost-effectively get below 4-5°F (2.2-2.8°C) as the tower size becomes exponentially larger at narrower temperature differences.

In addition to chiller condenser cooling, open-loop cooling tower water is frequently used for air compressor cooling, hydraulic system cooling and other machine cooling applications. For the provided temperatures, open-loop cooling is relatively inexpensive and efficient, at least from the cooling system-only perspective.

Closed-Loop Cooling Tower

One of the drawbacks to open-loop cooling tower cooling is the condition of the water in the open air, direct contact system. Open-loop water typically has significantly higher relative mineral content due to the unavoidable mineral concentration from evaporation and tightly controlled blowdown resulting from efforts to minimize water use. In addition, open-loop water has contaminants picked up from the air flow through the towers, as well as entrained air and dissolved oxygen. Finally, the water must also have chemical or other treatment to minimize the effects in the plant of the various undesirable characteristics.

These characteristics often lead to oxidation corrosion in the piping system and components, mineral scaling in heat exchangers (particularly common in air compressors and hydraulics running at much higher temperatures than the typical chiller condenser) and transfer of ferrous corrosion products to other surfaces which might not otherwise have been affected, such as the tubes in chiller condensers, brass fittings and valves.

One method of eliminating the drawbacks to open cooling tower water is isolating the machine cooling from the open loop. This can be done through either a heat exchanger separate from the cooling towers (either a plate heat exchanger or a shell and tube) or through the use of a "fluid cooler" cooling tower design incorporating a closed-loop liquid cooling capability into the cooling tower itself as a pre-packaged unit.

The separate heat exchanger can provide a closer approach temperature to the tower water with 2-3°F (1.1-1.7°C) typical (similar to the free cooling approach). However, this design requires the additional space and equipment cost of heat exchangers and pumps (including any redundant units). Packaged fluid coolers typically offer water approach temperatures of around 5°F (2.8°C) and cost more than a standard open cooling tower, but are less costly than the total equipment cost of the separate heat exchanger design and require less space.

Fluid cooler cooling towers combine closed-loop cooling and evaporative heat rejection in a single, unified package.

As with many things, there are pros and cons to both methods.

Typical design temperatures are 87-88°F (31°C) for the open tower and separate heat exchanger method, and around 90°F (32°C) with fluid coolers. Note that water consumption can be slightly higher with the fluid cooler approach than the open tower due to the marginally higher energy use – and subsequent heat rejection – of the fluid cooler design (this assumes intentional high efficiency design of the open-loop system heat exchanger[s], pumps and piping).

Seasonal Closed-Loop Cooling Tower

While closed-loop cooling tower cooling can't provide temperatures below the mid-80s° F (27°C) at design conditions, they can provide efficient lower temperatures on a seasonal basis.

Depending on the required temperature, where the higher the temperature the higher the hours and vice versa, this method can provide moderate temperature cooling water in the range of 55-75°F (13-24°C) at economical energy costs. Water consumption remains essentially unchanged from the other cooling tower-based methods.

This approach is distinguished from CHW free cooling only in the temperatures being provided. It is provided as an alternative for cases where separate CHW and tower water distribution piping systems are in place (more typical in larger plants) and where worthwhile numbers of TCUs are operating to supply moderate cooling water temperatures to processes that normally require CHW as a resource (i.e., below the mid-80s°F or 27°C). When seasonally offsetting CHW use, the benefits are as cost-effective as free cooling. Note that in many cases where this would apply, CHW free cooling would potentially

provide greater savings by offsetting a greater cooling system load; however, in other situations, the CHW conditions or the specific local climate may make CHW free cooling too limited, raising the potential benefits of the higher seasonal closed-loop tower cooling option.

Reduced Water Consumption Cooling Methods

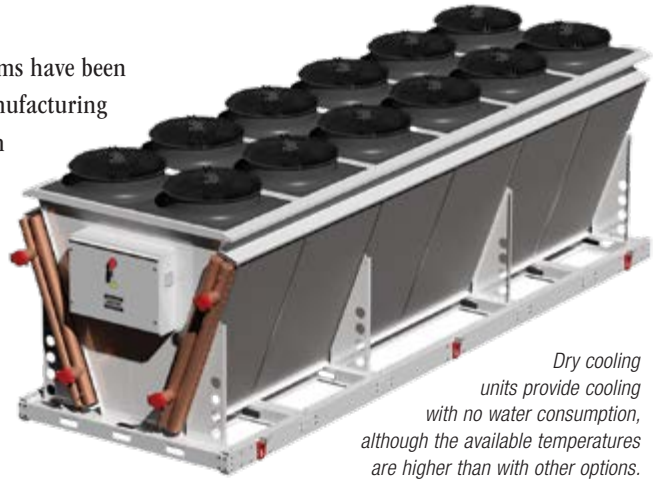
With the exception of the air-cooled chiller option, all of the preceding cooling methods have required the evaporation of water in a cooling tower as the final step in rejecting process heat to the environment. However, there are cooling methods that don't require the same water consumption, particularly adiabatic cooling and dry cooling.

The trade-off with these methods is they only provide relatively warmer cooling water at the design conditions. Depending on the locational availability of water, and also the required cooling temperatures, these methods may be applicable for many machine cooling purposes.

Dry Cooling

Dry cooling systems are air coil-based systems in which the process cooling liquid is run through the coil tubing with ambient air passed through the coil and fins. An automobile radiator is a common example of dry cooling.

Because the only power consumption is by the fans (plus potentially some additional pumping energy from the coil liquid flow losses), dry cooling systems are the most energy efficient type of heat rejection. Significantly, the water consumption for these is zero as they do not use evaporation in the cooling process.



Dry cooling units provide cooling with no water consumption, although the available temperatures are higher than with other options.

Historically, dry cooling systems have been relatively rare in general manufacturing cooling applications although they are widely applied in select industries with applicable temperatures for cooling hydraulic and gearbox oils and compressed gases. With current water availability concerns, cooling tower manufacturers are developing innovative new unit configurations to improve the performance of dry systems, for example, making stacked V systems offering more heat rejection capability in a smaller footprint than traditional horizontal or single V coil units.

Critically, the non-evaporative heat rejection aspect of dry cooling systems limits their ability to provide cooler temperatures compared to other cooling designs. Cost-effective systems are typically limited to supply temperatures around 10-20°F (5.6-11.1°C) warmer than the ambient cooling air. In practice this means design supply temperatures of 105-120°F (41-49°C) cooling water based on design ambient air temperature of 95 or 100°F (35 or 38°C). Closer approach temperatures (5-10°F or 2.8-5.6°C) can be obtained with larger coil systems relative to the heat rejection rate, and these may be desirable in locations with moderate peak dry bulb temperatures and significantly limited water availability. In these cases, the additional coil unit cost would be offset by the water savings.

The trade-off with dry cooling and adiabatic systems is they only provide relatively warmer cooling water at the design conditions.

Average cost per ton for dry cooling units selected for a typical 10-20°F (5.6-11.1°C) approach to design ambient air temperature is around $600-700 per ton. Depending on the coil tubing design, there may be incremental pump requirements (i.e. more horsepower due to higher head demands) which should be included in the relative system cost comparison with other system designs.

From an operations perspective, dusty or corrosive environments can be challenging due to coil plugging and fin and coil tube surface corrosion. Coil systems must be kept reasonably clean to perform as intended, as oxidation of the fins (typically aluminum) and/or the tubes (typically copper but sometimes stainless or galvanized steel) reduces the heat transfer performance of the coil. The lovely blue-green patina that gives character to copper statues and architectural features unfortunately consists of copper carbonate, which under ordinary circumstances can modestly reduce the heat transfer of the coil.

Most important to any coil-based system performing to its design rating is ensuring full air flow through the coil at the specified conditions. Off-design air flows can be low cfm (caused by coil blockage or fan failures) or above design entering air conditions due to air recirculation or induction of hot exhaust from other sources. Reduced air flow and/or warm entering air are typically more harmful than coil corrosion except in acute circumstances.

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Adiabatic Closed-Loop Cooling

Similar to dry cooling systems, adiabatic cooling systems are air coil-based systems. To improve their performance over conventional dry coil systems, adiabatic units are supplemented with evaporative pre-cooling of the incoming air, typically in the form of spray heads or wetted pads.

The evaporation of water in the air reduces the dry bulb temperature several degrees and improves the performance of the coil vs. the straight dry bulb air temperature otherwise entering the unit. Critically, the lower water temperature is often sufficient to support machine cooling applications that require maximum temperatures of 90-95° (32-35°C) at design conditions.

The coils themselves don't perform any better than in plain dry-cooling applications. Instead, the lower entering air temperature enables the coils to supply modestly cooler water. The effect is nearly linear to the reduction in the dry bulb air temperature after the evaporation. Consequently, the relative benefits of adiabatic cooling systems would be significant in a hot, and/or dry climate (e.g. Phoenix, AZ, 110.2°F [43.4°C] dry bulb, 70.0°F [21.1°C] wet bulb [all data from ASHRAE 2005 0.4% design conditions] or Denver, CO, 91.2°F [32.9°C] dry bulb, 60.6°F [15.9°C] wet bulb), while a more humid location such as New Orleans, LA (93.8°F [34.3°C] dry bulb, 78.8°F [26°C] wet bulb), would see less meaningful differences.

Note that the entering air temperature is not lowered all the way to the wet bulb temperature. There is still an approach difference between the wet bulb and the actual entering air dry bulb post-humidification, typically 8-10°F (4.4-5.6°C). However, the nearly 30°F (16.7°C) difference between dry bulb and wet bulb in drier climates means water from the adiabatic coils can be significantly cooler than from the dry cooling units only.

Adiabatic systems at design conditions can typically deliver 90-100°F (32-38°C) cooling water depending on the unit selection. Cost is moderately higher than dry cooling units due to the additional complexity of the evaporative features (spray system or evaporative pads, circulation pumps, controls), with a typical range being from $700-900 per ton. In addition, there is the cost of water consumption when the evaporation systems are operating.

Similar to dry cooling coils, adiabatic system performance depends on good air flow at the required conditions. In addition, water quality must be considered for spray nozzle function and/or moisture pad scaling. Spray nozzles have less impact on air flow but can be prone to poor spray patterns or dripping from partially clogged nozzle openings, and both conditions reduce the effectiveness of the evaporative cooling. The ideal spray system completely evaporates the water spray without wetting the coils. Some systems direct the spray away from the coils to avoid this, but the coil intake air velocity has to be high

Adiabatic systems offer a balance of modestly cooler water temperatures with limited use of water at peak conditions

enough to ensure the humidified air is pulled into the unit.

Wetted pads are somewhat less sensitive to water quality but can still have mineral scaling (which can restrict air flow) and channeling (which results in poor evaporative effect) if the water distribution system isn't clean and working well. Moreover, the pads themselves can trap dirt and choke the coil air flow. Conversely, they can also protect the coils from fouling, which is beneficial if the pads are kept clean enough to not impact the air flow.

Generally, care must be used in choosing this design and establishing the maintenance protocol. If possible, dusty environments should be avoided and the systems either placed in less dusty locations or another cooling method should be used. As with dry cooling coils, reduced air flow can significantly impact system performance. This is more likely to deliver poor results if not closely managed. Periodic coil cleaning and regular replacement of the pads are best practices for operating these systems.

Selection Questions Summary

Reviewing the following questions will help clarify the applicable choices for cooling method in any particular situation:

- What is the required temperature for the cooling application?
- Can the temperature be raised by increasing cooling flow, e.g. using larger heat exchangers?
- Which is the more critical constraint: energy efficiency (high power cost location) or water consumption (water constrained location)?
- Is there already cooling equipment at the location? What type is it and is there available capacity, either year-round or seasonally?
- Does the potential exist to use a method seasonally if not applicable for design/year-round use?
- Is the cooling load large enough to make the seasonal use cost-effective in either energy or water savings?
- Are there environmental considerations (high levels of dust, space limitations) that could affect the reliable operation of the cooling system?
- Is the host site reasonably capable of operating the system given the staffing and operating capability of the plant?

As always, any decision is a compromise among many competing factors. In most production situations, reliability and operation simplicity (at least the aspects relevant to the plant operators) are the most critical factors in a successful solution.

Conclusion

Process cooling can be provided through a variety of means depending on multiple factors related to the application and location. This article reviewed various cooling methods typically available for industrial uses highlighting their efficiency, water use and operating implications.

Any decision on cooling method is a trade-off between multiple competing factors. In some situations, one factor (such as water use) becomes paramount in the choice. Many times, there are different options that could be satisfactory. In these cases, informed decisions balance the pros and cons of the alternate approaches and their demands on the plant. Company culture and corporate support are important factors, but these should not prevent users and engineers from implementing better solutions when the opportunity exists. BP

Images courtesy of EVAPCO, Frigel, Kaltra, Marley and SPX Technologies and Trane

About the Author

Clayton Penhallegon, Jr.is President and Managing Member of Integrated Services Group, which specializes in industrial cooling water system operational effectiveness and cost reduction. He has worked for over 35 years with various industries including plastics, paper, wood products, metal containers and textiles. He holds a Bachelor of Mechanical Engineering from Georgia Tech, an MBA from Georgia State University and is a registered PE in Georgia.

About Integrated Services Group

Integrated Services Group performs industrial cooling water system operational effectiveness and cost reduction technical services. Its services include system assessments, new and upgrade system design, system start-up and retrocommissioning and high efficiency control design and implementation. ISG celebrated its 25th year anniversary in 2022 and serves clients throughout North America. For information, visit https://www.isg-energy.com.

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Sizing Air Compressors for Spray Finishing

By Shane Vrankin, Service Consultant, C.H. Reed

Achieving a high-quality finish on a coated product, whether it's painted or powder coated, is dependent on a variety of variables that impact coating quality before material ever comes out of a spray gun. For example, it's essential to have the proper paint agitators, paint pumps, spray guns, hoses, line sizes and pump cycle rates. But an even bigger requirement is a properly sized compressed air system to effectively operate the pneumatic painting and powder coating equipment.

Compressed Air Sizing Considerations for Paint and Powder Finishing

Air compressors provide the necessary air pressure to atomize and propel paint and powder particles from a spray system onto the surface of an object being painted or coated. An improperly sized compressed air system produces unstable results. If the air compressor is undersized, it won't keep up with demand, causing pressure drops. This affects the atomization of material and results in uneven coats, not enough paint coverage and costly rework. If the air compressor is oversized for the spraying application, you'll experience excessive air compressor start and stop cycles leading to motor burnout and increased utility costs due to energy spikes during startup.

Things to take into consideration when identifying the proper compressed air requirements for paint spray finishing or powder coating equipment – whether you're refining an existing compressed air system, adding trim air compressors or installing a new compressed air system – include:

Pressure and Volume Requirements: What type of finishing applications are you using the air compressor for and how frequently will it be used? Different types of paint or powder jobs require different air compressor setups. For example, large-scale industrial secondary manufacturing companies generally use more

A complete paint spray system

Above: C.H. Reed headquarters in Hanover, PA

air due to higher product outputs and worker shifts than an automotive body shop or a small kitchen cabinet manufacturer.

Industrial operations often require higher pressures and volume compared to automotive touch-ups and resprays. The frequency and intensity of your finishing operation will influence the size and type of the air compressor needed for quality results. If your shop has a high volume of work, multiple shifts and sprays continuously, it's important to select an air compressor that can provide the necessary pressure and volume to meet the requirements of your coating equipment.

Rotary screw air compressors are recommended for finishing applications requiring a continuous supply of compressed air for long periods of time. Reciprocating air compressors are typically meant for intermittent use where smaller, non-continuous amounts of compressed air are needed. The choice between a rotary screw or a reciprocating air compressor depends on how often compressed air is required, and to what extent, to complete the task.

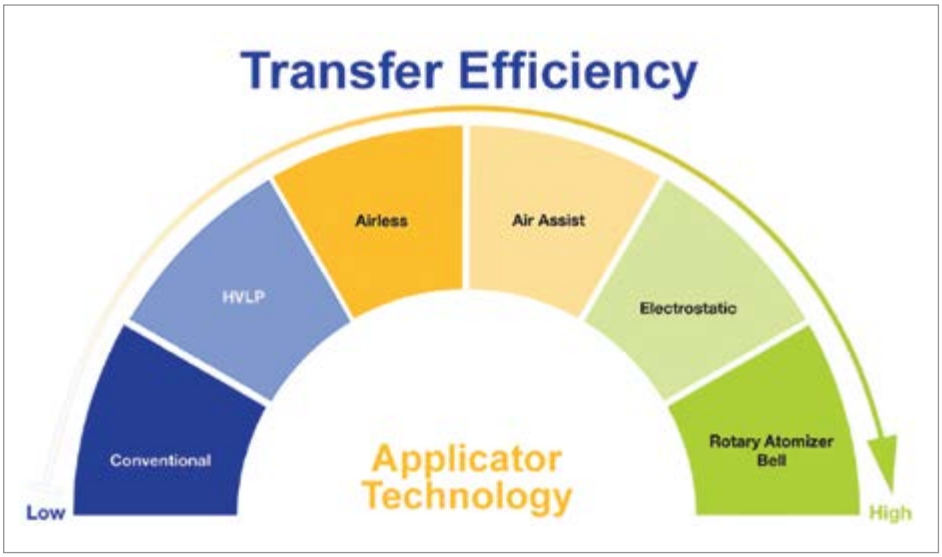
Spray Equipment and Painter Technique: Another factor to consider is the type of spray equipment, along with the painter's technique, as air consumption is influenced by the operator's trigger time and the type of paint or powder technologies used. Trigger time is simply how long the operator of the spray equipment holds down the applicator's trigger, releasing the mixed fluid and air and propelling it out the nozzle to coat the product. Mastering precise and repeatable trigger control is crucial for increasing material transfer efficiency, lowering compressed air use and producing consistent spray results.

Different paint and powder applicator technologies require different amounts of compressed air. Typically, the more technologically advanced the spray applicator technology, the less compressed air it consumes, and the more efficiently it transfers material to the product. For example, at a 25% trigger time, a low-pressure spray gun will consume roughly 88 cfm, while an air-assisted airless spray gun will consume 40 cfm. Conventional paint spray guns use more air than airless sprayers, air-assisted sprayers, electrostatic sprayers and rotary bell applicators.

There are differences between manual spray equipment and automatic spray equipment, as well. Manual spray involves a worker operating spray equipment by hand. Automatic applicators take the human out of the process, allowing robotics and automation to coat the products in an efficient, repeatable manner, increasing paint transfer efficiency and material savings and using predictable amounts of compressed air.

It's worth noting the purchase price of spray technologies increases as the paint transfer and compressed air efficiencies increase.

A high-efficiency electrostatic paint spray gun in operation



A comparison of different types of spray guns and their transfer efficiency (courtesy of Graco)

Sizing Air Compressors for Spray Finishing

Finishing Equipment Air Requirements: The size of the air compressor might be the most important factor to consider when designing a finishing system. Each tool and piece of equipment running off the compressed air system has specific air requirements.

Identify the correct cfm, psi and horsepower (hp) requirements for all finishing equipment in the system. This includes everything from the paint pumps, pressure pots and agitators, all the way to the spray guns and applicators, along with other pneumatic tools that will be powered by the air compressor. It is critical to understand the ratings and requirements of pneumatic equipment to ensure the air compressor provides sufficient air flow (cfm) at the correct pressure (psi) while working as efficiently (hp) as possible.

Most paint spray guns require an average of 10 to 15 cfm at 90 psi (6 bar) to successfully atomize material. Identify every piece of pneumatic equipment that will run off the compressed air system and calculate the air compressor size based on that total. When selecting an air compressor, it's recommended to size up to 140% of total demand to ensure the air compressor keeps up while leaving room for future growth.

Clean Environments: Quality finishes, be it powder or paint, require quality finishing environments. Paint spray and powder coating booths ensure a clean and safe space that provide the necessary airflow needed for the best results possible. Suitable booths meeting the standards set forth by OSHA, the NFPA and the EPA have five main components including the proper walls (single-skin or dual-skin), the correct door for pressurized or non-pressurized booths, a filtered air intake plenum, an exhaust chamber to exhaust and filter air (regardless if it's a cross-draft, semi-downdraft, side downdraft or downdraft booth), an air make-up unit to restore equal amounts of exhausted air while maintaining steady air flows and temperatures and a manometer to indicate when paint filters need to be replaced. Every paint booth is different. Choosing the correct spray booth for your application requires regulatory compliance and expertise in booth design, installation and support.

The same is true for the environment the compressed air system resides in. Clean, dry air is essential for achieving high-quality paint and powder coating results. Moisture, oils and

other contaminants getting into the compressed air stream leads to various defects, including bubbling, flaking, peeling, wrinkling, fisheyes, solvent pops, blisters and poor fluidization. This leads to costly rework.

Choose a clean, dry, centralized, climate-controlled space, if possible, to house the compressed air system feeding your finishing operation. Install inlet and in-line particulate filters to remove particulates and other contaminants from the air stream. Also, invest in air treatment equipment, such as a desiccant compressed air dryer and an aftercooler to achieve lower dew points and reduce humidity. The more your air stream is contaminant-free and dry, the better coating results you will achieve.

A clean air compressor room

Air Audits for Spray Finishing

If you plan to use your existing compressed air system for new paint or powder finishing equipment, conducting an air audit to identify and understand your facility's compressed air and energy use is highly recommended. An air audit reveals important details about your company's current air consumption and system demand, along with opportunities for improvement. It helps determine whether or not your current compressed air system is sufficient to provide the necessary air requirements for the new paint or powder equipment, or if additional trim air compressors are needed.

Using data-logging technologies to assess and measure voltage and current, moisture, temperature, flow and pressure, an air audit can help:

- Verify cfm output
- Identify artificial demands
- Identify inappropriate uses
- Locate pressure drops
- Identify insufficient storage
- Identify leaks

Sizing Air Compressors for Spray Finishing

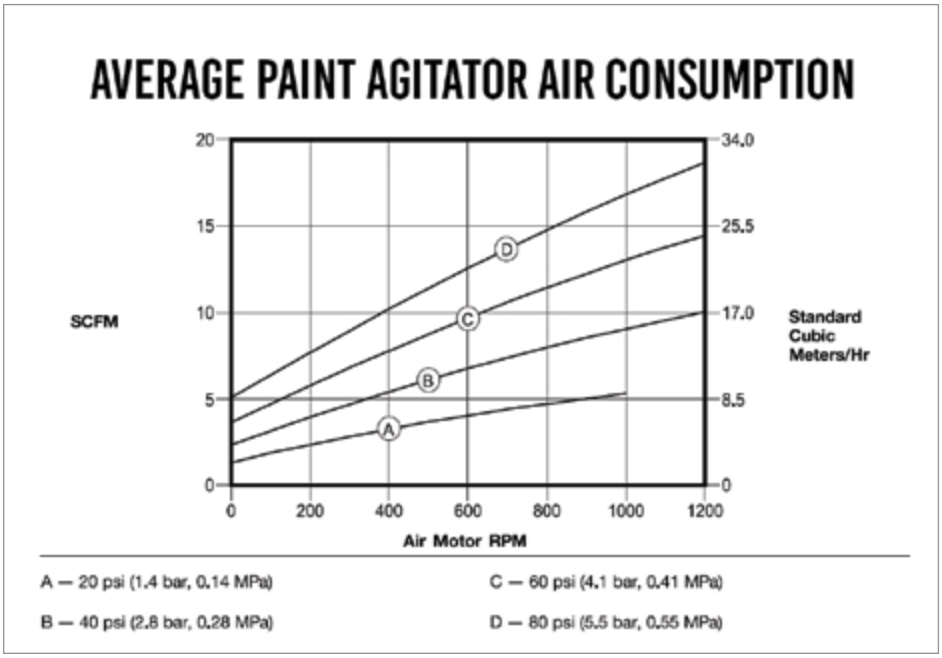
This data can be used to resolve the inefficiencies detected. It also takes the guesswork out of determining whether or not your existing system can supply the compressed air requirements of your finishing equipment, or selecting and sizing a trim air compressor to add to your system. As previously stated, size your compressed air system to 140% of total demand to guarantee it can keep up and to leave room for future growth.

Air Audit Example 1

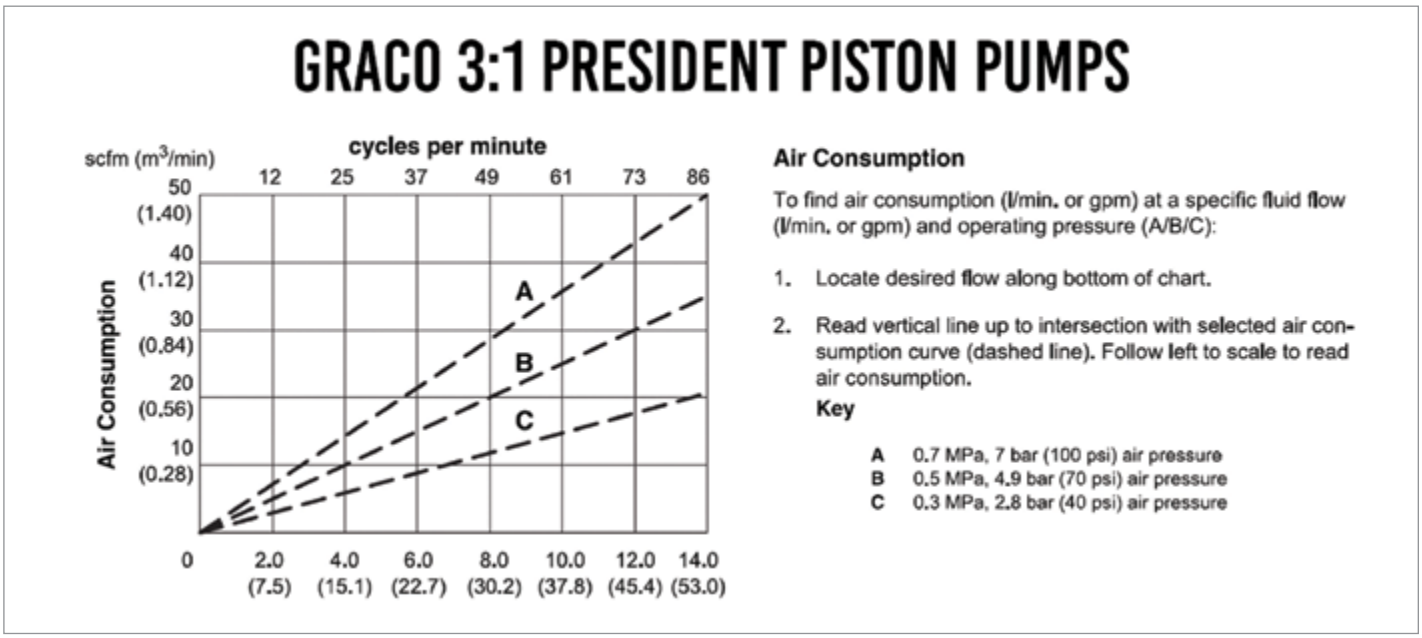
Below is an example of a paint finishing project C.H. Reed completed for a machinery manufacturer. An air audit was completed in its paint kitchen to identify opportunities for cost reduction, process improvements and equipment upgrades that would add value and benefit its operation.

Each piece of equipment in its finishing operation consumes compressed air based off specific fluid flow rates and operating pressures. For example, the chart below reveals the average air use for a single paint agitator. As you can see, it varies based on operating conditions.

After conducting air audits for this manufacturing company's paint pump room, paint proportioning stations and paint application equipment, the pneumatic operating estimate of this customer's painting operation was as follows: 8 pneumatic paint pumps using 10 cfm each equals 80 cfm total; 12 pneumatic paint agitators using 8 cfm each, equals 96 cfm total; 8 electrostatic air spray guns using 20 cfm each equals 160 cfm total.



Average paint agitator air consumption (courtesy of Graco)



Piston pump air consumption (courtesy of Graco)

This gives us a grand total of 336 cfm of compressed air consumed. Using this data, C.H. Reed was able to identify major opportunities for reducing the amount of compressed air used by the painting operation. Following the 140% rule, this facility needed a compressed air system capable of handling 470 cfm.

Air Audit Example 2

A customer in the defense and aerospace industry was looking to purchase compressed air equipment to feed a new paint delivery and spray booth system. C.H. Reed identified the air requirements for its new finishing components: 16 paint piston pumps running continuously at 15 cycles per minute at 75 psi (5 bar) using 10 cfm each, for 160 cfm total; 6 drum agitators running continuously at 5 cfm each, totaling 30 cfm; 3 mix tank agitators running continuously at 5 cfm each, equaling 15 cfm total; 6 HVLP (high volume low pressure) spray guns running intermittently at 20 cfm per gun, totaling 120 cfm. Additionally, the customer had miscellaneous paint proportioners that use little air. It was estimated 25 cfm could handle all of them.

This gives us a total estimate of 350 cfm airflow volume, so an air compressor capable of 490 cfm was recommended.

Whether you're adding onto an existing compressed air system, adding trim air compressors or installing a new system to supply your finishing equipment, choosing the right air compressor for your paint or powder finishing operation is a critical decision that can greatly impact your bottom line. Consider partnering with an engineered systems solutions provider with the knowledge and expertise to select, design, install and maintain equipment specific to your paint finishing or powder coating application. BP

About the Author

Shane Vrankin is C.H. Reed's Service Consultant for the company's southern Pennsylvania, Maryland and Virginia territories, providing preventative maintenance solutions for compressed air end-users. Prior to that, he was C.H. Reed's Marketing Manager for 11 years, overseeing all aspects of the company's marketing initiatives for the compressed air and paint finishing business channels. He was responsible for all inbound and outbound marketing projects targeted to customer retention and growth.

About C.H. Reed

C.H. Reed is a mid-Atlantic distribution and service company for compressed air systems and equipment, industrial vacuum pumps, paint and powder finishing systems and fluid handling and process equipment. C.H. Reed offers industrial equipment, service, preventative maintenance and engineered solutions with support from top manufacturers including Quincy Compressor, Chicago Pneumatic, Graco and Carlisle Fluid Technologies. For more information, visit https://www.chreed.com.

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FACILITY MAINTENANCE

The Compressed Air Dry Tank Wasn't Dry

Making sure compressed air condensate drains perform

By John Bilsky, Facilities Specialist, Gentex Corporation

I'll never forget the phone call I received from production in 2006. They said there's evidence of water in the compressed air feeding an end-use production machine. Immediately, I examined the equipment in the air compressor room at Plant #4, starting with the compressed air dry storage tank. Imagine my amazement when I opened the drain valve on the tank and got a face full of water! Thanks to production calling right away, we avoided filling the dry tank completely full.

I needed to discover why there was so much water moving downstream. The only positive outcome to this disaster was the chance to identify where the weak points were in our system and rectify them. I worked backwards from the dry tank to discover the root cause and examine our system.

First off, the dry tank should always be dry, meaning no moisture should reach it. To ensure this is always the case, I installed a dew point probe in front of the dry tank for real-time text and email notifications of high dew points. In addition, I now add a zero-loss condensate drain on every dry tank to ensure our safety.

Working backwards from the dry tank, we had the refrigerated compressed air dryer outlet filter (or post-filter) with a condensate drain. In this case, the drain was overwhelmed by the volume of water in the air stream and could not remove all the moisture. However, this was not the root cause. The problem was further upstream.

Moving backward from the dryer post-filter brought us to the refrigerated compressed air dryer, where the air should be moisture-free above 35-38°F (2-3°C). I found the compressed air drain working properly on the separator, however, it also couldn't keep up with the volume of water it encountered. This caused a significant volume of water to remain in the airflow and bypass the separator and drain. The compressed air dryer wasn't maintaining the dew point. To ensure production was protected, I added another dew point probe on the refrigerated compressed air dryer's outlet. This gave me redundant probes with high dew point alarms.

Finding water droplets moving through the compressed air dryer told me the root cause was further upstream. Next in the system moving

The 1,000-gallon compressed air dry storage tank was almost full of water!

Was the refrigerated compressed air dryer the cause of the problem?

The refrigerated compressed air dryer pre-filter was the next possible trouble spot.

backwards was the dryer pre-filter, which had internal condensate float drains. Like the post-filter, it was overwhelmed by increased water content. To remove the condensate more effectively I changed the drains on the pre-filter from internal float drains to an external zero-loss condensate drain, which can manage increased volumes. Nevertheless, this was still not the root cause of the dry tank filling with water.

Moving further backwards in the system, our plants have a wet tank in most cases. In this plant, however, there was no room for a wet tank, so a centrifugal water separator was plumbed in line. This, when working properly, slings out water droplets before the pre-filter and the refrigerated compressed air dryer. In this case, the centrifugal separator had a single condensate drain fail. This was the root cause. As a result, high water volumes flowed through the system within the compressed air stream and overwhelmed the downstream components.

Having identified the root cause, I decided repairing the condensate drain was not good enough to protect production. This is when all our wet tanks, compressed air

This compressed air system had a centrifugal water separator just after the air compressor. The drain on the centrifugal water separator had failed and was the root cause of the problem.

dryer pre-filters and centrifugal water separators began getting dual condensate drains. I call the second drain the backup condensate drain, even though most work in tandem. All wet side drains have remote monitoring and alarm notifications, and are physically checked twice a week at a minimum.

When production says, "Hey, there's water at the point of use," start with your dry tank, and work your way backward. Use the time to make notes for system improvements while discovering the root cause. Now I can say, for 19 years running, we actively manage all condensate problems before production sees this type of issue. BP

About the Author

John Bilsky is the Facilities Specialist at Gentex Corporation for compressed air, nitrogen and purified water. He's experienced in engineering design, engineering improvements and maintenance for compressed air, nitrogen and water purification systems supporting production, R&D and lab services. He provides capital project improvements and oversees contractor installations. For more information, visit https://www.linkedin.com/in/john-bilsky-24715b10/.

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Real-World Installations & Maintenance

Edited by Troy Dreier, Senior Editor, Compressed Air Best Practices® Magazine

There's much we can learn from real-world compressed air, vacuum, chiller and cooling tower installations. This column asks readers to share lessons learned from system installations and maintenance practices they encounter in the real world.

Belliss & Morcom Air Compressors Go the Distance

Albert Williams is a Freelance Energy Auditor and Energy Engineering Training Instructor based in South Africa. Visit https://www.linkedin.com/in/albertedwardwilliams/.

Andrew Smith-Carrier is a Mechanical Engineer who has been working in industrial energy efficiency with a focus on compressed air for over 15 years, currently through SMARTCAir, which he founded. Visit https://smartcair.com.

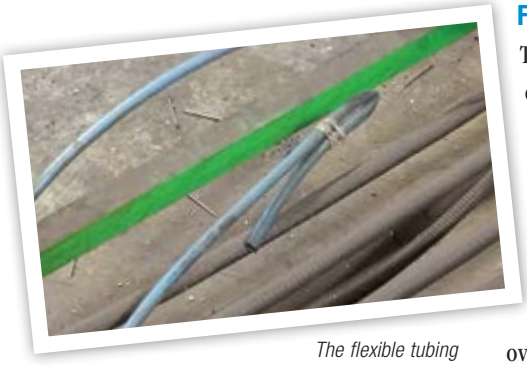
In our November 2024 issue, we shared the story of a 1937 Gardner Denver air compressor discovered by one subscriber. That prompted similar recollections from two other subscribers – both involving Belliss & Morcom reciprocating air compressors.

Williams discovered a 1918 Belliss & Morcom three-stage, reciprocating air compressor while auditing a compressed air system in a platinum mine. It was still operating and supplying 3,000 cfm. He sent in this picture of its nameplate.

Meanwhile, Smith-Carrier discovered this and 10 other 1940s belt-driven, 20-horsepower (hp) Belliss & Morcom reciprocating air compressors in an Ontario, Canada, carpet factory. The factory ran five or six of them at a time while rebuilding the others. That rotation kept up until 2015, when Smith-Carrier convinced the factory to replace them all with two 250-hp, rotary screw air compressors.

Two subscribers shared pictures from long-running Belliss & Morcom air compressors, one from a South African platinum mine and the other from a Canadian carpet factory.

Flexible Tubing Leaks Can Be Costly



The flexible tubing connecting compressed air system pipe drops to point-of-use applications needs regular attention, as it's often a source of leaks.

This unfortunate shortcut (pun intended) came from Andrew Smith-Carrier, cited in the previous item. He discovered the tubing pictured here while conducting a compressed air system audit at a nail manufacturing plant. For unknown reasons, the tubing was disconnected from a bank of solenoids, then folded over to prevent compressed air from escaping. The fold didn't do the job, however, and the tube leaked freely.

According to Compressed Air Challenge, Smith-Carrier noted, the cost of a 1/8-inch leak is over $4,000 per year. That makes the return on investment for repairing this tubing pretty short.

Most leaks in a compressed air system come from the "Dirty 30": the 30 feet of flexible tubing that connects the compressed air system's pipe drops to the end-use applications. Plant operators should pay close attention to this area, or risk watching their profits get blown away.

Submission Guidelines

We invite subscribers to share stories and photos of remarkable system installations they've come across. Email Troy Dreier at troy@airbestpractices.com. Please send a high-resolution image as a JPG or GIF file and a note describing the installation. If we publish your submission, we'll thank you with a $25 Amazon gift card.

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Two temperature sensors are installed in series in the direction of flow. The first temperature sensor measures the current process temperature of the compressed air, while the second sensor is electrically heated to a temperature that is 40°C higher than that of the first sensor. Higher volume flows results in a quicker drop in temperature at the sensors, so that the electric heater of the second sensor must increase its heat output. The electric energy required to maintain the temperature difference is proportional to the volume flow. This energy consumption is converted to provide the relevant flow measurements.

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- Basis for an economic design of systems and determination of leakage quantities

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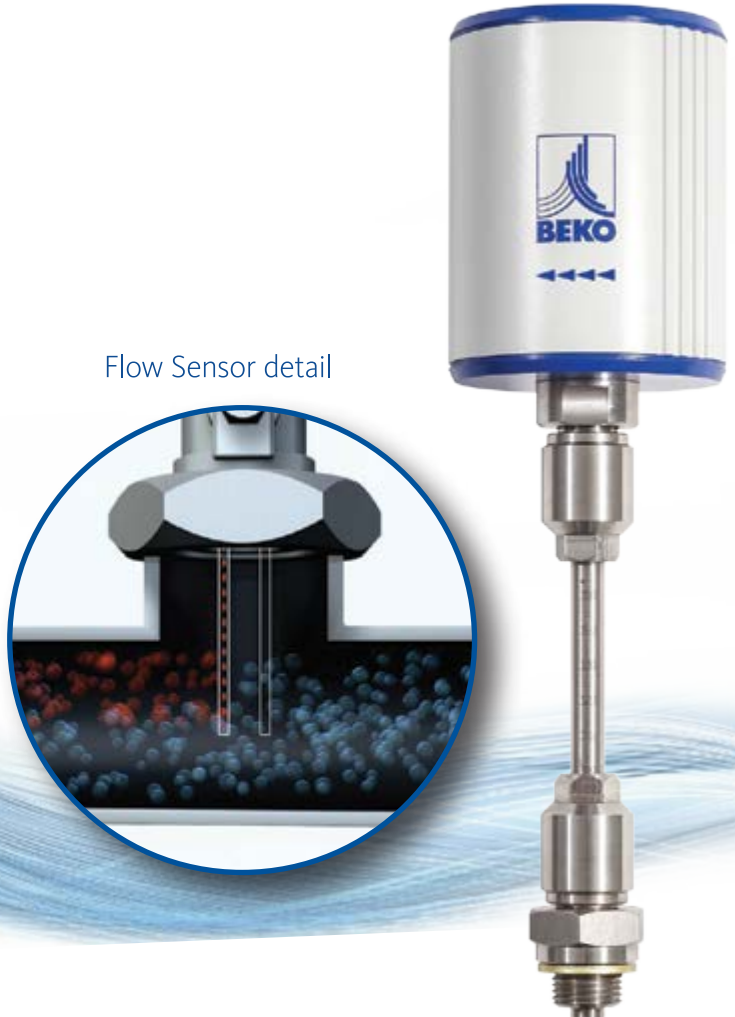
- Indication of calibration time via integrated display or service LED
- Ideal for compressed air technology due to calorimetric measuring principle



Flow Sensor detail

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