# APPLIANCE & HVAC REPORT

Reaching Design Engineers at the OEM Level

October 2022 www.appliancehvacreport.com VOLUME 4 ➢ NUMBER 4





**9 FEATURES COVERING**

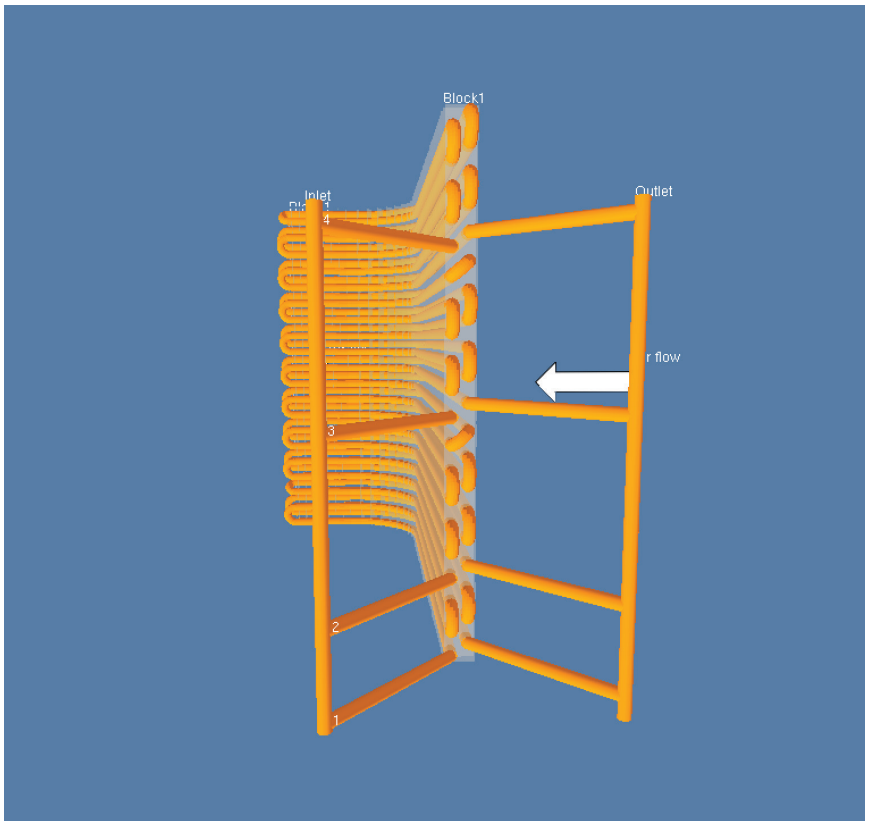
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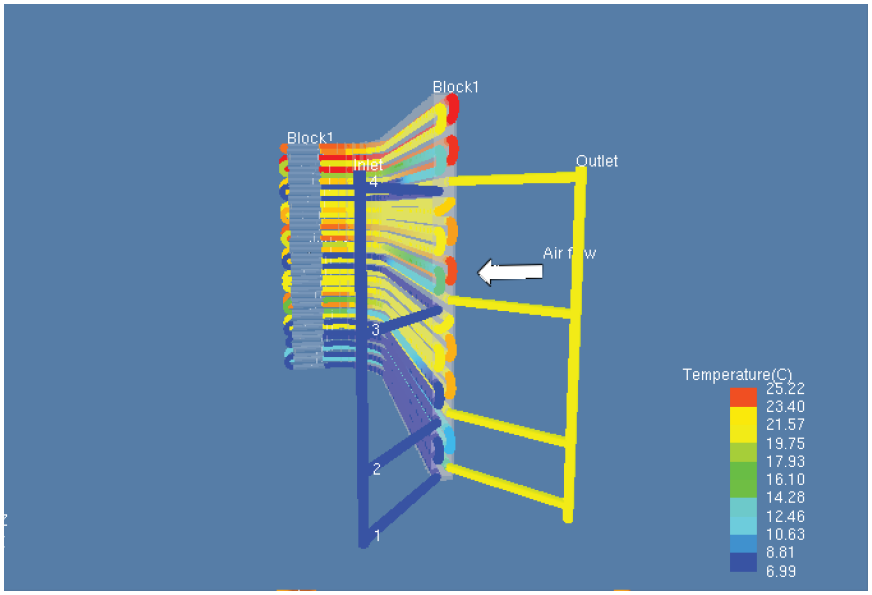

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COVER ART **Five Trends in Heat Pump Design** PAGE 10

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# Welcome to our October issue, the last for 2022



Good day readers. This is our fourth and final issue of 2022, as we now have completed 3 full years in existence. And what a ride it has been…we have weathered the pandemic and continue to move forward, providing you with solid technical information on a quarterly basis.

First let me thank all 24,000 of you. Because of the great reception to our editorial product, our ''open'' and ''click-thru'' rates continue to rise well above industry averages.

Why is that important? Well it helps us prove value to the advertising community that supports us…suppliers of various components and services who want to reach our design engineering audience. And this issue marks the most advertising revenue we have received in our three year history. No small fete if we do say so ourselves. See page 48 for the listing of clients for this issue.

And related to that I'd be remiss if I didn't thank the many organizations who have contributed whitepapers and technical articles for us to publish. This is our 13th issue (lucky 13) and we have had more than 80 organizations work with us. In this edition of THE APPLIANCE & HVAC REPORT you will see articles from the following: Ametek Dynamic Fluid Systems (as a grandpa myself, I love this piece's title), BCA Industries, Dristeem, Fair-Rite, Grid Raster, International Copper/Microgroove (who also supplied us with the great cover art), Littelfuse, Rinnai America and TE Connectivity.

So what's happening in 2023?

• We will be exhibiting at the AHR show, in Atlanta. Booth # B4474. Please stop by! The show is Monday-Wednesday February 6-8.

• We also hope to start two new projects: First, a monthly e newsletter. It will contain industry news along with previously published articles. Second, a bi-annual Case Study pub (readers feel free to contact me if you have case studies you want us to put in our print/digital editions).

• We are working hard to build our social media identity, via Linkedin and Twitter. We'd appreciate it if you ''liked'' and followed us. Here are the links to do so: https://www.linkedin.com/company/appliance-hvac-report and https://twitter.com/AppHVACReport

That's all folks.

Brad

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APPLIANCE & HVAC REPORT
Reaching Design Engineers at the OEM Level

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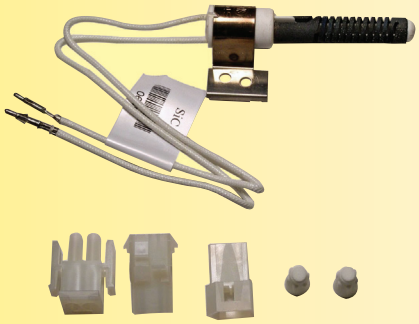
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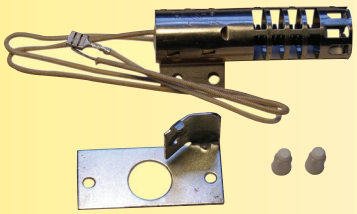
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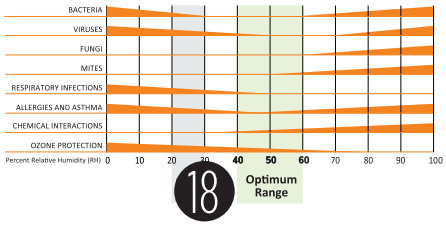
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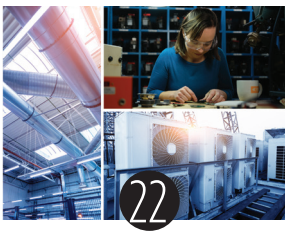
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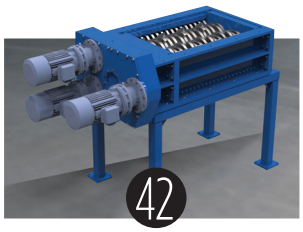
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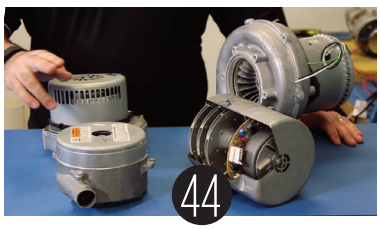
The longer lifespan of a tankless water heater (lasting 20 years or more) compared to the shorter life span of a tank water heater (lasting 10 to 15 years), means the cost upfront can be worth the investment.



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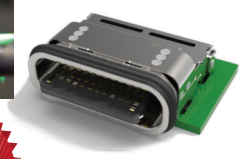

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# Smart Water Heater Design: Three Important Technologies You Shouldn't Forget to Use

**BY RYAN SHEAHEN**

New technologies, including the Internet of Things (IoT), enable every product, including appliances, lighting, and HVAC systems, to be computer-controlled smart devices. In essence, any product that performs some level of control can become a smart device. That concept is also true for the ubiquitous water heater. As a result, the market for electric water heaters is growing at an attractive rate with a CAGR of 7.4%. Governments are spurring growth by incentivizing consumers to convert their gas-based water heating systems to electric systems to achieve the Net-Zero Emissions Initiative. In addition, new building codes in some regions will not permit a natural gas hook-up, further accelerating the growth of all-electric products such as water heaters.

The addition of intelligence to a water heater adds sensitive electronic circuitry. It is incumbent upon the designer to ensure the reliability of the water heater by protecting the electronics from current overloads, voltage transients, electrostatic discharge (ESD), and overheating. Protecting the electronics also ensures that individuals who contact the water heater are safe from thermal and electric hazards. The designer also needs to ensure the use of long-life components.

This article provides designers with information on three critical technologies: protection, control, and sensing, for developing an electric water heater robust to external overloads, transients, and ESD. The components representing these technologies will help create a safe, efficient, long-life water heater that safely controls water temperature. By using the recommended components, design engineers will achieve the goal of developing high-quality, reliable, smart water heaters.

## Overview of a Smart Electric Water Heater

Like almost every electrical and electronic product available today, electric water heaters use a microcontroller to process programming information and deliver water at the required temperature. The water heater uses AC line power to control the heating element and power the microcontroller and the other DC circuitry, such as the touch-screen display and the wireless interface. Temperature probes provide the input and output water temperatures, enabling the microcontroller to control the heating element. Figure 1 shows a typical water heater, its primary circuit blocks, and recommended components for protection, efficient control, and sensing.

Figure 2 shows the block diagram for an electric water heater in greater detail with the recommended protection, control, and sensing components listed in the adjacent table. This article presents how to protect the circuit blocks and offers appropriate component solutions that apply control and sensing.

## Protecting the Water Heater From Overloads, Transients, and ESD

***The AC Input Protection block*** protects the water heater circuitry from the current overloads and high voltage transients inherent on the AC line. Use a fuse to protect against current overloads and a metal oxide varistor (MOV) to absorb voltage transients induced on the AC line.

Consider using a cartridge fuse to allow easy replacement in the event a current overload causes the fuse to trip. Ensure the fuse holder that supports the

**Figure 1**: Example tankless electric water heater with recommended components that provide protection, efficient control, and sensing

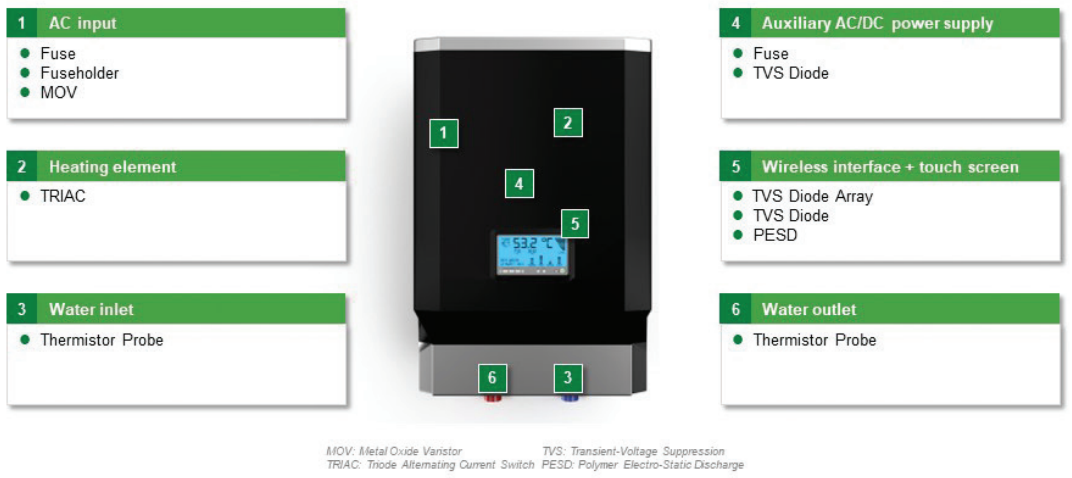
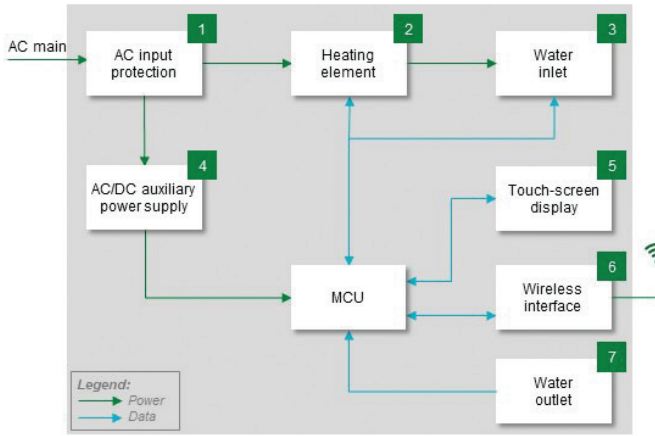



**Figure 2**: Block diagram of a smart water heater and the table showing the recommended protection, control, and sensing components




| | Technology |
|---|---|
| 1 | Fuse |
| | Fuseholder |
| | MOV |
| 2 | TRIAC* |
| 3 | Thermistor Probe |
| 4 | Replaceable Fuse |
| | TVS Diode |
| 5 | TVS Diode |
| 6 | Diode Array |
| | Polymer ESD |
| 7 | Thermistor Probe |

- *Tankless water heaters typically have ONE element; most larger systems have TWO heating elements, one at the top and bottom of the tank.*
- *Tankless systems typically has 40 A or 90 A TRIAC for fast heating. Tank systems typically use lower power 16 A or 25 A TRIAC.*

fuse is UL/CSA/IEC compliant.

Use a metal oxide varistor (MOV) to absorb AC line-induced voltage transients from machinery, appliances, and even lightning. Look for a MOV with:

- The ability to absorb as much as 10 kA of transient current
- The capacity to absorb at least 400 J of transient energy
- Compliance to IEC 61051-1 and 61051-2, Varistors for Use in Electronic Equipment.

***The AC/DC Auxiliary Power Supply*** powers the MCU, the Touch-Screen Display, and the Wireless Interface. Consider secondary fusing and transient protection for the sensitive semiconductors. Use a fast-acting DC fuse in this circuit. Also, consider a transient voltage suppressor (TVS) diode which can absorb up to 400 W of pulse power. TVS diodes can clamp a transient in less than 0.1 ps to avoid damaging sensitive semiconductors. To save PC board space, look for a surface mount TVS diode.

***Touch-Screen Display users*** have direct contact with the display to set controls for the water heater and obtain the water heater's status. As a result, the display is susceptible to ESD from human contact. Use a TVS diode to protect the touch-screen display circuitry. Models of TVS diodes comply with IEC 61000-4-2, Electrostatic Discharge Immunity Test, and provide ESD protection up to 30 kV for either a through-the-air strike or through direct contact.

***The Wireless interface*** transmits data and receives control information from PCs, PLCs, tablet computers, and smartphones. Protecting the data lines from ESD avoids corruption of data transmission and reception. Consider bi-directional TVS diode arrays shown in Figure 3. Versions of this TVS diode can safely absorb ±12 kV of contact ESD discharge and 40 A from a fast transient. These diodes minimize signal distortion with less than 0.1 pf capacitance added to the circuit.

Alternatively, consider polymer ESDs for protecting data lines. These components have low capacitance, typically under 0.25 pF. The leakage current is under 10 nA to minimize power consumption in the Wireless Interface circuit

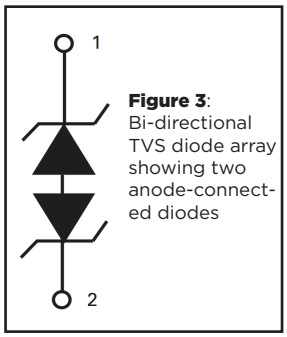



**Figure 3**: Bi-directional TVS diode array showing two anode-connected diodes

## Maximizing Efficiency and the Life of the Water Heater

Electric water heaters will typically use a TRIAC to control the heating element. A TRIAC only needs a low-power drive circuit for control, and it eliminates contact bounce when switching power to the heater and has no audible noise. TRIACs offer high reliability, with versions offering surge capacity up to 250 A and a voltage capacity up to 100 V. The solid-state switching provided by a TRIAC provides reliable long-life operation.

Tankless water heaters typically have one heating element, but larger systems can have two heating elements. One element is at the top of the tank, and the second heating element is at the bottom of the tank. For fast heating, tankless systems typically use a 40 A or a 90 A TRIAC which is a much smaller component than an electromechanical relay with a similar contact current rating. Tank systems typically use lower power, 16 A or 25 A TRIACs.

## Controlling Water Temperature and Protecting the Water Heater From Overheating

Use thermistor temperature probes to monitor the water temperature at the Water Inlet and Water Outlet. A thermistor provides more accurate temperature monitoring than other temperature sensor types. The fast thermal response of a thermistor probe can contribute to the water heater's efficiency. Also, take advantage of a thermistor's small form factor.

## The Benefits of Including Components for Circuit Protection, Efficient Control, and Sensing

It does not take many components to protect a water heater and enhance its reliability. Save development and compliance testing time by including the three technologies, circuit protection, efficient control, and sensing, into the project plan. Not emphasizing these aspects of the design can lead to re-design, introduction delays, and cost overruns.

Fortunately, the component manufacturer's application engineers can help save development time with:

- Cost-effective component selection
- Guidance on applicable standards
- Pre-compliance testing to help catch problems before the water heater is submitted to a standards body for compliance testing.

Using the recommended components for protection, control, and sensing will ensure a high-reliability water heater with low in-warranty repair costs and high customer satisfaction. ●

**References:**
1. Circuit Protection Products Selection Guide. 2020 Littelfuse, Inc.
2. Power Semiconductor Selection Guide. 2021 Littelfuse, Inc.
3. Sensing Products Selection Guide. 2019 Littelfuse, Inc.
4. Protection Relay & Controls Catalog. 2022 Littelfuse, Inc.



***Ryan Sheahen*** *is the Global Strategic Marketing Manager for the Electronics Business Unit. Ryan joined Littelfuse in 2011 as an inside sales specialist. He was previously the Global Product Manager for the magnetic sensing product portfolio. His current responsibilities include developing marketing collateral, managing marketing activities for new product launches, and performing marketing studies and feasibility analysis for new product ideas.*

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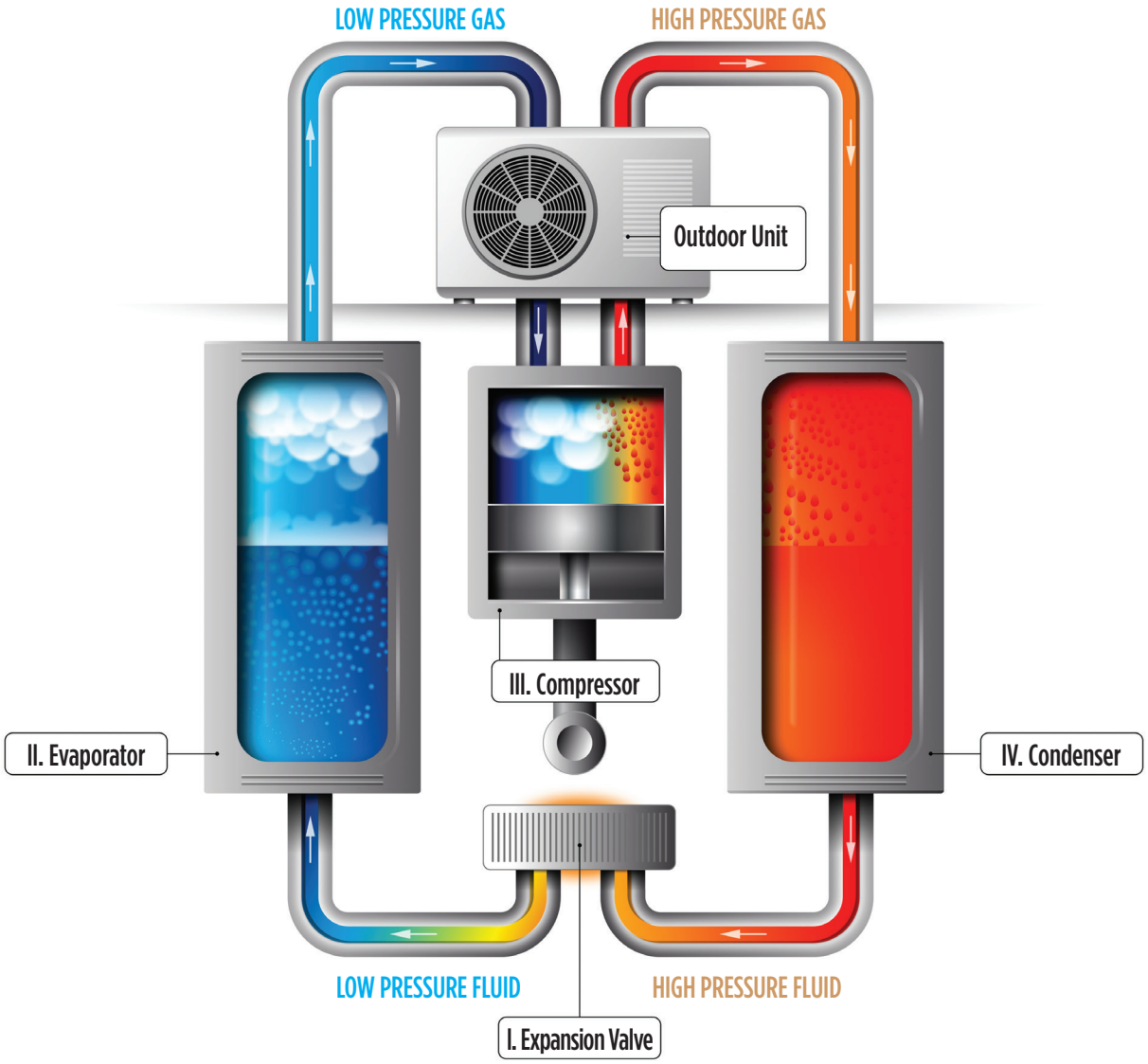


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# Heat Pumps Deliver High Efficiency Heating

## Five Trends in Heat Pump Design for Residential Heating

**BY FRANK GAO, KERRY SONG, YORAM SHABTAY AND HARRY SCHMITZ**

Throughout history and up to modern times, mankind has accomplished heating mainly by burning fuels such as coal, oil and natural gas and later also by electrical resistance heating. Nonetheless, there is another method of heating: heat pumps.

According to the Second Law of Thermodynamics, isolated systems will always arrive at a state of thermodynamic equilibrium. In other words, temperature differences will even out. Through the vapor compression cycle (VCC), however, refrigerant can be heated or cooled further than the ambient (Fig. 1).

The VCC works as follows:

I. Cooled refrigerant passes through an expansion valve.

II. The refrigerant picks up heat as it expands through outdoor evaporator.

III. The compressor adds work energy as it increases the pressure and temperature of the refrigerant.

IV. Heat gained from Steps II and III is released through the condenser.

Then the cycle repeats.

Depending on the outdoor and indoor ambient temperatures as well as the efficiencies of the coils, the heat output can be many times the work input. This advantage over electrical resistance heating is of great interest

for energy efficiency. The ratio of heat output to work input is also called the coefficient of performance (COP).

Such a device is called a "heat pump." Air conditioners, refrigeration equipment and indeed any appliance that uses the VCC could be labeled a "heat pump." In this article, the term "heat pump" is restricted to refer to equipment and appliances that use the VCC for heating.

## Wanted: Imaginative New Heat Pump Designs

The need for better heat pump designs is urgent for two overarching reasons: First and foremost, heat pumps can replace equipment and appliances that currently burn hydrocarbons. This "electrification" or "decarbonization" allows for heating to be accomplished with clean renewable energies such as hydroelectric, geothermal, solar, and wind.

Second, thanks to the laws of thermodynamics, heating by the VCC is ***much more efficient*** than heating by combustion or electrical resistance. Heat pumps significantly increase the system efficiency by moving outdoor energy indoors. The kinetic energy from the compressor is added to the thermal energy absorbed from the outdoor ambient. The heating capacity (in Btu/h, or kilowatts) is typically many times the compressor power (in horsepower, or kilowatts).

Suffice it to say, the nations of the world are addicted to fossil fuel. Weaning one and all from fossil fuel will depend in part upon imaginative new designs of heat pumps. New principles relating to the application of the VCC are emerging with the potential to revolutionize heating as much as cooling.

Several of these trends are as follows:

1. Ground source heat pumps (GSHPs)
2. Air source heat pumps (ASHPs)
3. Air-To-Water heat pumps (ATW HPs)
4. Low GWP refrigerants
5. Cold climate air source heat pumps (CC-ASHPs)

The intelligent application of new heat pump technology itself can substantially reduce the release of carbon dioxide into the atmosphere.

Let's take a closer look at these trends.

### *1. Ground Source Heat Pumps*

In past decades, ground source heat pumps (GSHPs) or water source heat pumps generated much enthusiasm. The main selling point was that such heat pumps could work well even in cold climates. Typical temperatures at a depth of a six to ten feet (that is, below the frost line) are steady at about 55 °F (13 °C).

GSHPs remain popular in many locales. Closed loop systems circulate heat-carrier fluid through pipes installed in the ground. Open loop systems pump groundwater stored in aquifers and mines. Heat pumps are used to extract the low-grade heat from warm carrier fluid or groundwater and upgrade it to more useful temperatures (> 40 °C) required for the heating of buildings. The cooled carrier fluid or groundwater is then returned to the subsurface and the cycle repeats.

GSHPs can be used for heating, cooling or both, i.e. heating during winter and cooling during summer. Figure 2 compares working temperatures and depths for various types of GSHPs as well as geothermal heating and engineered geothermal systems (EGS).

These methods of heating are especially interesting for district heating where large heat pumps can serve thousands of homes. An interesting twist on GSHPs is the use of coal-mine water as an open-loop heat source.

In Great Britain, for example, the Coal Authority owns most unworked coal as well as former coal mines. The

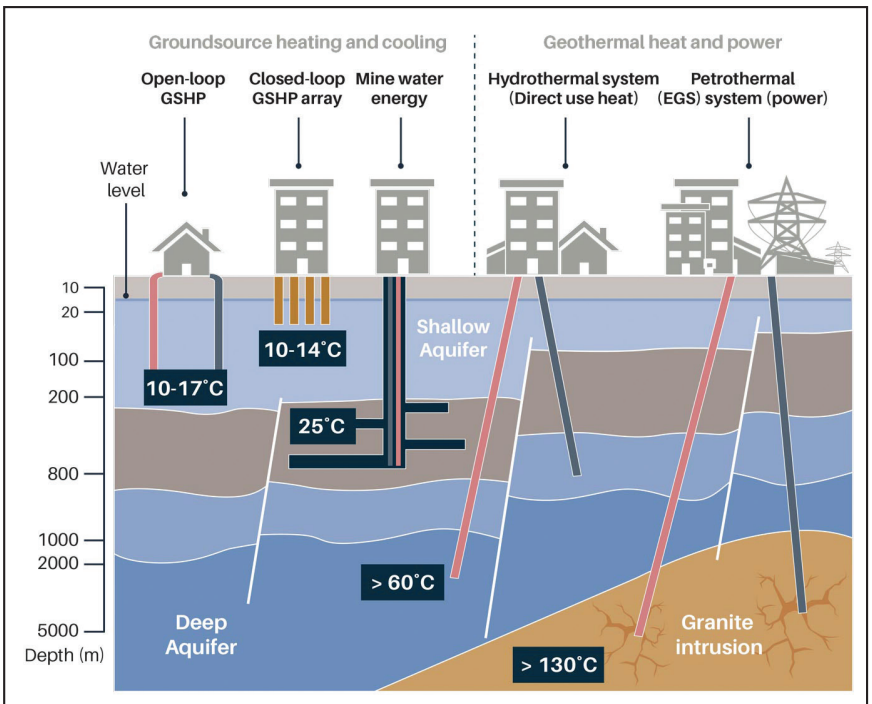



**Figure 2**: Comparison of groundsource heating and cooling with geothermal heat and power. Acknowledgement: CP22/041 Geothermal Energy Technologies, BGS © UKRI. All Rights Reserved. Sourced: https://www.bgs.ac.uk/geology-projects/geothermal-energy/

Coal Authority is a non-departmental public body of the United Kingdom government sponsored by the Department for Business, Energy & Industrial Strategy. According to the Coal Authority, one quarter of the population of the UK lives in settlements on coal fields. Often these abandoned coal mines are filled with water, offering a plentiful source of geothermal energy for domestic heating [1, 2].

### *2. Air Source Heat Pumps*

Air source heat pumps (ASHPs) can be further classified as Air-to-Air (ATA) heat pumps and Air-to-Water (ATW) heat pumps. The common denominator is that the evaporator captures heat from the ambient air.

ASHPs offer several advantages compared to GSHPs. The main advantage is lower cost. In the USA, where ducted furnaces and central AC are everywhere, air source heat pumps look a lot like central air conditioners, but the roles of the outdoor unit (ODU) and indoor unit (IDU) are reversed. Indeed, many brands of ASHPs are reversible. They can be used for cooling in the summer and heating in the winter, especially in lower latitudes where winters are mild. ATA HPs in the heating mode use the ODU as an evaporator and the IDU as a condenser. Ducted systems are especially common in legacy homes that previously used a gas furnace for heating.

When the ODU serves as an evaporator, the copper tubing in round tube plate fin (RTPF) heat exchangers tends to be larger in diameter than the copper tubing in outdoor condensers. Copper tube diameters as large as 3/8 inches (9.52 mm) or 1/4 inches (6.35 mm) are not uncommon for this application. Microchannel heat exchangers are rarely used in outdoor evaporators because of issues with drainage, freezing and defrosting.

The IDU could be configured to allow heated air from the condenser to be directed through a system of ducts; alternatively, the condenser could be remote from the compressor. Refrigerant from the compressor could be routed through insulated copper pipes to wall units hung in various living spaces. Either of these configurations would be considered an ATA ASHP.

A new generation of low-cost, mass-produced window units recently was introduced into the marketplace. These units use smaller-diameter copper tubes in a reversable configuration. In other words, the compressor can pump refrigerant to the indoor facing heat exchanger in the heating season or to the outdoor facing heat exchanger in the cooling season. Since these window units typically do not operate efficiently at temperatures below 45 °F, they are not considered heating systems ***per se*** but are useful as efficient supplemental space heaters for most heating days, especially in milder climates.

An important figure of merit for heat pump selection is the number of heating degree days. These are essentially weather statistics for different regions. An outdoor temperature 1 °F below 65 °F for a 24 h period represents one heating degree day; an outdoor temperature of 45 °F for a 24 h period represents 20 heating degree days; and so on. Thanks to the abundance of weather stations across the USA and most other countries, extensive historical databases of local temperatures are available. Heating degree days can be readily calculated for no charge using various online apps. For example, one such calculator is available at degreedays.net.

The trend now is toward ASHPs. Except for extremely cold climate zones, ASHPs can provide adequate heating through most heating days although COPs drop on very cold winter days. Using the latest technology, the ASHPs are saving energy for homeowners even in Northern climates.

Condensers and evaporators in such heat pumps can be readily modeled for performance under various operating conditions using HXSim simulation software. HXSim is available at no charge from the International Copper

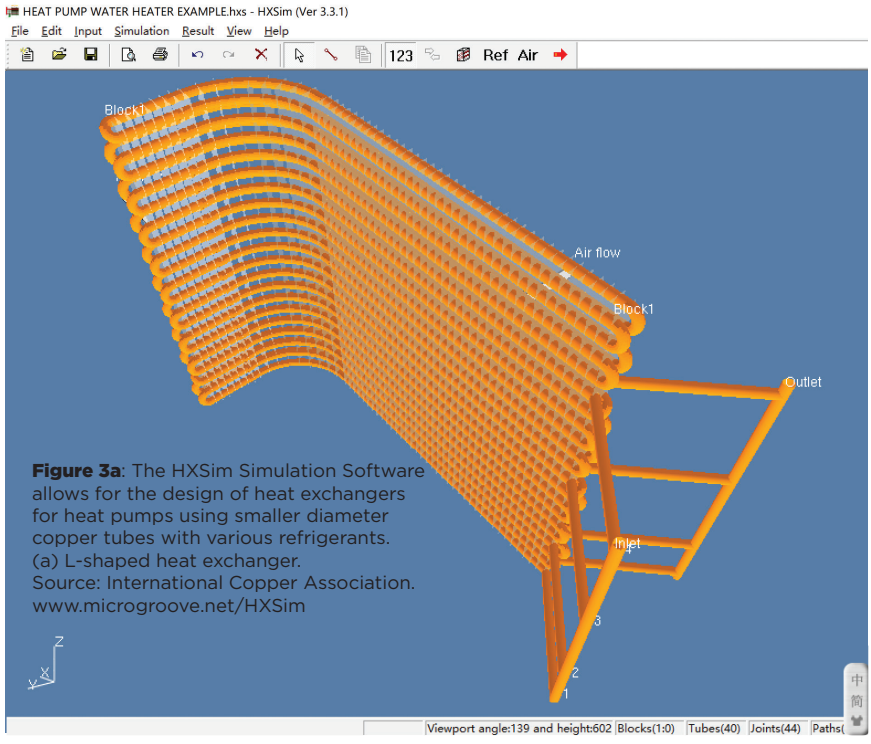
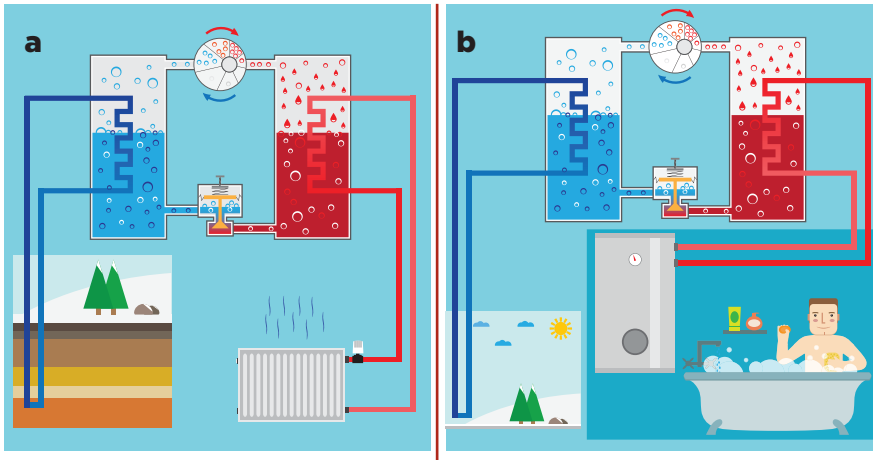



**Figure 3a**: The HXSim Simulation Software allows for the design of heat exchangers for heat pumps using smaller diameter copper tubes with various refrigerants. (a) L-shaped heat exchanger. Source: International Copper Association. www.microgroove.net/HXSim

Association via its microgroove.net website [3]. HXSim software can model I-type, L-type and C-type heat exchanger blocks with copper tubes as small as 4 mm in diameter for many different refrigerants. The use of HXSim software has been described in a past issue of the ***Appliance and HVAC Report*** [4]. A recent issue of the ***MicroGroove Update*** newsletter compares HXSim with other heat exchanger simulation packages [5].

Outdoor evaporators for heat pumps come in many shapes and sizes. In the United States, they are typically C-Type heat exchangers similar to the outdoor condenser for a residential central air conditioning system. Simple I-Type (flat slab) heat exchangers also can serve as evaporators in split systems. Figures 3a and 3b show 3D representations of C-shaped and L-shaped heat exchanger blocks with smaller diameter copper tubes for use in a heat pump as simulated with HXSim simulation software.

**Figure 4a / 4b**: Heat pumps can produce hot water: (a) Ground source heat pump (GSHP) for space heating. (b) Air source heat pumps (ASHP) for domestic hot water.a




### *3. Heat Pump Water Heaters*

A heat pump water heater (HPWH) could derive its heat from a ground source or an air source. Either of these heat pumps is more efficient than a fossil-fuel-burning boiler. Output can be used for space heating or domestic hot water (Fig. 4a and 4b).

Heat from the compressed refrigerant is transferred to the water through a finless condenser coil or brazed plate heat exchanger. The hot water can then be pumped to radiators or baseboard heaters; or radiant heating can be accomplished by pumping hot water or a secondary fluid through a network of pipes built into floors or walls.

Chinese medicine advocates "keep the feet warm and the head cool." Radiant heating through floors emits heat near the feet and the heat gradually decreases from the floor to the ceiling. This approach is in accord with the health preservation principle of traditional Chinese medicine and has become popular in China. The Shanghai office of the International Copper Association China (ICA China) recently released a study on a residential systems using ground and air sources with ATW and ATA heat pumps [6]. The company Leomon Technology (Cihu Technical Area, Maanshan. China) offers various heat pump products that are used in such systems. Its website hosts several informative blogs in English on heat pumps, radiant floor heating and related topics [7]. Leomon Technologies has more than twenty years of experience in the refrigeration and heating industry in China.

Heat pumps have received much attention from the U.S. Department of Energy (DOE), the California Energy

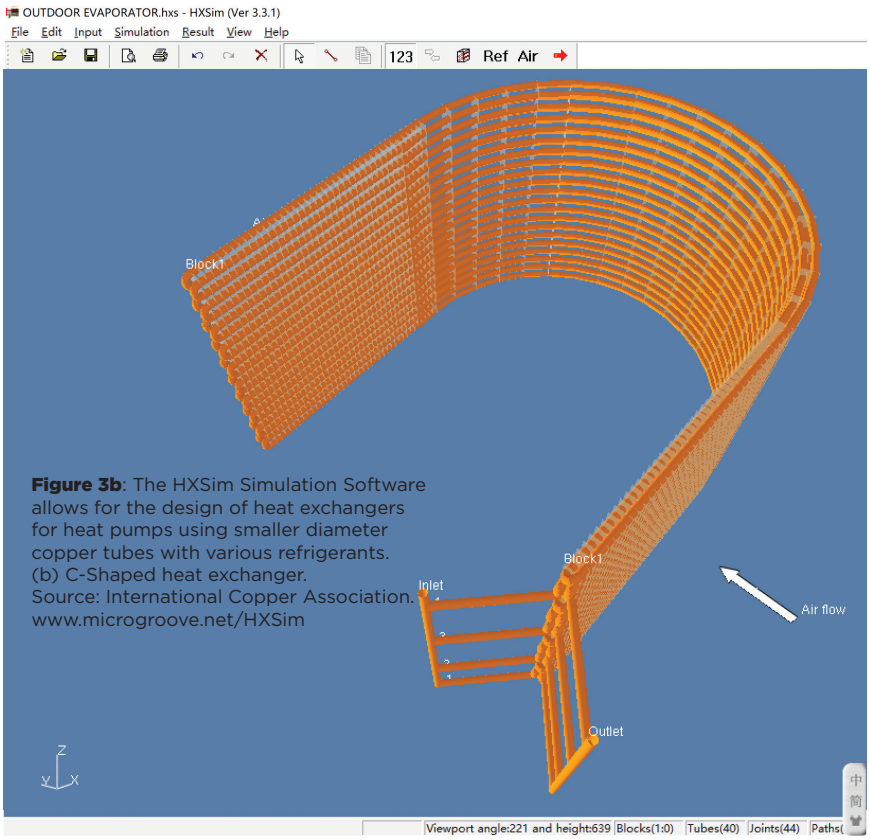



**Figure 3b**: The HXSim Simulation Software allows for the design of heat exchangers for heat pumps using smaller diameter copper tubes with various refrigerants. (b) C-Shaped heat exchanger. Source: International Copper Association. www.microgroove.net/HXSim

Commission (CEC), the European Heat Pump Association, the EIA International Heat Pump Forum, the American Council for an Energy-Efficient Economy (ACEEE) and many other government agencies and non-governmental organizations (NGOs). The DOE is authorized to establish and amend energy conservation standards and test procedures for consumer water heaters [8].

The 2022 Hot Water Forum (HWF) included several sessions dedicated to heat pump water heaters [9]. At the virtual conference, Amruta Khanolkar of the New Buildings Institute described 120v plug-in HPWHs, including an overview of market opportunities and technology readiness [10]. Case studies were presented on HPWHs for various regions of the country as well as for manufactured homes. Many case studies were also presented on commercial HPWHs (CHPWHs) for multifamily homes as well as restaurants. An HXSim case study at the 2022 HWF demonstrated that refrigerant charge reduction can be achieved without affecting heating capacity by reducing copper tube diameters from 9.52 mm to 5 mm in the evaporator coil [11].

The universal adoption of HPWHs presents a tremendous opportunity to reduce GHG emissions. Unfortunately, adoption of this energy efficient technology has been slowed by the low cost of natural gas as an energy source as well as the low installed cost of gas-fired water heaters and electrical resistance water heaters. Consequently, HPWHs for residential heating has been slow to catch on in the USA compared to Europe, for example. Equity is an important issue in the adoption of HPWHs. Field tests have been undertaken across the USA in different climate regions, including the South as well as colder climates in the Midwest and Northeast. The economics of HPWHs have been scrutinized by many research teams presenting at the 2022 HWF.

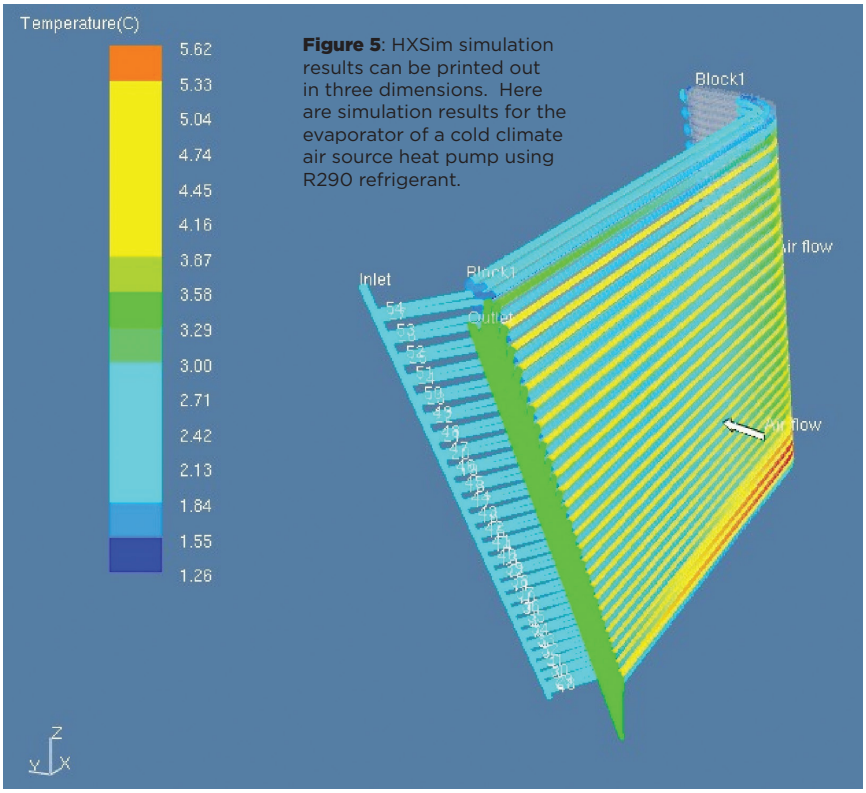



**Figure 5**: HXSim simulation results can be printed out in three dimensions. Here are simulation results for the evaporator of a cold climate air source heat pump using R290 refrigerant.

Commercial HPWHs for restaurants and affordable multifamily housing are of keen interest.

Despite lackluster sales, many OEMs exhibited HPWHs at recent trade shows. Notable were residential appliances from A.O. Smith, Gree, Rheem, Rinnai, Stiebel Eltron and others. Bradford White Water Heaters provides the AeroTherm® Series Heat Pump Water Heater as described in a video on its website [12].

### *4. Low GWP Refrigerants for Heat Pumps*

Heat pumps offer much higher energy efficiencies than natural gas or electrical resistance heating. The high coefficients of performance (COPs) of heat pumps are the driving force behind their adoption. The COP of a heat pump is the ratio of useful heating or cooling divided by the work input. That said, there is a one catch. Most of today's heat pumps contain HFCs or HFC-HFO blends. The advantages of high COP are offset by the high Global Warming Potential (GWP) of the HFCs. Refrigerant GWP has been discussed extensively at recent conferences, including IIR's TPTPR Conference [13] and the Purdue's Herrick Conferences [14-15].

The current generation of HFO-HFC blends are far from ideal. HFO-HFC blends suffer from thermal glide [16]. Furthermore, some HFOs break down into trifluoroacetic acid (TFA), which is harmful to life even in small concentrations [17]. TFA is a "forever chemical," which remains in the environment for a long time. While ultralow GWP HFOs may be friendly to the atmosphere, they may be harmful to the environment in other ways.

For these reasons and others, several industry leaders are advocating for the use of low-GWP ***natural refrigerants*** such as hydrocarbons (R290 and R600a) as well as carbon dioxide (R744) and ammonia (R717). While these have

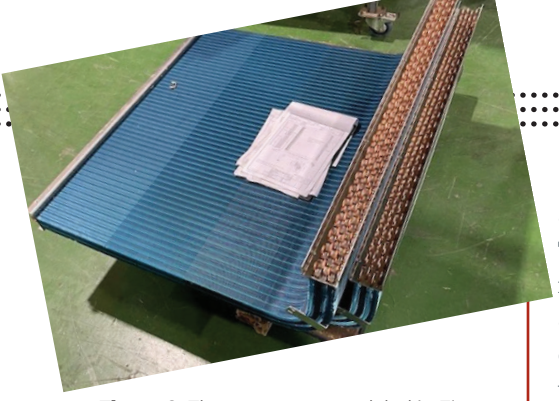


**Figure 6**: The evaporator modeled in Figure 5 was built and tested confirming the accuracy of the simulation. This L-shaped evaporator is made from 216 hairpin copper tubes with 5 mm outer diameter. There are four hairpin tubes in each of the 54 circuits.

mainly been used in refrigeration equipment, there is a growing push to use them in other applications.

In particular, dramatically higher charge limits have been approved by the the International Electrotechnical Commission (IEC) safety standard for propane (R290) and other flammable refrigerants in household air conditioners, heat pumps and dehumidifiers [18]. These increases are being put on the fast track, especially in the light of the urgency to install more heat pumps in Europe to alleviate dependence on fossil fuels.

Yoram Shabtay of HTT and Peter Mostovoy of Lordan described an ODU for an R290 Heat Pump Water Heater at the 2022 ATMOsphere America Summit [19]. While R290 is flammable, there is an option of placing components charged with R290 outdoors where charge limit conditions could be relaxed. This approach opens up new possibilities for developing heat pumps with low-GWP natural refrigerants. In this case, the 14 kW evaporator is made with 5 mm diameter copper tubes. Heat exchanger designs were simulated using HXSim software (Fig. 5) and performance was verified on the actual units (Fig. 6).

### *5. Cold Climate Air Source Heat Pumps (CC-ASHPs)*

The R290 heat pump application described in the last section also happens to be suitable for operation in cold climates. Most major AC manufacturers now boast cold-climate air source heat pumps (CC-ASHPs). These heat pumps have features that make them attractive and practical even at higher latitudes. High COPs in cold climates could spur the adoption of heat pumps for space heating as energy costs increase (Fig. 7).

The Northeast Energy Efficiency Partnership (NEEP) is one of six Regional Energy Efficiency Organizations (REEOs) funded in part by the US Department of Energy to support state efficiency policies and programs. NEEP maintains a product listing of CC-ASHPs [20].

Consider that the ODU of a CC-ASHP is an evaporator. As the refrigerant expands, it reaches temperatures even colder than the outdoor temperatures, since heat must be transferred from the environment to the refrigerant. According to Leomon Technologies, CC-ASHPs may have COPs of 3.8 around 8.3 °C (47 °F) but COPs drop to 2.3 around minus 8.3 °C (17 °F) [21].

If the outside temperature drops too low, backup resistance heating may be required. Some CC-ASHPs are reported can operate below zero, i.e., at outdoor temperatures < 0 °F (< minus 18 °C), according to ***Consumer Reports*** [22]. A CC-ASHP with a COP greater than one presumably would be ***more efficient*** than a boiler or electric resistance heaters even on the coldest nights of the heating season.

It is desirable for CC-ASHPs to incorporate a defrost cycle. Consequently, optimal operating cycles are under investigation. The idea is to briefly reverse the flow of the refrigerant to melt any ice buildup on the fins and tubes of the heat exchanger. The Copper Development Association sponsored research on this topic by Optimized Thermal Systems [23].

Remarkably, CC-ASHPs using low-GWP refrigerants are already under development as mentioned in the previous section [19].



**Figure 7**: Even at temperatures below freezing, today's cold climate air source heat pumps (CC-ASHPs) deliver heating more efficiently than either burning fossil fuels or electrical resistance heating.

## Toward the Future

The magic of the VCC revolutionized our modern world. It ushered in the age of air conditioning, leading to major demographic changes and creating whole industries dedicated to comfort. Simultaneously, refrigeration led to the creation of a global cold chain, crossing national boundaries ''from farm to fork'' in ways never possible before.

Yet the story of the VCC has not yet been fully written. The use of heat pumps for heating has barely begun, mainly because there has been no need. If necessity is the mother of invention, then innovations in heat pump designs can be assured in the next few years.

Many agree that rebates and tax incentives will be required to stimulate broad adoption of heat pumps on the scale necessary to meet energy conservation goals. The recently passed ''Inflation Reduction Act of 2022'' includes numerous incentives for heat pumps and other energy saving products. Details can be found in the final bill as well as numerous online reports [24].

The stakes couldn't be higher. ●




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**References:**


**1.** _____, "Geothermal energy from abandoned coal mines," The Coal Authority, Nottinghamshire, United Kingdom.
https://www2.groundstability.com/geothermal-energy-from-abandoned-coal-mines/

**2.** Rebecca Morelle, "Could super-sized heat pumps make gas boilers extinct?" ***BBC News***, 18 March 2022.
https://www.bbc.com/news/science-environment-60772187

**3.** ICA Partners with SJYU to Offer Powerful Heat Exchanger Simulation and Design Software.
See www.microgroove.net/HXSim for instructions on downloading the simulation software and user guide.

**4.** Yoram Shabtay and Kerry Song, "Heat-Exchanger Simulations Fast-Track Adoption of MicroGroove Copper Tubes," ***Appliance & HVAC Report***, September 2020, Page 14.
https://www.appliancehvacreport.com/magazines/2020_v2i4/#page/14

**5.** _____, "Real Insights in the Age of Simulations: Accuracy of Modeling of Heat Exchangers is Uncanny," ***MicroGroove Update***, Volume 11, Issue 2.
https://microgroove.net/microgroove-update-newsletter

**6.** _____, Residential systems in China using ATW and ATA heat pumps, the International Copper Association, China Office. Translated from Chinese. Download from MicroGroove Technical Literature Webpage.
https://microgroove.net/technical-literature

**7.** _____, "Air Source Heat Pump and Underfloor Heating," China Heat Pump blog, (Leomon Technology: Cihu Technical Area, Maanshan. China). Website showcases Chinese heat pump products "
https://www.chinaheatpumps.com/About-us.html

**8.** "Appliance and Equipment Standards Rulemakings and Notices: Consumer Water Heaters"
https://www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=32

**9.** The 2022 ACEEE Hot Water Forum (virtual conference). Program and slide decks available online. https://www.aceee.org/2022-hot-water-forum-virtual

**10.** Amruta Khanolkar, "Retrofit Ready Game Changing Technology: 120V HPWHs," 2022 ACEEE Hot Water Forum. 2022 ACEEE Hot Water Forum.
https://drive.google.com/file/d/1xIyqsbHlTvoGYVO5WPrQicc0N4NmcS2q/view

**11.** Yoram Shabtay, "Simulations Demonstrate the Advantages of Smaller Diameter Copper Tubes in ,https://drive.google.com/file/d/149nkK_p5fhCNbJvMLbxkztdV7cLu9vZb/view

**12.** _____, "The AeroTherm® Series Heat Pump Water Heater," Bradford White Water Heaters. (See Video)
https://www.bradfordwhite.com/aerotherm/

**13.** 6th IIR Conference on Thermophysical Properties and Transfer Processes of Refrigerants, Online Conference, September 2021.
https://iifiir.org/en/events/6th-iir-conference-on-thermophysical-properties-and-transfer-processes-of-refrigerants

**14.** Proceedings of the 202One Purdue Herrick Conferences online.
https://docs.lib.purdue.edu/iracc/

**15.** 2022 Purdue Herrick Conferences, Program Online.
https://engineering.purdue.edu/Herrick/about/news/Conferences/2022

**16.** Michael Petersen, Steve Kujak, "Review of Lower GWP Refrigerants For Retrofitting R-410A Applications," 2022 Purdue Herrick Conferences.
https://www.conftool.com/Herrick2022/index.php?page=browseSessions&form_session=25

**[17].** Michael Garry, "ATMO America: Scientist Urges U.S. EPA to Broaden Definition of PFAS to Include F-Gases, TFA," June 20, 2022.
https://r744.com/atmo-america-scientist-urges-u-s-epa-to-broaden-definition-of-pfas-to-include-f-gases-tfa/

**18.** Michael Garry, "Higher Hydrocarbon Charges Unanimously Approved in IEC Standard for Home ACs and Heat Pumps," Hydrocarbons.com, News Item, May 2, 2022.
https://hydrocarbons21.com/higher-hydrocarbon-charges-unanimously-approved-in-iec-standard-for-home-acs-and-heat-pumps/

**19.** Yoram Shabtay and Peter Mostovoy, "A Cold Climate R290 Heat Pump Water Heater Case Study," 2022 ATMOSphere America.
Slideshow: https://atmo.org/announcement/atmo-america-2022-hvac-heat-pumps/
Video: https://www.youtube.com/watch?v=Oa-v9TdtuiU&t=22s

**20.** _____, "NEEP's Cold Climate Air Source Heat Pump List," Northeast Energy Efficiencies Partnerships, Boston, Mass. https://ashp.neep.org/#!/product_list/.

**21.** _____, "Do Air Source Heat Pumps Work in Cold Weather?" China Heat Pump blog, (Leomon Technology: Cihu Technical Area, Maanshan, China).
https://www.chinaheatpumps.com/Do-Air-Source-Heat-Pumps-Work-in-Cold-Weather.html

**22.** Liam McCabe , ***Consumer Reports***, "Can Heat Pumps Actually Work in Cold Climates?," August 2, 2022.
https://www.consumerreports.org/heat-pumps/can-heat-pumps-actually-work-in-cold-climates-a4929629430/

**[23].** Dennis Nasuta, Song Li and Regina Hong, "3 mm to 5 mm Microgroove Heat Exchangers in Frost-Developing Conditions," Copper Development Association Webinar with Optimized Thermal Systems, December 7, 2021.
ICA-OTS Landing Page: https://microgroove.net/ots-ica-educational-outreach
YouTube: https://www.youtube.com/watch?v=WPL4YqLOjOk

**[24]** "Inflation Reduction Act of 2022," Wikipedia, Wikimedia Foundation, 15 August 2022,
https://en.wikipedia.org/wiki/Inflation_Reduction_Act_of_2022

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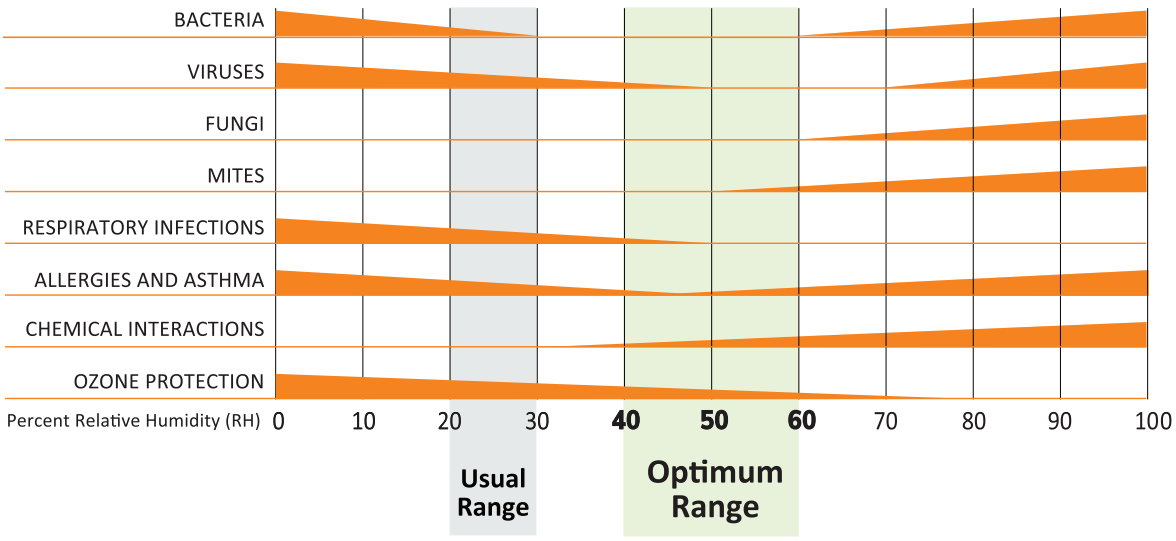



**Figure 1**: A key study done in 1986 showed that the indoor relative humidity (RH) level, or the amount of water vapor present in air, should be kept between 40 and 60% RH to reduce the transmission of viruses. Many studies have been done since that also support this guidance.

# Humidification For High Percentage Outdoor Air

**BY CHRIS HABETS, P.ENG, CEA, LEED AP BD+C**

## High Outdoor Air Systems (HOAS)

Many building operators and managers are optimizing their HVAC systems to significantly increase outdoor air intake for healthier indoor air quality. In fact, many jurisdictions are mandating 100% outside air as a result of the recent COVID-19 pandemic.

Taking in more outdoor air reduces the spread of illness and increases occupant comfort, but it is important to keep in mind that it also affects building systems.

When the HVAC system of a building is adjusted to bring in more outdoor air, the requirements change, so humidification strategies should be reviewed and realigned for optimization of indoor air quality and energy efficiency. This is especially true with indoor relative humidity playing a significant role in supporting human health, productivity and process.

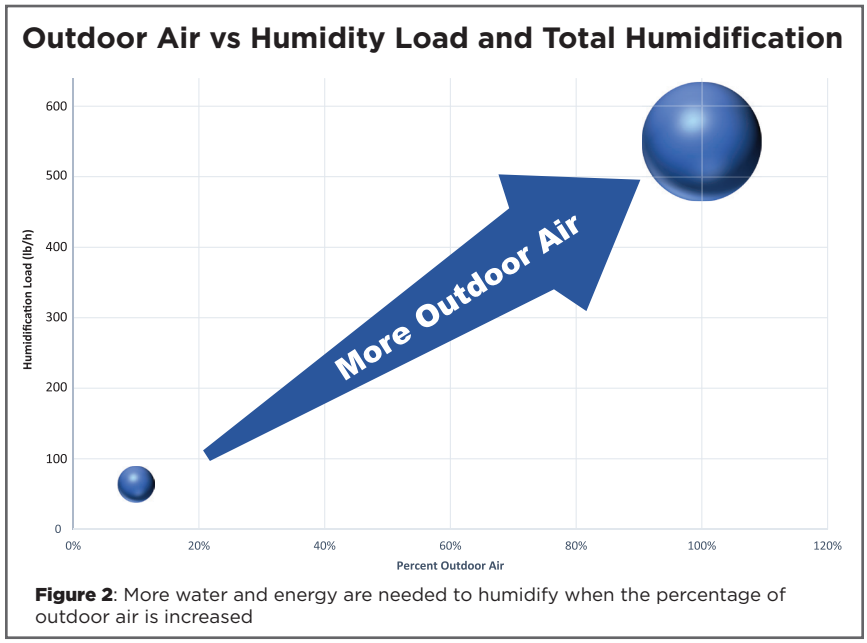



**Figure 2**: More water and energy are needed to humidify when the percentage of outdoor air is increased

### More Outdoor Air Requires More Humidification

Humidification loads are primarily driven by the amount of outdoor air being brought into a building. In general, more outdoor air means an increased need for humidification.

Now, with buildings bringing in an even higher percentage of outdoor air, there will be even larger humidification loads, particularly in the cold winter months. To maintain a 40% relative humidity level for occupant health and comfort, more water will need to be added to the air of a building than before.

**"To maintain a 40% relative humidity level for occupant health and comfort, more water will need to be added to the air of a building than before."**

For example, a building that normally runs on 10% outside air that switches to 100% outside air would need humidifiers that are almost ten times larger in order to add up to ten times as much moisture over the entire year. Simply opening a window will not work to increase indoor humidity levels during the heating season in most regions.

It is crucial to have the correct humidification system in place to handle this increase in load for any building that is using high outdoor air percentages. Below are some factors to take into consideration when adding to the humidification capacity of a building.

### Compare The Two Main Methods of Humidification Humidifiers

#### *Adiabatic Himidifiers*

Many buildings use adiabatic, or evaporative, systems to add humidity to the building. When there is excess heat in the air these humidifiers can be very energy efficient because there is no need to add energy to the system; they use the heat in the air to evaporate water into the building air management system.







However, in high percentage outdoor air systems, the air at the humidifier must be warm enough to evaporate all the water needed. In cold climates, the humidification load increases significantly due to the 100% outside air requirement and the system must preheat the additional incoming air, potentially to 104 °F or above.

Most existing building heating systems are not designed to do this, especially when those systems were originally designed for lower outdoor air requirements. This could mean adding both heating capacity and additional adiabatic humidification capacity to meet the increased humidification need.

**"An existing adiabatic humidifier, while well suited to hot arid climates or for systems with the option of a lot of air recirculation, may not be the most energy efficient option in most climates."**

An existing adiabatic humidifier, while well suited to hot arid climates or for systems with the option of a lot of air recirculation, may not be the most energy efficient option in most climates. It may not even be a feasible solution for a high percentage outdoor air system in a cold climate. Another challenge for adiabatic humidifiers is the non-uniformity of temperatures across an air handling unit with a large heating requirement, meaning that evaporation will not be evenly distributed in the incoming air, making wetting downstream possible.

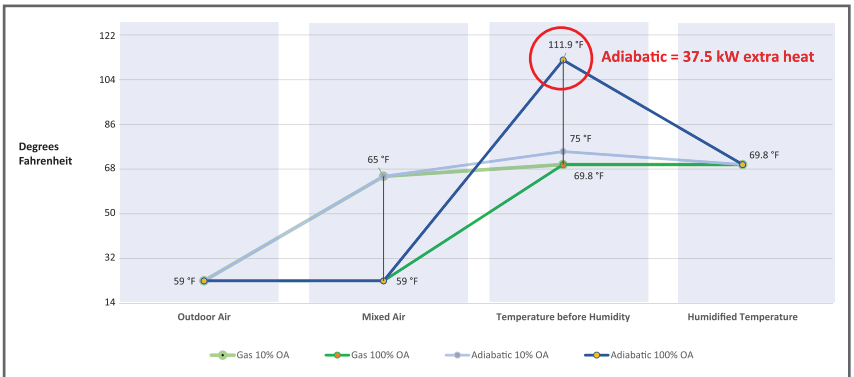



**Figure 3**: Comparing temperatures required in duct for different humidification systems at 5,886 cfm/hr

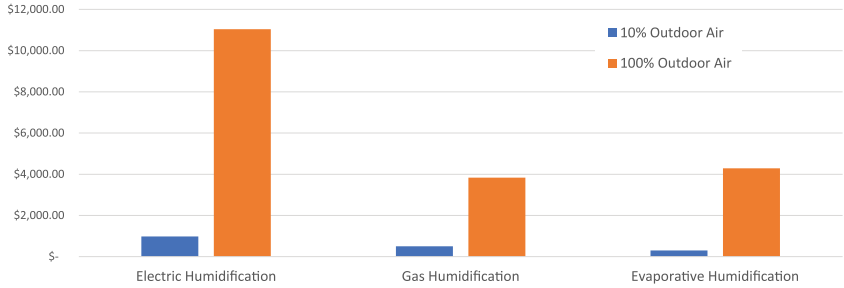



**Figure 4**: Comparing costs of humidification types by outdoor air requirements at 5,886 cfm/hr for one year

***Isothermal Humidifiers***

The most common way to humidify a building is to add steam to the air from an isothermal humidifier, more commonly known as a steam humidifier. Isothermal humidifiers work by boiling water inside the humidifier tank and distributing it into the ductwork through a steam manifold or directly into the space.

**"For larger humidification systems, natural gas (or propane) is almost always more economical than electricity."**

Of course, isothermal humidifiers add energy to the system, but in HOAS, adiabatic humidifiers would need energy added to the air as well. Which is more efficient and effective? And what fuel should be used to boil the water?

On the question of fuel, electricity and natural gas are the most common options. For larger humidification systems, natural gas (or propane) is almost always more economical than electricity due to the significantly lower cost of natural gas, which is roughly one third the cost of electricity. "Larger humidification systems" mean a system with a capacity of 44 kg per hour or higher in most situations.

Some gas humidifiers, such as the DriSteem GTS® humidifier LX series, operate at greater than 90% efficiency, meaning it uses nearly every Joule of energy available in the gas. For comparison, an adiabatic humidifier will draw energy from the air, which is often heated by a natural gas boiler with system efficiencies between 70% and 85%.

The GTS LX series humidifies the air in a high percentage outdoor air system using less natural gas than the pre-heating source needed for an adiabatic system. Additionally, the building's existing heating system would not need to be upgraded to meet the increased pre-heat demands of an adiabatic system.

Installing a new gas humidifier like the GTS LX is likely less expensive than installing more capacity to a building's heating system and adding adiabatic humidification.

The GTS LX humidifier also allows for polypropylene (PP) or polyvinyl chloride (PVC) venting to make installation even easier for up front savings and continued energy savings.

Adding more outside air also increases water consumption and extends operating hours, which in turn increase maintenance requirements. Comparatively, the GTS LX humidifier requires less costly maintenance than an adiabatic system. In addition, gas humidifiers offer indirect savings by reducing water usage as well as the wastewater costs associated with higher demand/increased capacity.

Utilizing a gas-fired steam humidification system like the GTS LX instead of an adiabatic system has numerous additional benefits. Gas humidifiers reduce peak load energy concerns and associated costs so the boiler system size can be maintained or reduced even as the percent of outside air used increases. Gas systems are able to provide humidification instantly to maintain the required setpoint, while wetted media type adiabatic systems require hygienic drying cycles where humidification may be temporarily unavailable. Adiabatic systems also may be slow to come back on line or unable



**Figure 5**: DriSteem gas-fired humidifier

**"Where an adiabatic wetted media system may struggle to maintain precise humidity control in a high percentage outdoor air system, the GTS LX humidifier reacts quickly to changes in demand."**

to maintain the required setpoint.

Where an adiabatic wetted media system may struggle to maintain precise humidity control in a high percentage outdoor air system, the GTS LX humidifier reacts quickly to changes in demand, and can produce as low as 5% of its rated capacity, meaning it will always maintain the required humidity even with quick weather changes. The GTS LX humidifier does this with ultra-low NOx emissions, making it the most environmentally friendly option. To maximize energy savings, ensure that high-efficiency insulated tubes are used to distribute the steam – saving up to 85% of the condensate production.

### Humidification Review

If a building currently does not have a humidification system, it is time to add one to avoid dry indoor conditions due to increasing percentages of cold outside air being incorporated into the air management system. If a humidification system exists, a review will be needed to ensure it is properly sized, operating correctly, and energy efficient for the building.

In most climates, utilizing a gas-fired steam humidification system will deliver the most economical and precise means of maintaining a healthy indoor relative humidity range of 40-60%. Look into a high-efficiency gas fired humidifier (such as the DriSteem GTS® humidifier LX series) in your HOAS system for lower upfront and operational costs.

Reviewing the capabilities and performance of your humidification system when outside air percentages change is critical. Your indoor air quality and the health of building occupants depends on it. Reach out to your local DriSteem representative today for a review.



***Chris Habets*** *has a passion for helping people and the environment, Chris started Good Habets as a way to aid local businesses to cut down on their utility bills, save energy, and save money while using his engineering expertise.*

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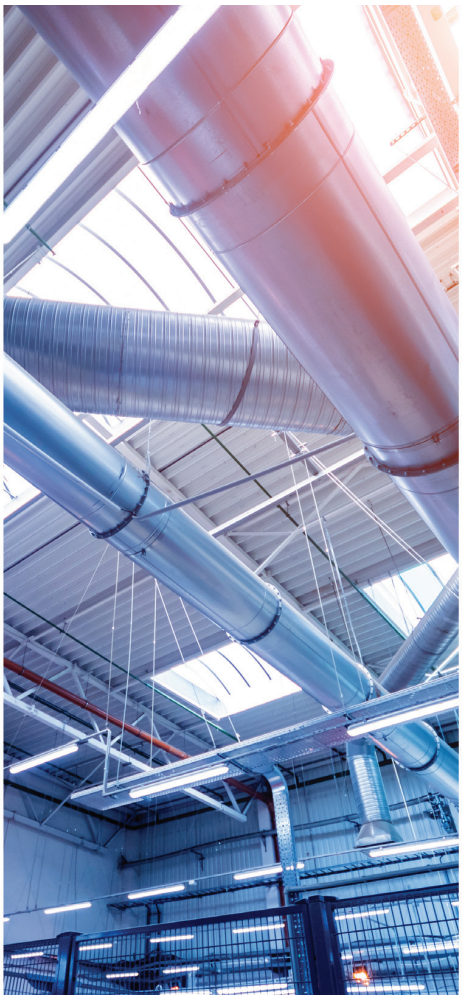

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## A Look into Today's Trends and Opportunities for HVAC

**BY TE CONNECTIVITY**

Diving into 2022 and beyond, government and industry leaders are focused on identifying ways to address energy and clean air issues in the face of major environmental, healthy living and consumer trends that drive how we all live and operate. One area of focus: HVAC.

HVAC systems provide heat, ventilation, and air conditioning for both residential and commercial buildings. These systems filter and clean indoor air to keep people healthy, comfortable and maintain optimal humidity levels. With a focus on energy-efficient and clean air advancements, HVAC capabilities are effectively attempting to address climate change and decarbonization concerns while also delivering the kinds of safe, healthy, and comfortable-living solutions required from a growing and increasingly urbanized population.

We at TE Connectivity (TE), a world leader in connectivity and sensor technology, have taken a closer look at the HVAC market and are sharing our insights to help manufacturers capitalize on the opportunity for innovation and market share gain. Engineers need to be aware of the myriad of global issues and trends driving HVAC systems growth, and the design and technology challenges that must be considered.

### Market Shifts and Trends

We are all living amidst unprecedented change, resulting from a cross-current of environmental and

**Residential**
Houses, small stores and restaurants

**Commercial**
Office buildings, hotels, shopping malls, warehouses and medical establishments

*Energy-efficient system advancements are fueling the significant growth of the global HVAC market. With recorded sales of approximately $241 billion in 2020, HVAC is projected to reach more than $300 billion by 2026.* [1]

public health issues that are impacting our world and heightened focus on healthy, energy-efficient solutions. As the adoption of energy-efficient systems that reduce costs and power wastage becomes more prominent around the world, here's a closer look at the underlying changes that are driving HVAC growth now and will continue to do so, into the foreseeable future.

## Net Zero and Decarbonization

The march to net zero is an unavoidable reality in the continuing fight against climate change and presents a direct challenge to the buildings and construction sectors. A 2019 report from the International Energy Agency (IEA) indicated that these two sectors combined were responsible for more than 30% of global energy consumption and nearly 40% of carbon emissions.

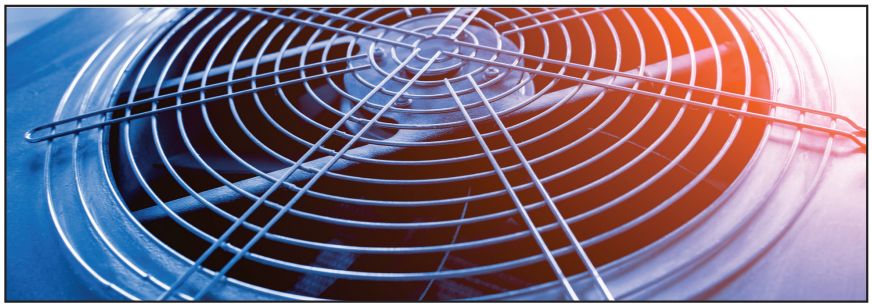
In 2015, the Paris Agreement was signed by 196 countries to limit global warming and reduce greenhouse gas emissions in order to achieve a climate neutral world by mid-century. This has helped to usher in new government policies and grants to improve energy-efficiency and support clean energy innovations. Paving the way for investments in HVAC technologies around the world.

• In the ***Asia Pacific*** region, Australia has instituted minimum energy performance standards while the Indian Bureau of Energy Efficiency and Labelling Standards is looking for manufacturers to actively adopt more advanced cooling technologies. The Chinese government is promoting the efficient use of energy, establishing minimum allowable values for energy efficiency and related grades for room air conditioners. The new standard, GB 21455-2019, is not only the strictest standard introduced to date in the Chinese market but is considered among the most stringent on an international basis, as well 2.

• In ***Europe***, countries across the continent are initiating net zero strategies based on policies recommended by the International Energy Agency. For example, the United Kingdom (UK) and France have massive regulatory frameworks in place and binding targets for the building sector. In the UK, achieving net zero includes a plan to install 600,000 heat pumps per year by 2028. 3 Not only has this expanded UK manufacturing but the government is investing an additional £60 million into heat pump innovation. In addition, low-carbon heating systems will be required in all new homes built after 2025, replacing gas boilers 4.

• In ***North America***, the U.S. and Canadian governments are issuing grants and making investments in energy-efficient technology. In addition, local government incentives and personal tax credits in the U.S., are encouraging energy-saving home improvements to help offset costs. Policy changes are also going into effect. Minimum Energy Performance Standards (MEPS) will be required for residential central air conditioners and heat pumps. Products installed as part of a home's central heating and cooling system and manufactured after January 1, 2023 will need to meet minimum Seasonal Energy Efficiency Ratios (SEER) and Heating Seasonal Performance Factors (HSPF) 5.

Beyond government programs and



regulatory pressures to construct net zero buildings, the private sector – whether in response to consumer demands or shareholder activism – has also embraced the need for net zero commitments. Companies are pledging net zero emission targets and taking a harder look at their overall operations, including the energy efficiency of the buildings in which they work. Together, these forces are steering construction companies to look towards HVAC companies for energy-efficient or low CO2 emitting systems that meet net zero thresholds.

### Covid-19

Since its emergence in 2020, the Covid-19 pandemic has changed the way in which the world operates. Among the fragilities it has exposed is the direct correlation between HVAC systems and the spread of germs, dramatically changing the landscape for indoor environment control.

Reports have claimed that HVAC systems are a probable point of contact to spread the virus by recirculating contaminated air. This has led to a heightened increase in the inspection, testing, surface and air sampling, cleaning, and disinfecting of HVAC air conveyance systems and associated ductwork.

Increased awareness on indoor air quality has also led to new standards that require better air filtering and ventilation, as well as air quality monitoring. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) has set new guidelines for filtration rates to maintain good indoor air quality, while the Federation of European Heating, Ventilation and Air Conditioning Associations (REHVA) has put forth recommendations on how to make HVAC units safer.

### Infrastructure Needs, Population Growth and Changing Lifestyles

In addition to being driven by net zero goals and Covid-19, demand for HVAC systems is increasing due to infrastructure needs that support residential and commercial growth and changing personal lifestyle preferences.

• In the emerging Asia Pacific and Middle East regions, commercial construction projects that require infrastructure commitments are the major drivers for the global commercial HVAC market – particularly in developing countries such as China and India. On the residential development front, a growing population is also leading to new HVAC installations across the region, with high demand for energy-efficient air conditioners that can offset hot and extreme weather conditions.

• Conversely, in both Europe and North America, HVAC growth is mainly being driven by the maintenance and replacement of services. However, in places like the U.S, a rising average of construction spending, rapid urbanization, growth in disposable income, and an increased focus on smart homes have all accelerated the installation of HVAC systems.

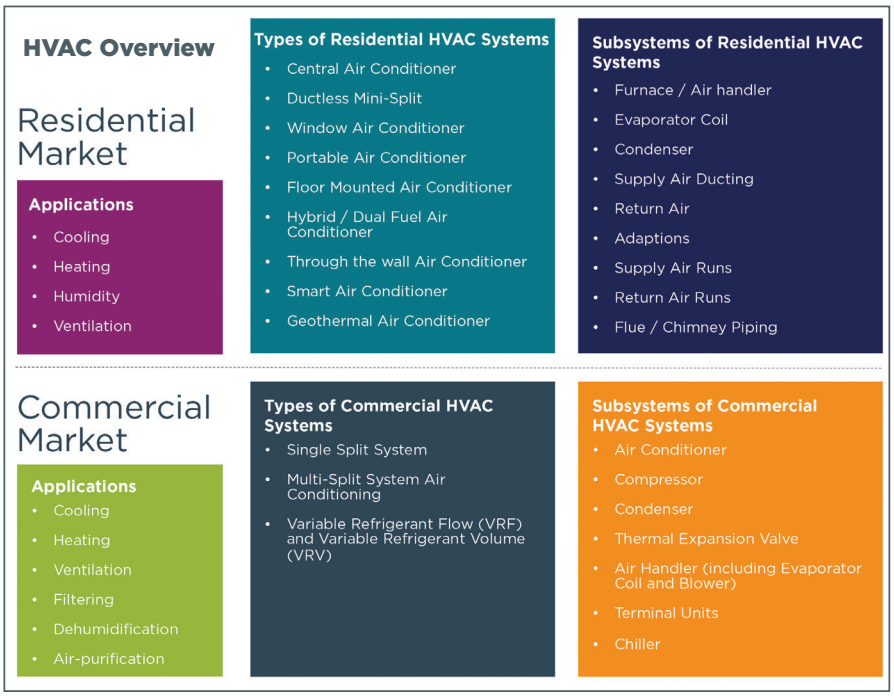
### HVAC Market: A Look at Global Growth Projections

The global HVAC market comprised both the residential and commercials sectors. Estimated to reach $270 billion in sales between 2025-2030, it has a projected CAGR of 5.3% over the next 4-9 years.

Much of this growth has been led by the ***residential*** segment, which accounted for more than 40% of sales in 2021. However, the ***commercial*** HVAC market is poised for growth, estimated to reach ***$29.4 billion by 2026*** and reflecting a 6% CAGR between 2020-2026. By geography:

• The ***Asia Pacific*** HVAC market is projected to reach a value of ***$70.7 billion by 2024***. China is expected to be the largest market, as it was the largest contributor to the HVAC market in 2021 with a more than 45% revenue share owing to the rise in population, urbanization and surge in consumers' disposable income.

• The ***European*** HVAC market is



expected to reach ***$78 billion by 2025***. This is significant growth even with a lack of uniformity in demand from countries across the continent, a dependence on fiscal stimulus, the containment of Covid-19 spread, and the recovery of the construction industry.

• ***North America's*** HVAC market was valued at $32 billion in sales in 2020 and is expected to reach ***$43.2 billion by 2026***. This reflects a CAGR of 4.7% over the 2021-2026 period.

## Design Challenges

With the HVAC industry primed for both residential and commercial growth, HVAC designers are being tasked to create highly energy-efficient systems. Designs are also impacted by a number of considerations and challenges.

• ***Harsh environments:*** HVAC systems need designs to withstand harsh conditions in both hot and cold climates by taking into account dust and debris limiting condensation and humidity and reducing corrosion. For example, water ingress causes deterioration of exterior wall assemblies, requiring HVAC designs to accommodate more airtight and insulated wall and window assemblies. Limited floor space, a large glazing area and ceiling height, and opaque window coverings that offer privacy but reduce the amount of interior heat, are factors that must be considered in addressing condensation concerns. In addition, HVAC systems need to control indoor humidity in both heating and cooling mode to prevent moisture that causes damage to building materials and components

• ***Maintenance:*** Ongoing maintenance is a critical component for the effective use and long-term value of HVAC systems in both residential and particularly, commercial settings. As a result, designers must build systems that offer relative ease in maintenance, repair, as well as retrofitting

• ***HVAC upgrades:*** Designers need to pay close attention to controlled ventilation, dehumidification, and filtration within their HVAC designs as these are key areas where facility managers are focusing on upgrades. ASHRAE and REHVA guidelines have given rise to HVAC upgrades that include:

– Replacing fixed-speed with variable-speed fan motors to enhance the control of airflow and allow for a minimum setting that produces lower speed airflow

– Introducing sophisticated airflow-control systems, such as those that are sensitive to pressure, in allowing for smoother adjustment of airflows

– Installing high-performance air-purification systems to reduce dirty indoor air, which can be rife with recirculating allergens, bacteria, and viruses

• ***Smart home compatibility:*** A well-designed IoT-enabled HVAC system must allow for seamless data accumulation, filtering, and sharing in smart home applications. Along with these analytics, the systems should be enabled with preventive maintenance and continuous optimization. Connected HVAC platforms should also provide users with direct access to power consumption and CO2 emissions stats

• ***Seamless technologies/ data reliability:*** System designs require interoperability and inter-usability among its various parts to maximize functionalities and overall system efficiencies, as and ease the integration of component parts into a larger system. Data reliability is also key to the HVAC unit in producing better operational results. Data provided by air quality sensors not only can unlock the combined benefits of greater efficiency and better indoor air quality through HVAC optimizations, but also can help earn building certifications and boost occupant wellness. In addition, product concepts for connected HVAC systems should consider data reliability in preventing and dealing with lost messages. If expected data packets fail to arrive, the design should assume conservative default values, so that people and technology are protected from damage, and there is no loss of comfort to the user

• ***Ventilation to minimize pollutants/Covid-19:*** HVAC systems must work with other air quality and purification systems to provide effective ventilation and minimize the spread of viruses, such as Covid-19, and other sources of indoor pollution. Epidemiologic evidence has put pressure on HVAC designers to maintain Indoor Air Quality (IAQ) as science has demonstrated a clear association between exposure to damp indoor environments and adverse health effects. Prolonged damp conditions can lead to growth of molds, bacteria, and insect pests in HVAC systems – an issue that must be eliminated to avoid "sick building syndrome"

• ***Cost-Savings:*** Apart from these listed challenges, HVAC equipment manufacturers and design engineers must adhere to regulatory standards and energy-efficiency labels while keeping costs in-check. The value-add that any advanced feature provides should offset all other associated costs

## Testing Capabilities

Testing is also an important component of any system design. For HVAC, there are three primary testing areas to be considered:

• ***Environment tests:*** HVAC systems must be able to withstand thermal shock and condensation and humidity, as well as reduce corrosion. Issues to evaluate include temperature

cycling; salt spray; mixed-flow gas; dust/ waterproofing; glow wire testing (GWT), hot-wire ignition (HWI) and needle flame testing; as well as Highly Accelerated Life Test (HALT) and Highly Accelerated Stress Screen (HASS) testing

- ***Electrical tests:*** The impact of high current and temperature rise in HVAC poses challenges to components. Testing should evaluate low level contact resistance; dielectric withstanding voltage; current carrying capacity; temperature rise; and electromagnetic compatibility (EMC)
- ***Mechanical tests:*** Long-term, high-intensity operations in harsh environments place high demands on durability within HVAC systems. Testing should evaluate sinusoidal/ random vibrations with temperature and humidity; and normal force and low-level contact resistance (LLCR)




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**Sources**

**I.** 1 Expert Market Research, 2020: https://www.expertmarketresearch.com/reports/hvac-market

**II.** 2 Minimum allowable values of the energy efficiency and energy efficiency grades for room air conditioners– Policies – IEA, 2020: https://www.iea.org/policies/11661-minimum-allowable-values-of-the-energy-efficiency-anden-ergy-efficiency-grades-for-room-air conditioners?country=People%27s%20Republic%20Of%20China

**III.** 3 Decarbonizing heat in homes - Business, Energy, and Industrial Strategy Committee (parliament.uk), 2021: https://publications.parliament.uk/pa/cm5802/cmselect/cmbeis/1038/report.html

**IV.** 4 Gas boilers replacement by low-carbon heating systems – Policies - IEA: Gas boilers in the UK will be replaced by low-carbon heating systems in all new homes built after 2025, 2020: https://www.iea.org/policies/8506-gasboilers-replacement-by-low-carbon-heating-systems?region=Europe

**V.** 5 U.S. Energy Information Administration (EIA): According to the U.S. Energy Information Administration (EIA), starting 2023, new residential central air conditioning and air-source heat pump systems must meet new minimum energy-efficiency standards. The new HVAC standards will require a seasonal energy-efficiency ratio (SEER) of no less than 14 SEER for residential systems in the northern part of the country and 15 SEER in the southern portion, according to the EIA. For air source heat pumps, which use a heating seasonal performance factor (HSPF) rating, the EIA raised the minimum to 8.8 HSPF, 2019: https://www.eia.gov/todayinenergy/detail.php?id=40232

**VI.** 5 Updated MEPS - Central Air Conditioners and Heat Pumps – Policies – IEA, 2020: https://www.iea.org/ policies/11456-updated-meps-central-air-conditioners-and-heat-pumps?country=United%20States

**VII.** 6 International Energy Agency, 2021: https://iea.blob.core.windows.net/assets/4719e321-6d3d-41a2-bd6b461ad-2f850a8/NetZeroby2050-ARoadmapfor-theGlobalEnergySector.pdf

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# What's Happening



After working at **Vitamix** for nearly three decades, CEO **Jodi Berg** announced late last month her plans to retire this fall.

"The timing is right for Vitamix and for me personally," Berg said in a press release. "The company is in a very strong financial position and poised for its next century of strategic growth.

"It's been my privilege and honor to serve this company and the people dear to me for almost 30 years. I'm proud of all we have accomplished together."

To assist with the transition, Berg will move into the role of executive adviser. **Vitamix Chief Commercial Officer Steve Laserson** has been named as her successor.

The first CEO from outside the company's founding family, Laserson, who joined Vitamix in April 2020, will be responsible for the company's strategy and operations.



Environmental health technology company **CASPR Group** is pleased to announce **Jon Zucker** as its President. Zucker joined CASPR in late 2021.

Zucker's goal is to guide CASPR Group into a scalable, sustainable company as it manages increased demand for its proprietary Natural Catalytic Conversion (NCC™) technology. The company's solutions provide healthier indoor air and surface environments across industries including healthcare, education, transportation, and commercial real estate.

"Throughout my time interacting with Jon through the YPO organization, I've seen how his vision is always ahead of the curve and five steps beyond where the market is currently," said CTO and CASPR inventor Dr. Christophe Suchy. "CASPR's next stage of growth potential becomes exponential when we bring Jon's experience to the company leadership team."



**Nordson Corporation** publicly celebrated its sponsorship of the new **Nordson Innovation Lab** in the **ViaSat Engineering Pavilion, California State University at San Marcos** (CSUSM), during a ribbon-cutting ceremony on 11 March 2022. The CSUSM campus is located near Nordson Electronics Solutions facilities, where equipment used in electronics manufacturing is designed and built.

CSUSM's focus on student success and social mobility for first-generation college students and a diverse student population is closely aligned with the goals of the Nordson Corporation Foundation, the philanthropic arm of the company. Nordson donated $100,000 in 2019 to help fund the renovation of an existing building.



**FluidForming** hydroforming is a different process that uses an entirely new technology. **FluidForming FormBalancer** metal forming machines use water — recycled tapwater, in fact — as the forming force instead of oils and hydraulic fluids. Plus, nested tooling capabilities further minimize material waste. And finally, the 99.99% accuracy and repeatability rates that the FluidForming process can achieve virtually eliminate scrap from non-conforming parts.

FluidForming's cold forming metalworking technology is inherently green. Our precise and repeatable Six Sigma process (99.996% first-pass yield rate) minimizes waste while improving appliance fit, finish, and durability.



**Master Bond EP35AOLV** is a two part heat cured epoxy system, designed for bonding, sealing, coating and potting applications. It is a thermally conductive, electrically insulating compound that withstands aggressive chemicals, such as those found in downhole oil and gas processing. EP35AOLV exhibits superior protection against corrosion in various harsh environments and helps prolong longevity of critical equipment. With a service range that extends from -60°F to 500°F (52°C to 260°C) and a glass transition temperature of around 165-170°C, it is resistant to high temperatures.

The ideal cure schedule is 2 to 3 hours at 300°F, followed by 3 to 4 hours at 300-350°F. EP35AOLV has a forgiving 100 to 50 mix ratio by weight, and is flowable, with a mixed viscosity of 50,000-90,000 cps. It adheres well to a wide variety of substrates.



HVAC/R equipment manufacturers can now save time and resources, and benefit from strong application expertise, when specifying products from **Harris Products Group**. The long-time manufacturer has added **fabricated tubular products** including copper and aluminum headers, distributor assemblies and other complex brazed assemblies to its existing line of brazing alloys, torches and gas control components.

"Single source buying is an important advantage for many of our customers," said Kyle Smith, Director of Global OEM for Harris. "With our wider product portfolio, we're now able to support the entire coil. OEM customers will have one partner to turn to for application expertise, to develop solutions, to drive those higher first pass yields."

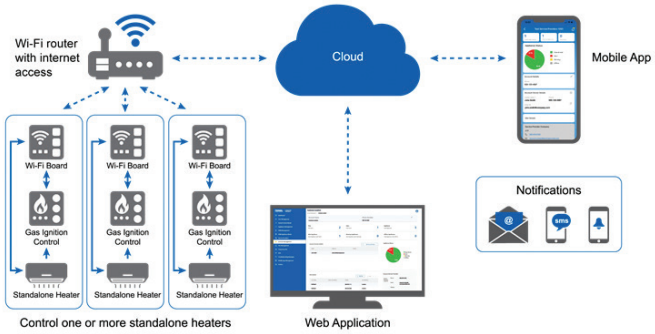
Harris is the only manufacturer who can offer the fabricated products as well as the alloys and equipment used for HVAC/R coil systems, Smith said. The expanded product line is the result of parent company Lincoln Electric recently acquiring Fabricated Tube Products (FTP) and Shoals Tubular, Inc.



**Littelfuse, Inc.** announced the new **EV1K Series Fuses**, the first Automotive Grade fuse with a rating of 1000 Vdc. They are designed and tested to meet the overcurrent circuit protection needs of the eMoblilty market, specifically Electric Vehicle (EV) applications.

The EV1K provides overcurrent protection in EV high-voltage power supply applications, including:

- On-board chargers (OBCs)
- Battery distribution units (BDUs)
- Battery packs
- DC/DC converter
- Traction motor inverter
- Auxiliary loads




**Fenwal Controls** introduced the **ConnectedControls IoT platform**, a wireless control system for use with gas ignition controls within freestanding commercial and industrial heaters. The Wi-Fi-enabled module is compatible with many original equipment manufacturer (OEM) heaters and introduces remote monitoring and control. Fenwal Controls, a leading supplier of gas ignition and temperature control components, is a part of Carrier Global Corporation (NYSE: CARR), the leading global provider of healthy, safe, sustainable and intelligent building and cold chain solutions.

Freestanding heaters are used in a variety of applications, including warehouses, airplane hangars, outdoor dining venues, recreational facilities, barns and other animal storage facilities. Without wireless connectivity, building managers only become aware of a failure if they are in proximity to the heater, meaning failures can go undetected for hours or even days. Lengthy failures can result in loss of comfort, productivity and damage or loss of product.




The **STMicroelectronics VIPerGaN50** simplifies building single-switch flyback converters up to 50 Watts and integrates a 650V gallium-nitride (GaN) power transistor for superior energy efficiency and miniaturization.

With its single-switch topology and high integration, including current-sensing and protection circuitry also built-in, the VIPerGaN50 comes in a compact and low-cost 5mm x 6mm package. The speed of the integrated GaN transistor allows a high switching frequency with a small and lightweight flyback transformer. Minimal additional external components are needed to design an advanced, high-efficiency switched-mode power supply (SMPS).

The VIPerGaN50 helps designers leverage GaN wide-bandgap technology to meet increasingly stringent ecodesign codes that target global energy savings and net-zero carbon emissions. It is suited to consumer and industrial applications such as power adapters, USB-PD chargers, and power supplies for home appliances, air conditioners, LED-lighting equipment, and smart meters.



**ETCO Automotive Products** include **1800 standard parts that meet IATF 16949:2016, SAE J2031 & 2032, and ISO 9001:2015 standards** and are available with compatible wire-attach equipment and booters. Featuring spark plug and distributor terminals, insulation boots, and battery terminals, all of these parts are manufactured in the USA for rapid delivery.

Designed to simplify automated and manual assembly operations for OEMs and harness makers, ETCO Automotive Products can be supplied in strip form or loose. They can be stamped from brass, tinned steels, stainless steels, beryllium copper, phosphor bronze and other alloy with thicknesses ranging from 0.006" to 0.078" and tolerances to 0.0005".




**AC Harmonic Filter Capacitors** have Dual-end Open Circuit Protection. Patented design safely expands mounting possibilities.

Similar capacitors in this category have one open-circuit pressure device located under the top cover that requires the capacitor to be mounted from its bottom stud. With the addition of a bottom pressure device, the PCD's terminals can be fixed to a rigid busbar allowing for activation of the bottom safety device when proper clearance is provided at the bottom. When activated, the bottom pressure device expands outward like a bellows.

While these fail-safe devices are designed to prevent case rupture at end-of-life, PCD series capacitors are designed to be exceptionally reliable with a service life of over 60,000 hours at rated voltage and temperature. Self-healing, metalized dielectric construction adds to their reliability.



**The Association of Home Appliance Manufacturers** (AHAM) has named **Kelly Mariotti**, Executive Director of the Juvenile Products Manufacturers Association as AHAM President & CEO. She succeeded Joseph McGuire, AHAM's leader for the past 23 years, who announced his retirement last November.

Mariotti joins AHAM with extensive trade association management experience and expertise in consumer durable goods. Since 2013, she has led the Juvenile Products Manufacturers Association, where she implemented strong member initiatives, employee engagement programs and public policy advocacy efforts. Since 2015, she has held a dual role as Vice President of Client Services at Association Headquarters, Inc. which serves 40-plus trade associations and professional societies.



**Douglas Electrical Components** ("DEC" or "Douglas"), a manufacturer of epoxy- based hermetic interconnects, has announced the acquisition of **Electronic Products, Inc.** ("EPI").

Established in 1960, EPI designs and manufactures ceramic and glass-to-metal hermetic packaging. The Company is headquartered in Newburyport, Massachusetts and provides packaging solutions for space, aerospace and defense and high-reliability applications.

**Chris Mosher**, President of EPI said, "Douglas shares our commitment to developing innovative solutions for our customers with excellent service and quality, and we are excited to join the team. I know EPI's customers will be well served by the access to a wider breadth of hermetic solutions." EPI will remain in its current location and continue to be led by Chris Mosher and the existing management team.




**BrainBox AI**, a pioneer in predictive and self-adaptive commercial building technology, is pleased to announce its global distribution agreement with **ABB**. ABB will offer BrainBox AI's technology services with a co-branded customer user interface (UI).This step confirms the next phase of the key relationship following the October 28, 2021, Series A funding announcement, wherein ABB participated as lead investor.

This agreement demonstrates ABB's clear recognition of the significant capabilities that BrainBox AI's technology offers and the synchrony with its goals to make buildings smarter, safer, and secure while improving energy efficiency and reducing carbon emissions.




Every three years, the **ZEIT publishing group** honors those brands that have set the standard for an entire industry worldwide. **SCHOTT CERAN®** is one of them – and has once again been named Brand of the Century.

It is impossible to imagine kitchens around the world without them: with more than 200 million units sold, glass-ceramic cooktop panels from SCHOTT are a success story that stands for quality, pioneering spirit, and innovative strength. For this, SCHOTT CERAN® has now once again been named Brand of the Century 2022 by the ZEIT publishing group and editor Dr. Florian Langenscheidt.

"With CERAN®, SCHOTT hasn't just invented the black glass-ceramic cooktop panel, it's defined a new era in cooking," said Jörg Wingefeld, Vice President Marketing & Sales of the SCHOTT Cooking Business Unit. "We've been melting our glass-ceramic exclusively in Germany for more than 50 years, and have been consistent in developing it even further."

"We are delighted to be named 'Brand of the Century' once again," says Kathrin Becker, Marketing Director at SCHOTT CERAN®. "This special award underscores how strong our ingredient branding is. True to our motto 'Excitement on top', we're committed to continue to set exciting trends for the kitchen."

**Michele Feria**



**Infinitum Electric**, creator of the breakthrough air-core motor, today announced the expansion of its leadership team with the recent appointments of Jack Powell as Director of Operations, Michele Feria as Director of Marketing, Ramon Guitart as Director of Engineering, Ed Carignan as Director of PCB Engineering and Stephen Mathew as Director of Product Management.

Infinitum Electric also announced it will move its headquarters to a new facility at the end of April to support the company's rapid growth and expanding operations. The new facility will be triple the size of the company's current offices and include a larger research lab and expanded production capabilities that will allow the company to address the growing electric vehicle and aerospace markets, which include electric vehicle takeoff and landing (eVTOL) applications.

Infinitum Electric is helping several industries transition to a more sustainable future with its smaller, lighter, quieter and more efficient motors. The company's air-core motors are gaining traction in HVAC equipment to improve building health while using less energy, and in electric vehicles and electric aircraft where extending range and reducing noise are particularly valuable.

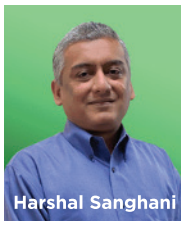
"We're thrilled to attract such a talented group of experienced industry leaders to support our rapid growth trajectory and help more customers build a sustainable future," said Ben Schuler, founder and CEO of Infinitum Electric. "We look forward to the impact these leaders will have in our next phase of growth as we scale production and meet demand for our high-efficiency motors across exciting new sectors and applications."

Infinitum Electric added 30 new employees across its two offices in Spokane, Washington and Round Rock, Texas with headcount doubling in research and development, and tripling in operations in 2021. The company is currently hiring additional team members for positions across product, operations, R&D and sales.

**Ramon Guitart**









**The Shepherd Color Co.** recently announced the appointment of **Chris Manning** to President and General Manager following the retirement of John Marten after 26 years of service. Manning has been the Commercial Sales Director overseeing the Global Sales teams & Distribution channels, Customer Experience teams, and Marketing & Technical Support Groups since 2007.

Manning has been with Shepherd Color for 20 years and holds a Ph.D. in Color Chemistry.

To streamline the business development strategies for Shepherd Color, two new commercial segment leaders have been appointed to replace the Commercial Sales Director role. The company has promoted **Harshal Sanghani** to Shepherd COLOR Commercial Segment Leader and **Mike Musick** to Shepherd TECHNOLOGIES Commercial Segment Leader.

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**The SCHOTT technology group** has won this year's **iF Design Award** with its latest glass-ceramic for cooking. CERAN Luminoir™ brings light features to the cooktop – even brighter, clearer and more true to color than ever before – that earned the coveted seal of approval for exceptional design and outstanding performance in the "Product" discipline, "Kitchen" category. Thanks to new material properties, CERAN Luminoir™ allows the LED light sources installed under the cooking surface to shine through brighter and clearer. White light in particular, but also colors, appear more brilliant and contours sharper. For household appliance manufacturers and lighting designers, this means new opportunities to make the cooktops of the future smarter and more exciting.



The illumination of cooking surfaces in the operating and cooking zone areas creates visual feedback during cooking. New material properties, first and foremost the special light transmission, allow white light to shine five times brighter through the new black glass-ceramic from SCHOTT than through conventional glass-ceramic cooktop panels. And that's without any additional filters or coatings. At the same time, the cooktop retains a deep black appearance at any time of day.

"With CERAN Luminoir™, we have launched a new generation of glass-ceramic for cooking that will make it even easier to develop smart cooktops with unique lighting designs in the future. Home appliance manufacturers can use it to make cooktop operation safer and more intuitive. The wide range of options for different light colors can bring the entire cooktop to life. For example, cooktops can create visual feedback for consumers or more easily integrate ambient lighting," explains Dr. Jörn Besinger, Head of Product Management and New Business Development for CERAN® at SCHOTT. "These functions are also increasingly in-demand by consumers in the non-premium segment."



**Infinitum Electric** raised $80M in Series D Funding led by **Riverstone Holdings** to scale production of sustainable motors. Infinitum Electric will use the investment to vertically integrate and automate production of its motors for the commercial and industrial market segments, and complete development and commercialization of a traction motor for the rapidly growing electric vehicle market, where its exceptional breakthrough power density can significantly extend the range of electric vehicles.

"As industrial equipment, cars, aircraft and buildings are rapidly electrifying, our revolutionary motor systems offer a path forward to reduce electricity demand and carbon footprint," said Ben Schuler, founder and CEO of Infinitum Electric. "Partnering with Riverstone Holdings, Alliance Resource Partners and our other new and existing network of investors representing leaders in the energy, semiconductor and industrial sectors, puts us in a strong position to scale production, deliver product and impact how the world sustainably consumes and generates power for the next generation."



**Tuya Smart**, described as a leading Internet of Things platform provider, has formed a partnership to produce smart appliances with kitchen and household goods company **Lock & Lock**.

The companies will work together to produce smart appliances, expanding Lock & Lock's smart appliance range worldwide in the process. L&L has been recognised with awards in the traditional tableware and cookware markets.

In partnering with Tuya Smart, Lock & Lock aims to produce new smart appliances that specialise in guaranteeing a positive customer experience, as well as top functionality and practicality.

"In order to create smart appliances based on the concept of both products and services stemming from life, Lock & Lock chose to collaborate with Tuya Smart...", a public statement read.

Tuya Smart has earned praise for producing a IoT development platform that has worked to reduce development costs and time for Lock & Lock. This is thanks to the platform's low and zero-code solutions, as well as Tuya Smart's willingness to develop smart products at a consistent rate.

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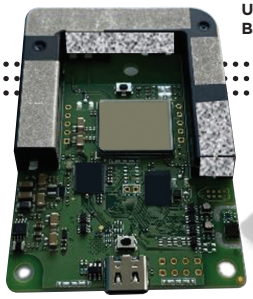
**SPIROL** recently launched their new and improved corporate website: **SPIROL.com**. The new corporate website is a culmination of over 74 years of engineering knowledge and experience in the fastening, joining and assembly arena. Simple to use and easy to navigate, the new SPIROL.com makes it effortless to connect with SPIROL's global locations, request technical support, submit an RFQ, as well as purchase product through their integrated eCommerce website: **Shop.SPIROL.com**.

Available in 10 languages, the new SPIROL.com has a specific Fastener & Assembly Resource Center for easy access to:

- Product Catalogues & Design Guides
- 2D/3D Drawings
- Instructional Videos
- White Papers
- Application Success Stories
- FAQs

SPIROL.com also provides an easy method of connecting with the global Application Engineering team to help design not only the engineered fastener, but also to make the critical recommendations for the interface between the fastener and assembly components to ensure that the product goes together, and stays together for the intended life of the assembly.

Visit SPIROL.com to access resources specifically focused on fastening, joining and assembly not available in any engineering textbook or online library.



U-shaped MetaSpan antenna combines cellular, Bluetooth, and GNSS antennas into a single block

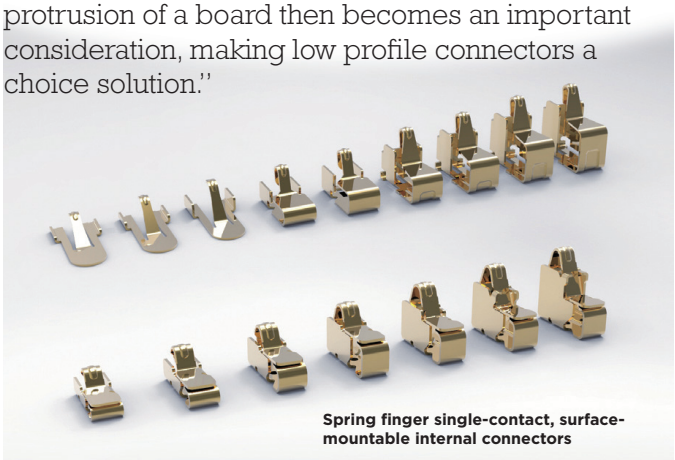


Waterproof IPX8 USB Type-C connector

**TE Connectivity** (TE), a global leader in connectors and sensors, addresses challenges related to miniaturization and offers design considerations for overcoming them with a focus on antenna design, PCB connectors and associated components.

"Approaching the design phase with a holistic view of the impact of all components—including antennas and PCB connectors—is a critical step to avoiding unanticipated performance issues that can result in late-stage design changes, higher expense, and delayed time to market," said Irfan Yousaf, TE antenna solutions expert. "Oftentimes, manufacturers rely on specifications to determine their antenna selection, but what needs to be considered early in the process are factors such as ground plane dimensions, distance to nearby components, antenna position, PCB layout, and component selection. All of these can have a significant impact on device performance and reliability, and in some cases, a custom antenna solution is required."

TE Product Manager David Currie commented, "One of the main drivers for miniaturization is the continually decreasing PCB size in IoT applications. Given reduced board real estate, engineers require products with a compact form factor. The smaller the connectors are, the more that can fit into a reduced space, which increases the utility of the board. "PCB clearance is also a driving factor. Not only are PCBs smaller, but increasingly there are more per application that need to be packed into a cavity that may have a unique or very thin shape. Connector protrusion of a board then becomes an important consideration, making low profile connectors a choice solution."



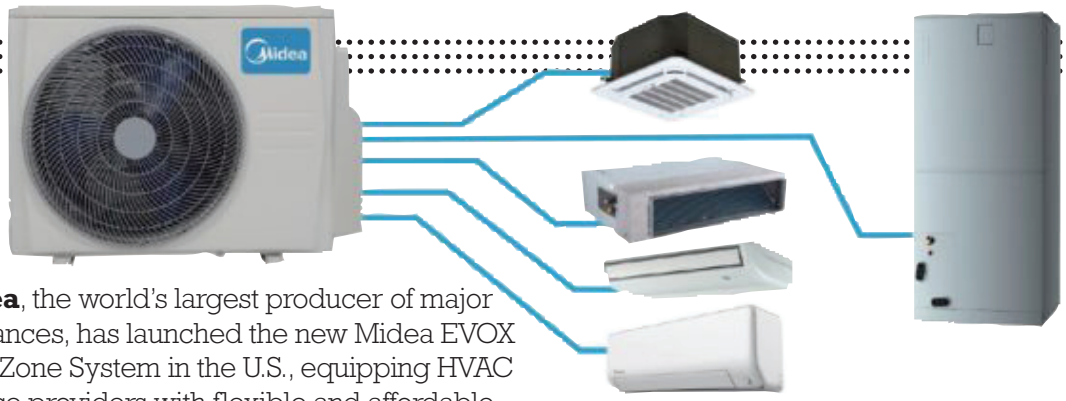
Spring finger single-contact, surface-mountable internal connectors




**Littelfuse, Inc.**, an industrial technology manufacturing company empowering a sustainable, connected, and safer world, announced the completion of its acquisition of C&K Switches ("C&K"). C&K is a leading designer and manufacturer of high-performance electromechanical switches and interconnect solutions with a strong global presence across a broad range of end markets, including industrial, transportation, aerospace, and datacom.

"The combination of our companies significantly expands our technologies and capabilities, enabling us to deliver comprehensive solutions offering to our broad customer base, across a wide range of vertical end markets," said Deepak Nayar, Senior Vice President and General Manager, Littelfuse Electronics Business. "Our businesses are highly complementary and enable us to leverage our collective go-to-market models and global footprints. It is a pleasure to welcome the C&K employees to the Littelfuse team, and we look forward to their contributions, as we continue to execute on our long-term growth strategy."

C&K has annualized sales of over $200 million and will be reported within the company's Electronics reporting segment.




**Midea**, the world's largest producer of major appliances, has launched the new Midea EVOX Multi-Zone System in the U.S., equipping HVAC service providers with flexible and affordable product and system combinations that can seamlessly mix and match ducted and ductless configurations across multiple applications with up to five zones per heat pump. The EVOX multi-zone heat pump system is ideal for new home installations or replacing older central systems in any weather climate with affordable, highly efficient inverter technology.

With all new central systems requiring the U.S. needing to meet new energy standards coming in 2023, inverter heat pumps with high SEER ratings are in demand. Multi-zone systems are proven energy savers by the Department of Energy, and Midea EVOX is leading the pack with an affordable and user-friendly system – both ducted and ductless – accessible to more Americans so they can help reduce their carbon footprint and future energy bills.

**Evolving at the Cutting Edge of the Industry**

The Department of Energy (DOE) recently emphasized that most heat pump products today have a significantly diminished capacity and efficiency in colder climates and initiated the Cold Climate Heat Pump Challenge, which Midea joined as a manufacturing partner. The challenge encourages the industry to develop the next generation of cold climate heat pump technologies. Today, Midea is proud to already be producing some of the most energy efficient and high performing inverter technology cold climate heat pumps on the market that are capable of 100 percent heating output at -4 degree Fahrenheit.

''Midea America is committed to making quality, innovative, highly efficient inverter technology more affordable for all American households so they can take advantage of rewarding rebates and long-term cost savings on their energy bills, along with a total comfort experience,'' said David Rames, Senior Product Manager, Midea America. ''We've worked with U.S. contractors to make sure the Midea EVOX Multi-Zone System is one of the most compatible inverter technology products in the industry today, and despite having some of the highest energy ratings, is very competitively priced – making it easier for suppliers and contractors to stock, sell and install a superior HVAC option.''

**One of the Most Compatible Systems on the Market Today**

Designed in close collaboration with U.S. HVAC contractors, the EVOX system is a game changer thanks to its unprecedented flexibility, providing versatile solutions to solve many of the most pressing barriers for contractors and consumers including the ability to mix and match with existing equipment (even non-communicating), and with a full lineup of ducted and ductless compatible split units, offers suppliers and installers with the options they need to adapt to most installation conditions and customer expectations.

Midea's industry first BI-COM technology enables the EVOX Inverter Heat Pump System to work with the EVOX communicating wall control or with existing 24V thermostats or smart/learning controls such as Nest and Ecobee. As a result, the EVOX System can be installed as a complete set or added in components to existing HVAC systems, without changing current duct design, refrigerant lines or communication wires. Either way, the system can function effectively as a communicating inverter combination.

High compatibility provides suppliers and contractors with flexible and attractive options for homeowners in terms of upgrades and budgets, including installing a full EVOX system or pairing EVOX components with existing air handlers or heat pumps. Most Midea EVOX products, including air handlers and ducted and ductless splits, can be used in single or multizone applications, reducing warehouse complexity and supply challenges and flexible sales plans help maximize revenue potential.

**BrainBox AI** announced the inaugural installation of its artificial intelligence technology in a New York City commercial property. The building, owned by Cammeby's International Ltd., is located at 45 Broadway. This announcement comes weeks after New York's Governor Kathy Hochul made a major commitment to decarbonizing buildings and two years before Local Law 97 fully takes effect.

"The installation of BrainBox AI's technology at 45 Broadway is a major milestone for us as we enter one of the world's most significant commercial real estate markets, said Sam Ramadori, CEO, BrainBox AI. "Our scalable technology enables buildings to become more sustainable and autonomous while reducing energy costs, decreasing emissions, improving day-to-day comfort, cutting down on maintenance, and extending equipment life."

In 2019, New York City passed the Climate Mobilization Act, a groundbreaking and ambitious plan for reducing emissions in one of the nation's largest commercial real estate markets. One law in particular, Local Law 97, specifies that most buildings over 25,000 square feet will be required to meet new energy efficiency and greenhouse gas emissions limits by 2024, with stricter limits coming into effect in 2030.






**Wacker Chemie AG** has started a feasibility study for a new silicone production complex at its Charleston site in Tennessee.

The move is part of a multi-phase construction plan at the US site, spanning several years and with an investment tag of over $200 million

First up will be production plants for high-consistency silicone rubber and silicone sealants as well as intermediates manufacturing units, added Wacker, the world's second-largest silicone producer. Plants for other products, such as silane-terminated polymers used as binders for adhesives & sealants and waterproofing systems, "could then be added," said the Munich-based group.

Wacker has been producing high-purity polysilicon for the semiconductor and solar industries at the Charleston site since 2015, and pyrogenic silica there since 2019.

Demand for high-performance speciality silicones is showing particularly strong growth in industries including automotive, construction, electronics and medical technology, noted Christian Hartel, CEO of Wacker.

"The planned expansion measures in Charleston are a further step toward making Charleston a fully integrated site with closed production loops, and an important prerequisite for accelerating our growth as planned," said Hartel.

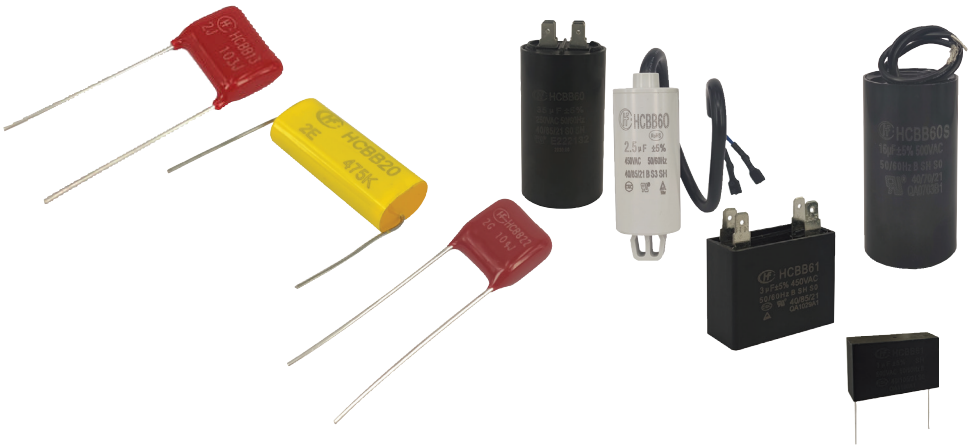


**Lance Dumigan** was recently appointed **Business Development Manager of Fabrisonic**. Lance says his career has taken some unexpected turns that have put him exactly where he was meant to be. He has started three companies, led strategic initiatives for several businesses, and consulted with many startups and small businesses.

**Superior Sensor Technology** is now offering an integrated pressure switch feature with three threshold pressure modes as part of its **NimbleSense**™ architecture, a system-in-a-sensor, application-specific pressure sensor platform for HVAC, medical and industrial products. Customers have an option to integrate the switching feature into Superior Sensor Technology's pressure sensors, eliminating the cost of an external switch, and improving performance with faster response times. The new pressure switch capability also maximizes design flexibility, reduces PCB board space, lowers power consumption, and minimizes product design complexity and manufacturing costs.

A pressure switch provides a failsafe response when a certain pressure threshold is met. As such, pressure switches often serve as a safety feature and are a critical component of many medical devices, HVAC systems and industrial products. The switch acts as an on/off mechanism that is triggered when a certain air pressure value is reached. For example, when measuring air pressure through an air filter, if the pressure value goes above a specified level, such as 2 inH2O, the switch can notify the maintenance crew to clean or replace the filter. A safety medical example can be seen with ventilators, where pressure switches are in place and activated if too much pressure is being applied to the patients.





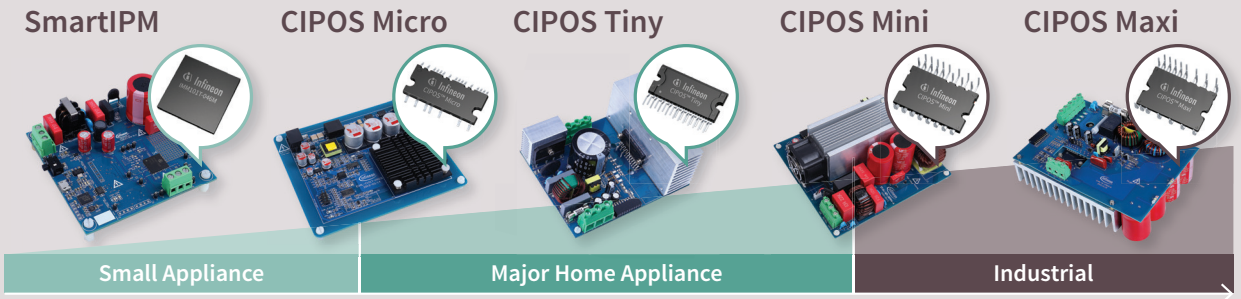
**Hongfa America, Inc.** launched its **Film Capacitor line** to provide engineers with a complimentary array of products to meet their PV Inverter, Electric Vehicle & Charging design challenges with new high-quality Film Capacitors. Although compact in size, its mighty performance and cost effectiveness stand tall next to its competitors within the industry.

Hongfa's film capacitors have applications in New Energy, Consumer Electronics, Automotive applications, Industrial Control, Rail Transit, and Smart Grid, and Consumer

Hongfa brings over 30 years of capacitor manufacturing experience to the table to produce this new line of products, providing a one-stop solution to meet your needs. Our new products have been tested and proven to be safer, more reliable and more durable than other lines.

The new capacitor line is available in the following versions: EMI Capacitors, DC EMI Filter Capacitor, Resonant Capacitors, DC-Link Capacitors, AC-Filter Capacitors, and Snubber Capacitors. Mounting configurations include IGBT (Axial-type), IGBT (Lug terminals) and PCB versions.

The HCBB62X2 Line of EMI Capacitors are metalized polypropylene film interference suppression capacitors. This line features interference suppression and overvoltage impact in across-the-line applications. Other features include encapsulation in a flame-resistant plastic case – sealed with epoxy resin, which provides excellent flame resistance.


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# Ferrite Power Magnetics

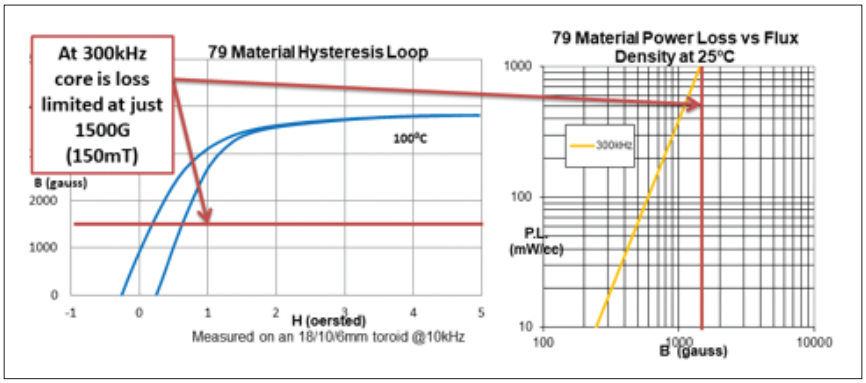
**BV MICHAEL ARASIM**

In theory, any (magnetic) material could be used for power conversion applications; however, there are specific material attributes that make some materials preferred over others. Frequency should be the first consideration in terms of performance. In order to get a general feel for a material's potential as an efficient power material, one can simply start by considering the relative μ' vs μ'' response at the frequency of interest. The μ' to μ'' ratio at the operating frequency gives an idea of relative Q (quality factor). A rule of thumb is for the ideal operating frequency to be Q > 50. Q is measured at low operating flux density (and at room temperature), so this is only a starting point.

The second consideration is the actual power loss (PL) vs. flux density (B) curves. Manufacturers supply specific power loss vs flux density curves (at constant temperature & sinusoidal conditions) for power rated materials. Specific power loss does not apply to any particular part or geometry but is measured on standard toroids as a material characteristic. On a component-by-component basis, power loss will be published as an absolute value, where Pabs= Pspecific * Volume. The volume could be the actual calculated geometric volume or (at times with more complex shapes) the effective magnetic volume (Ve = Ae * le). Geometric volume is more accurate, but with complex shapes variation of the cross-sectional area (Ae) creates hot spots where the actual cross-sectional area is at the minimum value (Amin) over the entire magnetic path and localized loss will be greater.

The most optimal materials will be those that demonstrate lowest power loss at the operating frequency, temperature, and maximized operating flux density. Other material attributes to consider are μ' vs temperature (μT), power loss vs temperature (PL vs T), amplitude permeability vs flux density (μA or μ vs B), and maximum flux density vs temperature (B vs T). hen the component is gapped (for applications where a DC bias consideration is required), these attributes may all shift.

At relatively low frequency (<50 kHz), power capacity is mainly saturation flux density constrained. At higher frequency it is the losses over frequency that are the constraints. As the operating frequency increases, the maximum material flux density (B max) becomes less important. At low operating frequencies, there will be non-ferrite materials that have higher Bmax capabilities which will provide more efficient power conversion (alloys, amorphous and nanocrystalline materials). Currently, ferrite is the most efficient and cost-effective choice for higher frequency power conversion readily available.



Fair-Rite Materials for Power Conversion

| Material Type | μ′ | Bmax (mT) | Tc (°C) | Sweet Spot (°C) | Typical PL (mW/cc) | At MHz | At °C | At B (mT) | Recommended Frequency Range | B* f Ref | B*f/ PL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 | 2000 | 500 | > 200 | 80 | 130 | 0.025 | 100 | 100 | < 100kHz | 2.5 | 0.019 |
| 78 | 2300 | 480 | > 200 | 80 | 50 | 0.1 | 100 | 100 | 25 - 500 kHz | 10 | 0.200 |
| 95 | 3000 | 500 | > 200 | 60 * | 180 | 0.2 | 25 | 100 | 25 - 400 kHz | 20 | 0.111 |
| 79 | 1400 | 480 | > 200 | 70 | 100 | 0.5 | 100 | 50 | 300 - 1000 kHz | 25 | 0.250 |
| 80 | 600 | 480 | > 200 | 25 | 130 | 2 | 25 | 30 | 1 - 5 MHz | 60 | 0.462 |
| 61 ** | 125 | 235 | > 300 | 25 | 300 | 5 | 25 | 12 | 2-15 MHz | 60 | 0.200 |
| 67 ** | 40 | 240 | > 400 | 50 | 350 | 10 | 25 | 10 | 2-25 MHz | 100 | 0.286 |

It is always desirable to have flat performance over temperature: the μT and PL vs T curves give an idea of a material's performance over temperature. Typically, most power materials have performance ratings characterized at 100°C, or the ''sweet spot,'' where power loss is at a minimum.

The 95 material (*) has been developed for minimal PL variation over temperature. Note that the type 61 and 67 materials (**) are perminvar types. These materials, while providing very desirable low loss and relatively flat temperature response, are susceptible to ambient and operating conditions. Aside from external influences (mechanical stresses and external magnetic fields), operation must be limited to where the power loss won't exceed 1W/cc. Above this point these materials can suffer from thermal runaway and the performance will be permanently compromised.

As a manufacturer, Fair-Rite publishes all power loss information performed under frequency-specific sinusoidal conditions. In many applications, the exciting currents and voltages are not sinusoidal, so other estimations and algorithms (MSE, iGSE, Herbert plot, etc.) should be considered.

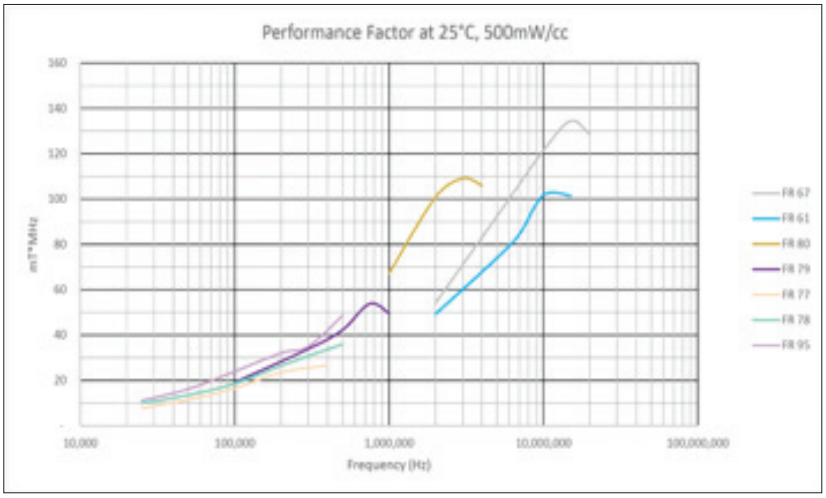
Operating at higher frequencies allows lower operating flux density for the same power levels and/or smaller component volume and/or mass. A general rule of thumb is to limit operation for 500mW/cc or less to ensure low component temperature rise (dT< 50°C). 300mW/cc to 1000mW/cc can also be used as operational limits depending on the cooling capacity of the system. Performance factor plots consist of frequency * flux density vs frequency at temperature and specific power loss. This makes it a useful tool for evaluating the relative performance of different material grades.

Hysteresis Loops can be a fair guide for a material's ability to deliver maximal flux density (B). This is especially true at low frequency, but at frequencies above 100 kHz they can't be relied on. The reason for this is that the loop changes as frequency increases. Temperature also changes this. A general rule of thumb is to limit ΔB excursions to no more than 1/2 the published Bmax (measured at 1 or 10kHz). As frequencies increase, operating ΔB should be further decreased to limit core loss. This also ensures reasonably low waveform distortion. There are three primary modes for the loss of a ferrite material; residual loss is inherent to the material and a constant, hysteresis losses are amplitude (B) dependent, and eddy current loss is a function of the material's complex permeability and permittivity and change with frequency. Other losses realized are heavily influenced by the winding of the core.

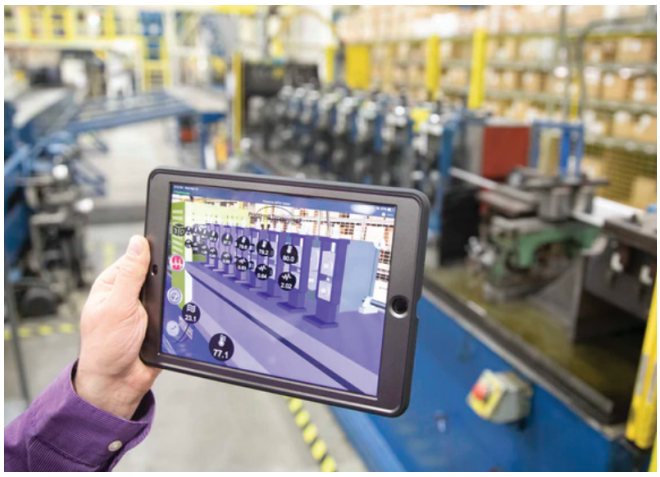
Ferrite materials lend themselves well to a wide variety of power applications. Low losses and high operating frequencies put them in a league of their own for high efficiency, high power density designs. Their successful implementation hinges upon having as complete an understanding as possible of the operational parameters and being able to leverage this knowledge to select an optimal material and geometry.



***Michael Arasim,*** *Lead Product Manager at Fair-Rite Products Corp*





# How 3D-Based AR/VR Is Driving Today's Automation & Robotics Technologies For HVAC Manufacturers

**BY DIJAM PANIGRAHI**

The evolving business climate in 2022 resulting from the continued pandemic, as well as spinoff issues such as supply chain, labor and inflationary challenges is forcing many HVAC businesses and manufacturing executives to implement automation and robotics technologies for their production, distribution and fulfillment facilities.

The ongoing economic challenges, along with continued pressure from business investors for a strong focus on the bottom line, has added pressure to companies that need to become even more efficient with their factory operations and product development teams.

Sure, many HVAC and appliance manufacturing facilities continue to rely heavily on human labor, but an increasing number of locations are now investigating automation and robotics technologies powered by Augmented Reality and Virtual Reality (AR/VR) to speed efficiencies, lower costs, and minimize human touch points to ease the pain from staffing challenges.

## Larger Investments in Automation

Demand for workplace robots in the U.S. rose by a record 40% during the first quarter1 compared with the same period in 2021, according to the Association for Advancing Automation, which tracks trends in the robotics industry.

Automation-driven robotics has been widely used in the automotive sector, such as assembly lines production. But now other industries like aerospace, retail and food production, construction equipment, and pharmaceuticals are seeing gains in the use of these machines on the plant floor.

The business benefits of increased productivity and reduced costs are obviously a boon to the bottom line. However, other leading drivers show that these technologies are helping to enhance new social distancing policies enacted during the early days of the pandemic.

## Increased Flexibility Across HVAC/Appliance Manufacturing Facilities

The COVID-19 pandemic has illustrated the need for more operational flexibility where advanced technology and automation can be applicable. In addition, the ability to scale up or down quickly to meet project deadlines, without impacting hourly shifts, has further helped with manufacturing efficiency.

Technologies such as AR/VR-driven robotics and automation have also greatly increased across plant floors, especially as the need to adhere to tighter supply chain and logistics demands has been paramount this summer.

## Doing more with less

As we move through 2022, continued disruptions to the global supply chain are becoming more of the new normal, and manufacturers continue to address the cascading events in different ways. For example, improving supply-chain visibility and

increasing customer satisfaction are clearly important. Fifty-nine percent said improving supply-chain visibility was their single most important business priority in 2022, while 45% chose improving customer satisfaction2. Better automation-driven technologies are paving the way for these improvements.

### Cloud-Based Automation Technologies Proving Pivotal

AR/VR is necessary today in automation and robotics technologies, but there are important areas to understand when leveraging such technology for manufacturing applications. The technology allows designers and manufacturers the ability to conduct real-time 3D visualization and CAD for design and manufacturing; faster training cycles; and professionals can work at drastically higher levels. In fact, some manufacturers report minimized errors using AR/VR through instructions overlay, remote assistance, and better planning and visualization. This has resulted in a more than 40 percent increase in productivity in some instances. AR/VR technologies provide significant time savings to the manufacturing build process through optimized decision process, which positively impacts the entire OODA Loop (Observe, Orient, Decide, Act).

One caveat HVAC and appliance facility managers must take into account is that not all automation technologies are created equal. It is important to pay close attention to the technology infrastructure and to choose a platform that is cloud-enabled so that projects can truly scale when needed. Manufacturers are overcoming their growth limitations by leveraging cloud-based (or remote server based) AR/VR platforms powered by distributed cloud architecture and 3D vision-based AI. These cloud platforms provide the desired performance and scalability to drive innovation in the industry at speed and scale.

The use of robotics and AR/VR-driven automation technologies requires the right speed and data for accuracy. Even though technologies like AR/VR have been in use for several years, many manufacturers have deployed virtual solutions that are built upon an on-premise environment, where all the technology data is stored locally.

On-premise AR/VR infrastructures limit the speed and scalability needed for today's virtual designs, and it limits the ability to conduct knowledge sharing between organizations that can be critical when designing new products and understanding the best way for virtual buildouts.

Manufacturers today are overcoming these limitations by leveraging cloud-based (or remote server based) AR/VR platforms powered by distributed cloud architecture and 3D vision-based AI. These cloud platforms provide the desired performance and scalability to drive innovation in the industry at speed and scale. ●


**Sources**

**1:** https://www.wsj.com/articles/robots-pick-up-more-work-at-busy-factories-11653822002

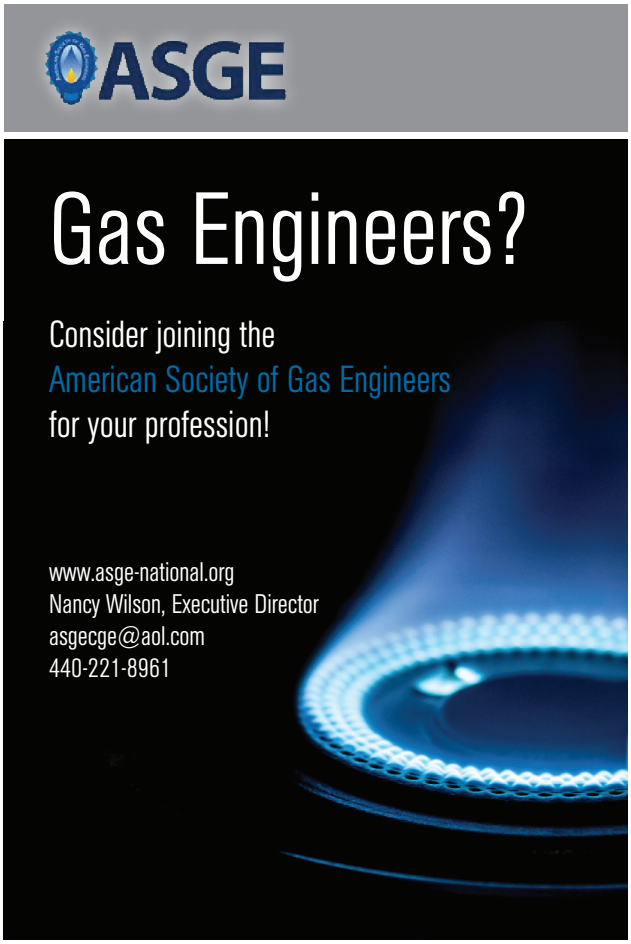
**2:** https://www.plasticstoday.com/business/improving-supply-chain-visibility-top-priority-manufacturers-survey-says





***Dijam Panigrahi*** *is Co-founder and COO of Grid Raster Inc., a leading provider of cloud-based AR/VR platforms that power compelling high quality AR/VR experiences on mobile devices for enterprises. For more information please visit www.gridraster.com.*







# The Benefits of Using Tankless vs. Tank Water Heaters

**BY DAVID FEDERICO**

For decades, traditional water heater tanks have reigned supreme in homes and buildings across the country. But, in recent years, tankless water heater options have increased in popularity. The first Rinnai tankless water heater was introduced to North America in 1999. There was such success in Asian and European countries with the water heater technology, companies such as Rinnai, saw the opportunity for growth in the American market.

Historically, tank water heaters have had the upper hand for decades. However, as we look toward the future, tankless water heaters continue to experience double-digit growth in North America, as the technology continues to evolve. According to ***Persistence Market Research's*** most recent tankless report, the product is expected to increase by 6% over the next 10 years, with the overall market share rising to $6.3 billion by 2031.

But even with the rise in adoption of tankless, there are still many purchasers who question the benefits of tankless verses tank water heaters. To combat some of these inquiries, and to ensure you and your customers are being provided with the best possible hot water solution, here

are several benefits to help inform you about the differences between tankless and tank water heaters.

### Cost benefits

Due to tankless water heaters being associated as expensive to purchase and install, tanks have generally been used as the affordable hot water option. But as material costs have significantly risen over the last few years, so have the prices of tanks. Now, a non-condensing unit can be found for a similar or lower price than a tank. And when it comes to installation, a tankless unit in some instances can be installed in the same amount of time as a standard tank, showing there is little to no monetary difference in installation costs.

Additionally, the longer lifespan of a tankless water heater (lasting 20 years or more) compared to the shorter life span of a tank water heater (lasting 10 to 15 years), means the cost upfront can be worth the investment. Once the tankless water heater is installed, the units tend to be easier to repair than tanks, eliminating the need to replace a heavy tank unit, which can save customers a significant amount of money in the long run.

### Space savings

A tankless water heater is a quarter of the size of a regular tank, and that is a huge benefit for building owners and businesses. One tankless unit is about the size of a carry-on suitcase, creating the ability to fit in smaller storage spaces like closets, cabinets or mechanical rooms. Its compactness, in comparison to tanks, is an advantage for businesses and homes, creating more work or living space. There are even more space savings when businesses need multiple units, often needed in hospitals, schools, hotels and restaurants.

### Never-ending hot water

Tankless water heaters can easily deliver a never-ending hot water supply at five gallons per minute (GPM) at temperatures of 120°F and with groundwater as low as 40°F. Just think, that's running three showers simultaneously. In comparison, operating three showers with a 50-gallon tank could be depleted in as little as 10 minutes.

By using tankless, hot water is always available, where and when customers need it. Tankless units don't rely on hot water storage or having to refill an empty tank before the hot water becomes available. A tankless unit heats hot water when activated, so customers never have to choose between taking a hot shower, doing a load of laundry, or running the dishwasher.

### Energy efficiency

The Uniform Energy Factor (UEF) rates tankless as a highly efficient hot water appliance, providing energy savings that benefit both a customer's pocketbook and the environment simultaneously. Due to the tankless design, it only runs when hot water is needed, compared to a tank, which is often heating and reheating water when not in use, minimizing wasted energy.

Utilizing data from ***Energy Star*** and their savings compared to conventional gas tankless water heaters, certified tankless water heaters will save on average $20 annually for a family of four or $300 over the unit's lifetime on gas bills. ***Energy Star*** stated, "If all residential gas tankless water heaters sold in the United States were Energy Star certified, energy cost savings would grow $215 million each year with over 1.8 billion pounds of annual greenhouse gas emissions being prevented."

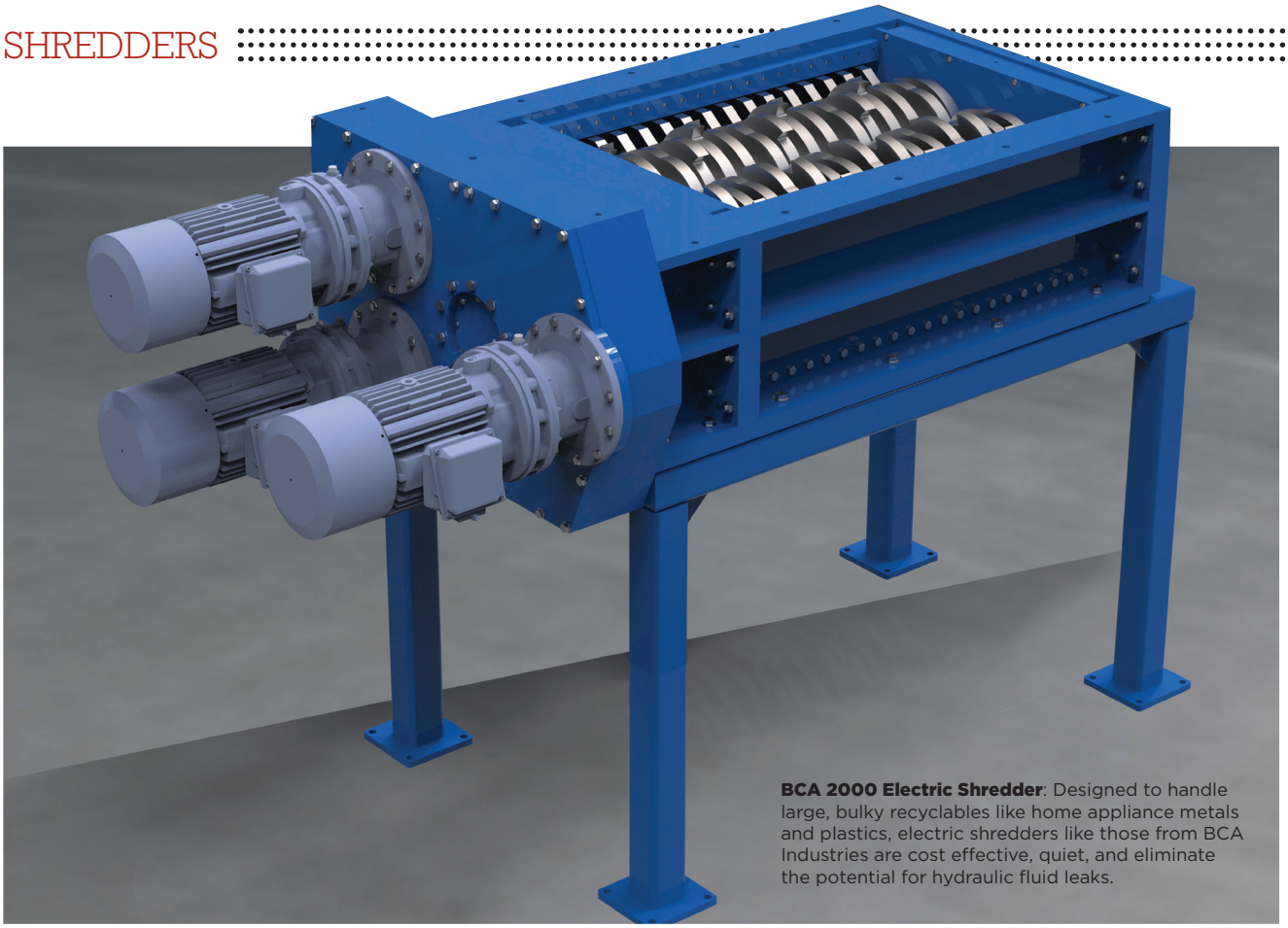
### Convenience

Along with tankless, comes smart technology. Accessories like room motion sensors and push buttons can be connected via Wi-Fi to help make hot water available faster at the faucet. These conveniences allow units to be controlled via smartphone or voice-controlled applications, providing scheduling and on-demand recirculation capabilities. This is especially helpful for businesses with true peak periods throughout the day, allowing them to schedule the amount of hot water needed at any given time. And the added Wi-Fi benefit can help customers keep an eye on usage or whether a unit may need additional repair services.

There are a lot of additional benefits of a tankless water heater in comparison to a traditional tank. As more and more buildings and residential homes are built or retrofitted, the preference for installing tankless water heaters in comparison to tanks continues to increase, as well as the continued investments companies, such as Rinnai, are making in product innovation and smart technologies, will boost the product's popularity with your customers. So, when you or your next customer needs to replace a hot water tank, it's a good time to educate them or yourself on the efficiency and economic benefits of a tankless water heater. These conversations will help build trust with your clients, grow your business and even increase profit. ●



***David Federico*** *is Senior Director of Marketing at Rinnai America Corporation with primary responsibilities for leading the marketing strategy for its residential and commercial products. Prior to joining the organization in 2016, David held marketing leadership positions at multinational corporations including Georgia-Pacific. To learn more about Rinnai's tankless water heaters, visit www.rinnai.us*



**BCA 2000 Electric Shredder**: Designed to handle large, bulky recyclables like home appliance metals and plastics, electric shredders like those from BCA Industries are cost effective, quiet, and eliminate the potential for hydraulic fluid leaks.

# OEM Recycling: Large Chamber, Electric Shredders Make Quick Work of White Goods

**BY DEL WILLIAMS**

When home appliance, aka ''white goods'' manufacturers need to shred defective oversized sheet metal or component parts prior to shipping for further recycling or re-use in production, the only option traditionally has been hydraulically powered, due to the high torque and power delivered. Although this is important for oversized parts, thick-gauge metals, and other hard materials, it is overkill for the light-gauge mild steel, sheet metal, and plastics used to manufacture most home appliances.

Enter electric powered shredders with design advances that can deliver the necessary torque and chamber size to quickly shred bulky, recyclable materials as used in the largest home appliances.

For white goods manufacturers, electric power offers some key advantages over hydraulic power. To start, electric shredders are generally less expensive than comparable hydraulic units. Electric shredders also eliminate the maintenance and inspection associated with hydraulic systems, namely fluid leaks and ruptured hoses. By eliminating hydraulics from the equation when large cutting chambers are still needed, facilities ensure a cleaner, safer work environment and prevent the potential slip and fall hazard represented by leaked hydraulic fluid on the plant floor.

Electric shredders are also much quieter. This lowers the noise level in decibels in already loud facilities. Consequently, it is easier for workers to communicate without having to shout over the loud background noise of operating machinery. The quieter operation of an electric unit also facilitates compliance with OSHA's permissible occupational noise exposure limit.

''Appliance manufacturers

that recycle oversized products constructed of light-gauge steel and plastic have expressed a preference for large chamber, electric shredders that are quieter, eliminate the potential for hydraulic fluid leaks, and cost a bit less," says John Neuens, Industrial Consultant for Milwaukee, WI-based BCA Industries, an established developer and manufacturer of industrial shredding and recycling equipment for a variety of industries.

Although electric shredders provide slightly less torque than hydraulic models, those designed to handle large white goods and other bulky recyclables can still deliver more than 100,000 ft. lbs. of torque per knife.

"Applying over 100,000 ft. lbs. of torque per knife in a large chamber is more than enough to efficiently shred sizeable, defective white good materials from stoves, refrigerators, freezers, washing machines, tumble driers, dishwashers, water heaters, and air conditioners," says Neuens.

He points out that one electric-powered unit, the customizable ES2000 shredder called "The Beast" from BCA Industries, is already being successfully used by the appliance division of a major global OEM at a facility in the U.S. Midwest. At the facility, the OEM is shredding bulky, hard to feed, substandard or defective appliance parts into small one-inch pieces and then transporting the scrap by rail to their recycling division.

With chamber sizes from 48" x 48" up to 48" x 72", the electric shredder provides from 100 HP to 800 HP and 100,000 ft. lbs. of torque per knife. This is more than enough size and power to quickly reduce defective oversized items into easily transportable, recyclable scrap.

According to Neuens, BCA Industries designs the electric shredder to many of the same specifications as its hydraulic models to maximize durability and longevity in the field.

"We designed the electric shredder to be extremely durable even if the intended use is lighter duty metals and plastics, in the event the manufacturer pushes the envelope of what feed materials are placed into it in the future," says Neuens.

For example, the electric shredder is designed with 24" AR500 base alloy knives with a hard-face weld, the same as the hydraulic alternative. The knives can be selected in a wide variety of sizes and specifications, which allows customization to suit the manufacturer's specific application.

Several features are designed to increase the electric shredder's useable life and reduce maintenance. Instead of 7" shafts, 8" chromoly shafts are utilized – the same as the hydraulic unit. In place of old HEX shaft design or a double key round shaft, the unit also uses an eight key design where the knife literally rides on disposable keys, not directly on the shaft. With the keys taking any abuse instead of the shaft, the design eliminates shaft washout and simplifies knife changes.

Since the electric unit is designed with a double labyrinth style drop zone and outboard bearings, this eliminates any direct path to the shaft bearings. It also allows compressed material a path to exit the shredder, eliminating the "catastrophic costs" of bearing and shaft replacement.

To expedite scrap reduction to the appropriate specified size, the electric shredder offers the option of BCA's patented Triplus system shredder "knife" technology. When used in the shredder, the knife technology can uniformly cut to any size in a single pass without a screen to quickly reduce scrap to a reclaimable proportion. The technology utilizes a unique bed knife design in a dual shaft shredder to cut the width of the material of the shredder. The size of the end-product is based on the size and geometry of the rotary and fixed knives as well as their gap distances.

A shredder using this design can produce over 85% correctly sized material in one pass with less than 10% oversized material, according to Neuens. He notes that the knife system can reduce scrap to the appropriate size with much less energy than typical shearing and grinding equipment. Power efficiency approaches 150% over any standard shredder.

Large chamber electric shredders are also easy to use for plant operators. The latest offer touch screen programmable functions and diagnostics and are PLC controlled with auto-reverse and overload protection.

"Manufacturers of oversized product that needs to be recycled finally have an electric-powered option that makes shredding onsite much easier, quieter, cleaner, and cost effective," concludes Neuens. "Although hydraulic power has been the default choice, large chamber, electric-powered units are an attractive alternative for home appliance manufacturers, bulky industrial tubes, gas tanks, plastic totes and barrels, laser skeletons, and most other recyclables." ●



***Del Williams*** *is a technical writer based in Torrance, California. He writes about health, business, technology, and educational issues. He holds a master's degree in English from C.S.U. Dominguez Hills.*



# Not Your Grandfather's Brushed Universal Motors... Anymore

**BY DAVE GILL**

Universal motor-driven vacuums have been a staple in many industries for years. Whether for vacuum cleaners, scrubbers, extractors, central vacuum systems, material transport, animal dryers, foggers or sprayers, these brushed motors are considered critical because of their versatility, durability and dependability.

Although the universal motor is a very mature device, many cutting-edge technologies as well as ongoing research have spurred evolution in brushed vacuum motors. Over the last 30 years, they have become smaller, lighter and faster. Additionally, there have been significant improvements in component designs. Bearings can now reach 50,000 to 70,000 RPMs, while commutators, brushes and fans can operate at higher speeds — and lasting a normal lifetime.

In this article, we'll explore:

- What makes brushed vacuum motors unique
- Bypass versus thru-flow motors
- Considerations for application design
- Moisture protection.

## What are Brushed Universal Motors?

Brushed universal motors are based on a universal motor design which uses a wound rotor and stator in series with one another. A commutator and carbon brushes serve as a high-speed mechanical switching system to serially distribute current to the rotor or armature coils and produce torque as they interact with the magnetic field produced by the stationary field coils.

In addition to the air-moving applications mentioned above, universal motors are commonly found in smaller, corded appliances, possess high speed and have excellent starting capability. Their speed-torque characteristics make them ideal for driving fan loads. They speed up in a non-linear way as load decreases and partly compensate for clogging filters in vacuum cleaners, delivering sustained performance. The workhorses of many applications, these motors are economical, have a high horsepower-per-pound ratio and

are less costly than their brushless counterparts.

### Design and Speed

When it comes to your application, you may have several goals to consider. Vacuum or pressure, airflow, cost, life and noise are just a few. Brushed motors are less expensive than their brushless counterparts. However, they do not provide the same features or life expectations. Brushes are consumable items.

While brushless motors do provide longer life, there is a cost for the magnets and electronics. Many brushless blowers also offer other technical features such as speed control, tach out signals and programmability. Brushed motors are more basic but deliver a lot of performance relative to cost.

The output power of a motor is the product of torque and speed at a given point, or: P ~ T x N

By taking speeds up, torque requirements are reduced at the same power level. Further, torque is proportional to the copper and steel content of a motor. Fans are smaller and faster. Smaller, faster motors allow similar air performance (output power) in a smaller, lighter and less expensive package.

When it comes to speed, brushed vacuum motors are fast. Historically, their standard speed was 15,000 to 25,000 RPM. This has been limited by component reliability. In recent years, however, material-savvy design evolution has allowed the standard speed to increase to between 30,000 and 40,000 RPM in many models. Some designs routinely run 40,000 to 45,000 RPM, while others exceed 50,000 RPM.

Smaller and faster motors present challenges to rotating components. Therefore, manufacturers rose to the occasion.

- Bearing manufacturers improved their designs with new greases and glass-filled nylon ball cages.
- The commutator manufacturers improved their bar anchoring systems, developing internal reinforcing rings and better phenolics.
- Carbon brush manufacturers developed additives for their molded brushes to promote good filming at high speeds and to reduce friction wear and arcing.
- AMETEK Dynamic Fluid Solutions has also stepped up its manufacturing game with improved processes to allow reliable operation at these speeds. Processes such as commutator turning, fusing and armature impregnation are critical to long life.

### Applications – Managing the Air Path

Vacuum blowers are available in two basic styles, thru-flow and bypass, referring to the relative paths of the working and cooling air. Each has advantages depending on the application.

### Thru-Flow Motors

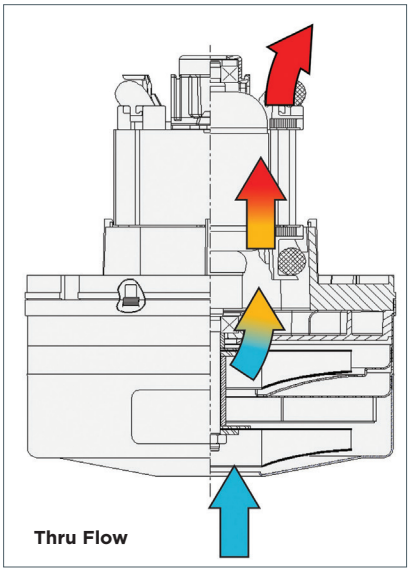
In thru-flow motors, the dry, filtered working air travels through the fan system and is discharged directly over the motor windings as it exits. The working air provides the cooling air for the motor. For thru-flow motors:

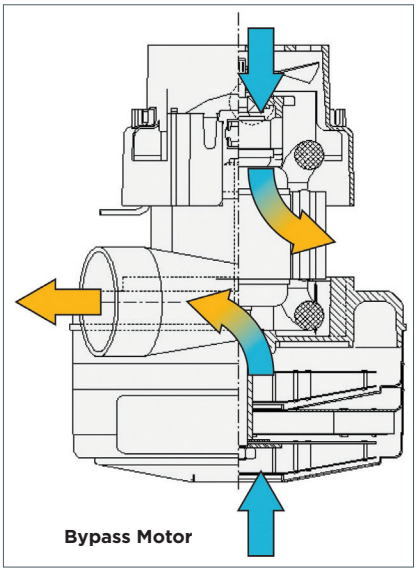
- Working air = cooling air
- Restriction in working air restricts the cooling ability of a motor; often thermal protection is required.

Thru-flow motors come in single- or two-stage configurations. Adding multiple fan stages allows pressure to build with each stage, delivering higher vacuum or pressure to the application. Single stage systems tend to provide better airflow at lower pressure/vacuum.

### Bypass Motors

In bypass motors, the working air is independent from the cooling air. A separate fan is used to direct cooling air over the windings. Bypasses are used when it is important to ensure that the cooling air doesn't mix with the vacuum or blower working air. Since the working air does not travel across the motor windings, bypass motors are a great option for scrubbers, carpet extraction and other wet pickup applications since debris and moisture will not contact the windings directly. The working air should still be filtered. However,


Thru Flow


Bypass Motor

bypass motors are not designed to pump water.

The OEM designer must take care when designing a bypass motor into a system:

• The working and cooling air systems are separated from each other; they operate at different pressure levels. Mixing them can disrupt the cooling flow.

• The cooling air path should be baffled to separate the cooling inlet from the cooling exhaust. Failure to do this can cause recirculation with increased heating of the air and poor cooling performance.

Bypass motors are available in peripheral and tangential discharge configurations and in single or multiple stages. Again, the purpose of the stages is to create more pressure or vacuum.

For bypass motors:

• Working air ≠ cooling air.

• There is a separate cooling fan.

• The separate paths can safely handle moist working air, but not liquids.

• Working air discharge can be tangential or peripheral.

AMETEK Dynamic Fluid Solutions also offers bypass designs in various diameters from 4.2''— 9'' in many vacuum and airflow ranges.

Your AMETEK Dynamic Fluid Solutions sales engineer can help you select the right motor for your needs.

## Determining the Ideal Design for Brushed Vacuum Motors

Since there are a variety of brushed vacuum motors available (currently more than 1,400 unique AMETEK Dynamic Fluid Solutions models), there are questions you should ask to determine the ideal design for your application. These include:

• What type of air will be picked up? Do you need a motor that has to pick up dry or moist air?

• What are the cooling requirements? You will need to figure out whether external cooling will be necessary, or if there is enough working air flow for cooling. Will some sort of thermal protection be required?

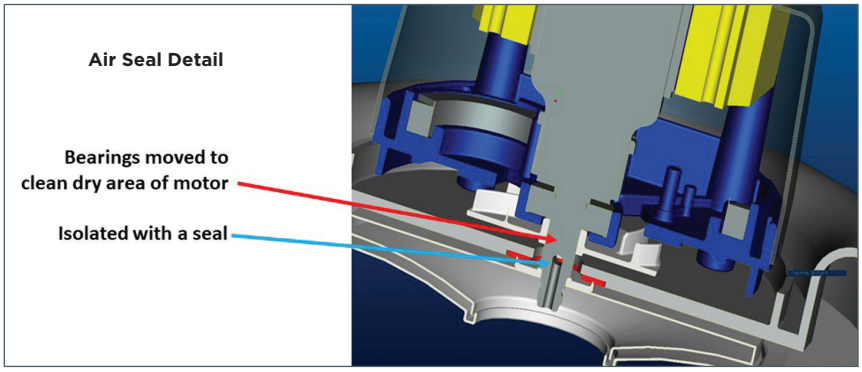
• What will the operating point be? You will need to determine what kind of airflow rate, pressure or suction, current draw or input power will be necessary to perform the intended job.

• What is the type of voltage? You will need to understand the available operating voltage. Will you need an alternating current (AC) or a direct current (DC) motor? Are you using line voltage or batteries? Or some other power supply? Universal motors can run on AC or DC, but they are sensitive to voltage. They must be designed for the operating voltage. What is your operating voltage level?

• What other features do you need? Does your application require thermal protection, serviceable brushes, air discharge (tangential, peripheral or thru-flow) or bearing protection? What about specific life?

• Do you have regulatory agency requirements? Specific insulation class needs? Thermal protection for locked rotor in unattended installations? End-product agency requirements such as blocked inlet protection?

By taking the time to think about the answers to these questions and collaborating with an AMETEK Dynamic Fluid Solutions sales engineer, you can determine the right vacuum blower for your needs.




## Protecting Bearings Against Moisture

Lamb® vacuum motors by AMETEK Dynamic Fluid Solutions take the worry out of protecting bearings from moisture damage. Our engineers have developed several solutions to protect bearings in moist applications. We use a patented air seal technology where a small fan creates a localized pressure in a chamber near the bearing. The pressure pushes moisture-laden air away from the bearings to keep them free of contaminants.

In addition, we use a PTFE washer on the shaft and right below the bearings on the pressure side. It works to create a physical sliding seal, keeping moisture away rather than using pressure to blow it away. Some motor designs incorporate both air seal technology and PTFE washers.

Our 6.6'' and 8.4'' bypasses have been designed with a physical separation between the bearing and the fan system offering the ultimate bearing protection.

We prove our designs by using a specialized life test to ensure optimal moisture protection. The test exposes the bearings to detergent suds and validates the effectiveness of the bearing protection. For additional protection, we also choose precision ball bearings with specialized greases and seals. ●



***Dave Gill*** *is a Senior Project Engineer at AMETEK Dynamic Fluid Solutions in Kent, Ohio. He has over 40 years in the motor and floorcare industries, mostly in universal motors. He works in both motor design and customer application engineering. Dave has a BS in Physics and Mathematics from the University of Mount Union.*

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