THE ASSEMBLY SHOW ISSUE / POWDER COATING SUMMIT ISSUE

APPLIANCE & HVAC REPORT

Reaching Design Engineers at the OEM Level

September/October 2020 VOLUME 2 ➢ NUMBER 4



11 FEATURES COVERING

COIL COATING
SENSORS
INSULATION
ADHESIVES
ECOFRIENDLY
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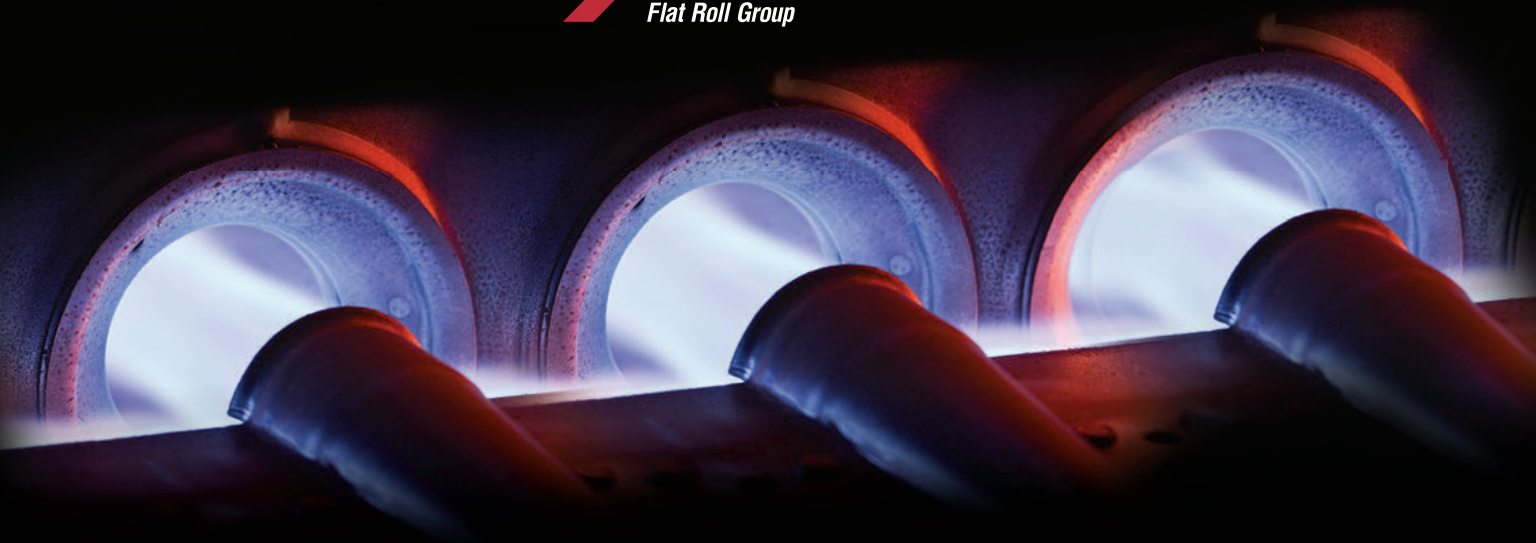
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Coronavirus Crisis



Wow, what we have all been through. Hard to believe. When your 5 year-old grandchild tells you, as mind did, "the coronavirus is here" you know everyone in the world must know about it.

Appliance & HVAC Report debuted last year in September, with plans to be bi-monthly in 2020. Events have forced us to scale back, so this is the only issue scheduled for the second half of this year. That means in total we had 4 issues in 2020. Timing is everything. So this will be our final issue of the year

Having said this, we did our best to come out with a strong edition, complete with excellent white papers and news items. That's our mission.

Our readers have remained loyal to us, as the open rate for our issues continue to range between 10-20%. Same with the eblasts we do for our advertisers.

One of our primary news items is ***Carrier Corp***. becoming an independent company again, after being part of ***United Technologies*** (UTC) for many years. As someone who grew up in Syracuse, NY I remember Carrier being headquartered there. And therein lies a tale.

1979 was a pivotal year. The explosion at Three Mile Island occurred. John Wayne died. And Carrier was bought out by UTC. Also, that year Carrier donated more than $3 million for naming rights to what became the Carrier Dome, where Syracuse University plays football and basketball, has concerts and myriad other activities.

The takeover of Carrier was not welcome. Carrier had a huge footprint in Syracuse. In fact, exit 35 off the New York State Thruway leads to Carrier Circle. And as I mentioned, the Carrier Dome.

Supposedly, in an act of defiance against UTC, Carrier donated more than $3 million for naming rights 'In perpetuity". Whether its true or not I don't know, but it certainly makes a great story.

The venerable ***New York Times*** has come out recently with a Home section in its Sunday paper, since so many of us are home more than ever before. And appliances are a big part of it. Part of this section is called "The New Essentials". Here are some recent ones as it relates to our market:

Make Good Coffee: Aero Press Coffee and Expresso Maker, American Weigh Scales LB-3000 Compact Digital Scale, Barzata Encore Conical Burr Coffee Grinder, OXO Brew Adjustable Temperature Pour-Over Kettle and Kalita Wave 185 Dripper

Clean Up the Mess (especially written I think for guys like me)**:** Black + Decker 20V Max Lithium Proof Pivot BDH2000 PL Hand Vacuum, Coway AP-1512HH Mighty Air Purifier, Zojila Rohan Dish Rack and iRobot Roomba 614 Robot Vacuum

Last but not least, here is our list of companies whose white papers/technical articles are in this issue: Bosch Rexroth, Comsol, Douglas Electrical, Dow, Fenwal, Inficon, Environmental Health and Engineering, International Copper Association, JBC Technologies, Littelfuse and National Coil Coating Association.

These are trying times, but we hope you are managing them, personally and professionally.

Founder & Publisher
Brad Glazer
Appliance & HVAC Report
(216) 233-6943
brad@appliancehvacreport.com

APPLIANCE & HVAC REPORT
Reaching Design Engineers at the OEM Level

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Brad Glazer
Founder & Publisher
brad@appliancehvacreport.com
(216) 233-6943

Mike Venezia
Account Executive, New England
Mike@appliancehvacreport.com
(860) 670-6909

Carol Lawrence
Sales Manager, Special Accounts
carol@appliancehvacreport.com
(435) 659-1855

Jeff Greene
Art director
jeff.greene1116@gmail.com

JABS Media, LLC

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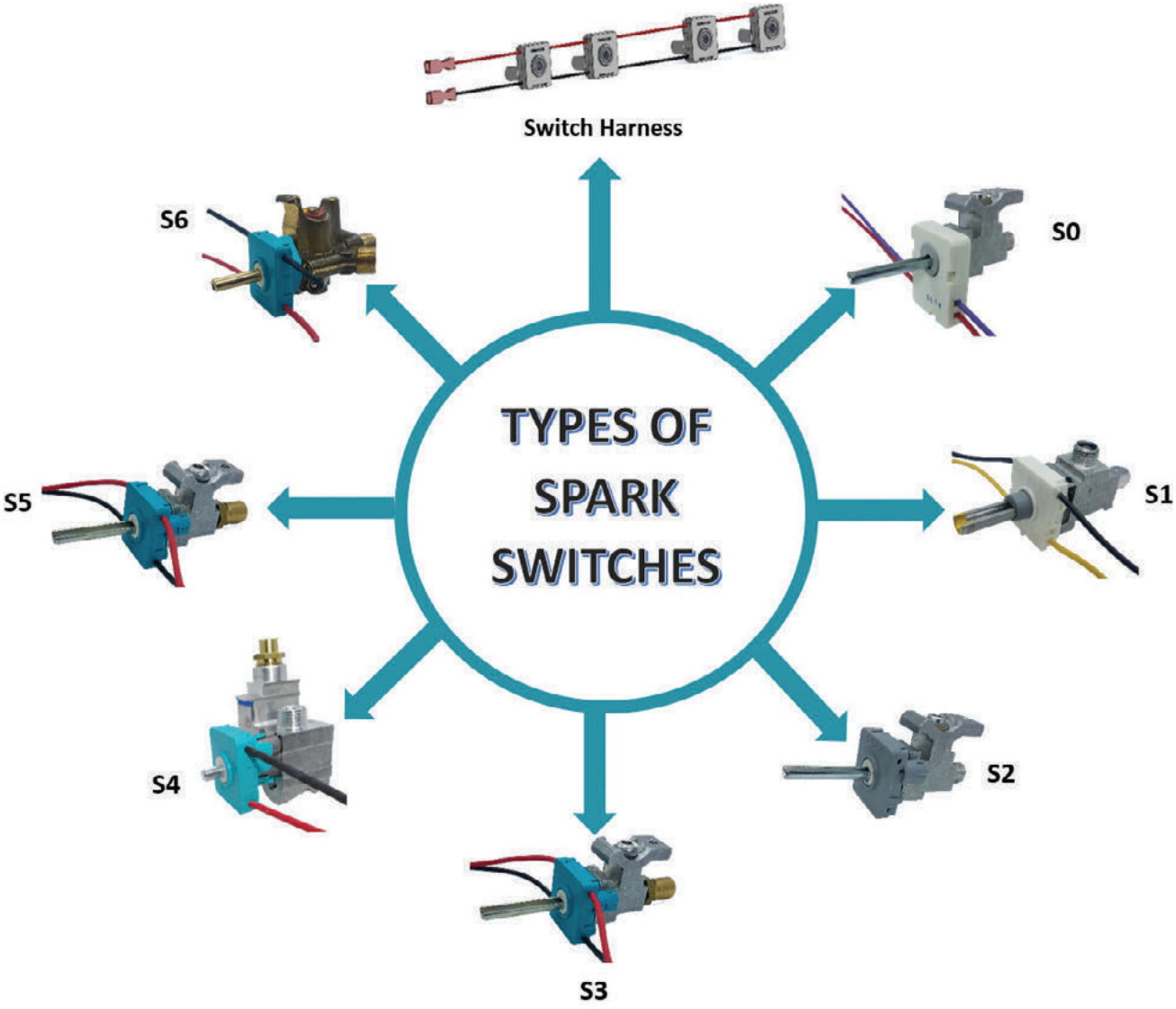
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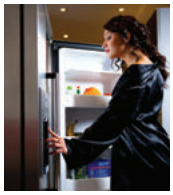
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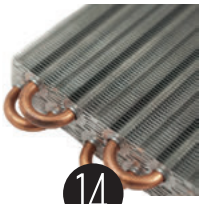
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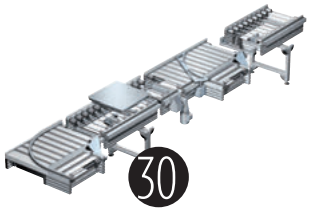
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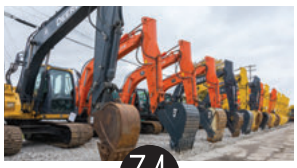
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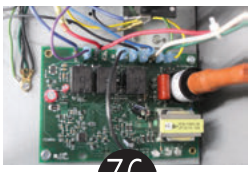
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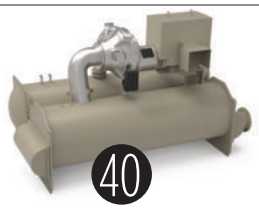
Gas-¬fired appliances can benefit greatly by using direct spark ignition (DSI), provided engineers know how to address potential electrical noise challenges.



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Coil Coating is Not Finished Yet

BY THE NATIONAL COIL COATING ASSOCIATION

Benjamin Franklin is attributed with saying, ''When you're finished changing, you're finished.'' This Founding Father was not speaking about technology and definitely was not speaking about appliances; however, his words could not be more appropriate for the evolution of coil coating in the appliance sector.

More and more, appliances reflect the changing trends, styles, and preferences of consumers. Long gone are the days of harvest gold or avocado refrigerators that did not match any other appliances in the home. Today's consumers want options, cohesive products, and functionality without sacrificing beauty; and the coil coating industry has been meeting those needs for many years.

In the 1980s and 1990s, prepainted metal began to be used on appliances; however, there were some limitations due to the severe temperature requirements, stain resistance needs and other manufacturing considerations. Over time, more and more painted coils began to arrive at OEMs' sites pre-finished (i.e., a paint line was no longer needed) and ready to be fabricated. This is because coil coaters and coating manufacturers were listening and changing. When a new method to measure color was needed to ensure uniformity, the industry responded. When manufacturers asked for paints that could be harder for stain resistance, yet still more flexible for formability, the industry responded. When they asked for prepainted coils with two finished colors so panels could be flipped from a bisque color on one side of the part to a white color on the other side depending on the kitchen suite, the industry responded.

In the early 2000's when washing machines moved from top loading to front loading, bright colors, high gloss blacks, and metallics also emerged. Washing machine and dryer pedestals, refrigerators, and other home appliances were available in these new colors and metallics. The coil coating industry rose to the challenge to change and adapt to the needs of the appliance industry to meet these new modern looks. Due to the versatility and uniformity of prepainted metal, coil coaters could match parts that were either post painted or plastic. This was possible because lot-to-lot variation of prepainted metal is strictly controlled through the highly automated continuous process of prepainting. In the coil coating process, metal is coated flat, before it is cut and formed

by the appliance manufacturer, allowing for tight controls from edge to edge and head to tail. In one continuous process, a 20-ton coil can be cleaned, treated, painted or laminated, and even embossed, providing color uniformity.

In recent years, stainless steel and coated stainless products have become the predominant style. Manufacturers strive to give homeowners a suite of kitchen appliances that all match with a modern look, but each does it with their own signature twist. Signature-looks are achieved through brushing, embossing, or tinting. Each appliance OEM has its own unique specifications to meet the consumers' desire for matching modern designs. With the technology and versatility of the coil coating process, prepainted metal has been their solution. Prepainted metal can be smudge proof, allowing stainless steel appliances to be fingerprint resistant and much easier to clean. Prepainted metal can even be engineered with anti-microbial additives which inhibit the growth of bacteria. Film laminates can be applied to prepainted metal that offer an alternative to traditional coatings. Whatever the need, whatever the challenge, prepainted metal can likely meet it.

In addition to the benefits of coil coating adapting to meet the innovative changes in the industry, appliance manufacturers have benefitted by using prepainted metal by reducing their costs and their need to meet environmental regulations. Using coil coated metal, OEMs eliminated the EPA compliance requirements associated with a paint line and the subsequent work-in-process inventory required for in-house painting.

The benefits of coil coated metal are nearly endless. They range from



eliminating an in-house paint shop to increasing productivity all while providing a product with superior corrosion resistance. The coil coating industry has risen to every challenge to meet the needs of the appliance manufacturers and their customers. When there is a new need in the appliance industry, the coil coating industry responds…always has, always will. We're not finished changing yet. ●

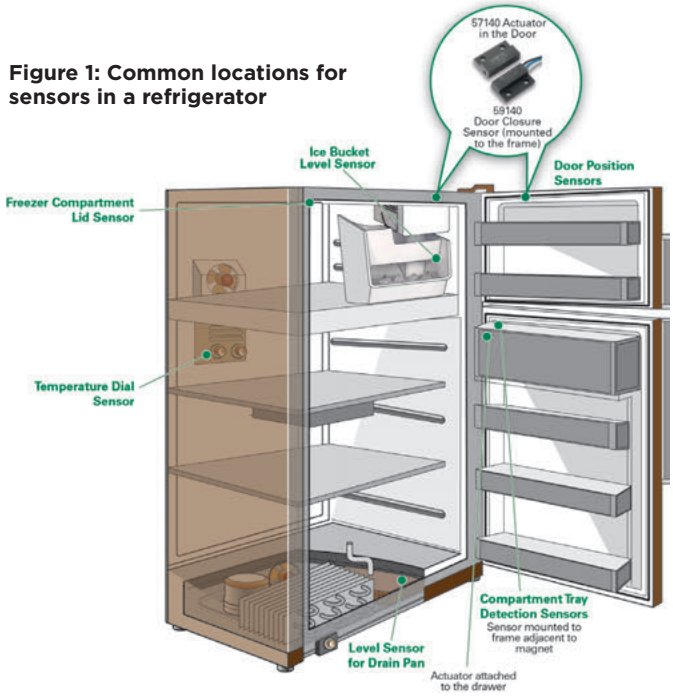
The National Coil Coating Association *(NCCA) is the association of businesses engaged in the process of coating coiled metals. Founded in 1962, NCCA consists of leading coaters and suppliers to the coil coating process. Coil coating is an automated process that permits a high degree of customized coatings to produce a cost-effective, environmentally friendly, quality product. Prepainted metals are used in a wide variety of industries including construction, appliance, transportation, automotive, HVAC and many more.*

For more information about coil coatings, cut edge resistance, anti-microbial coatings, or to find a supplier visit the National Coil Coating Association website at **www.coilcoatings.org**





Figure 1: Common locations for sensors in a refrigerator



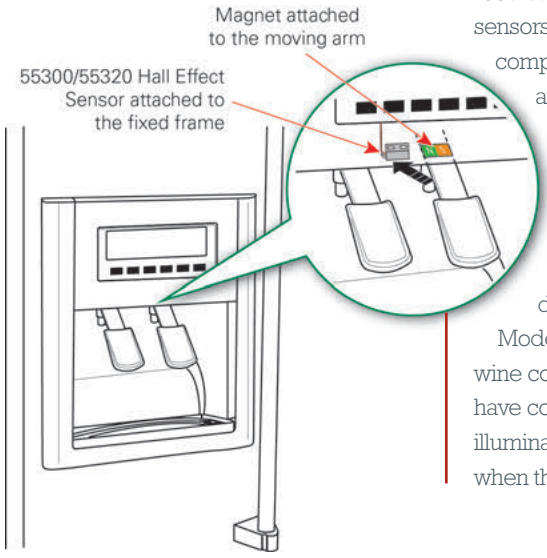
Position and Level Sensing Applications in Refrigerators and Freezers

BY RYAN SHEAHEN

Refrigerators, freezers, and wine coolers are among any household's major energy consumers. In fact, according to the U.S. Energy Information Administration's Residential Energy Consumption Survey, the refrigerator is the second-largest user of electricity (13.7%), right behind the air conditioner (14.1%). As with many other modern appliances, microprocessor-based electronics in refrigerators and freezers allow better control over various functions, allowing designs to better enable energy efficiency. These modern electronics also enable use of a variety of sensors to ensure reliable, safe, and more energy-efficient operation (Figure 1 and 2).

Reed sensors and Hall effect sensors are both highly reliable and will operate over millions of cycles with long-term integrity when used with microprocessor logic-level electrical loads. Both types of devices are operated by a magnetic field.

Figure 2: Sensor and magnet positions on a water/ice dispenser



Reed switches and sensors consume no power; Hall effect devices are semiconductors and will consume a small amount of current in both activated and de-activated states.

Refrigerator and Freezer Door Position Sensing

Refrigerators equipped with a microprocessor control unit are compatible with the use of noncontact-type sensing technologies such as reed switches/sensors and Hall effect sensors. These technologies are very compatible with the low DC voltage and current requirements of the microcontroller.

The traditional mechanical and plunger-type switches previously used for switching 120 VAC incandescent lights directly are no longer necessary. Modern refrigerators, freezers, or wine coolers that use a microcontroller have converted to an LED light to illuminate the interior compartment when the door is opened, which

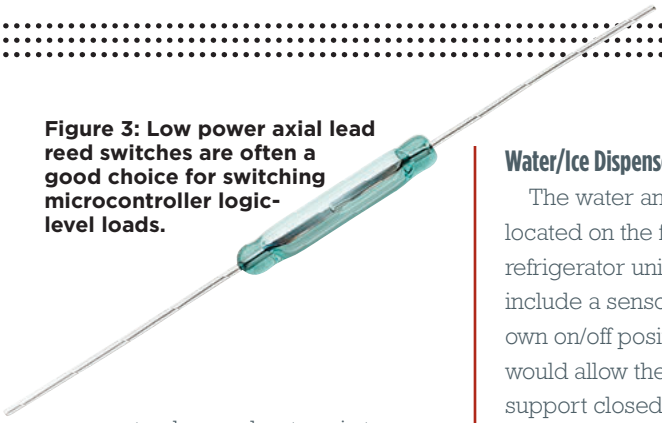


Figure 3: Low power axial lead reed switches are often a good choice for switching microcontroller logic-level loads.

represents a huge advantage in terms of energy saving. A proximity sensor is needed to detect if the appliance door is open or closed.

A reed sensor (Figure 3) or Hall Effect sensor can be used to detect the door's position. For example, in refrigerators, a reed sensor is mounted to the frame of the appliance and a permanent magnet actuator is mounted to the door. Each reed switch or Hall Effect sensor and magnet actuator is positioned in such a way that the reed switch or Hall Effect sensor is activated when the door is closed, and the light will turn off. When the door is open, the magnet on the door is outside of the sensor's activation range, so the sensor is deactivated and the light turns on. The controller uses reverse logic to control the light relative to the sensor activation.

The sensor units are not visible because they are mounted behind the panels of the frame or door, which greatly improves the aesthetic appeal of the appliance. Unlike mechanical or plunger switches that have visible levers or buttons, these noncontact sensors don't require making physical contact to operate.



Figure 4: This Hall effect sensor's rectangular package is ideally suited for mounting on a flat surface. Applications include water/ice dispenser lever position sensing.

Water/Ice Dispenser Lever Position Sensing

The water and ice dispenser located on the front of a French door refrigerator unit presently doesn't include a sensor for detecting its own on/off position. Adding a sensor would allow the microcontroller to support closed-loop operation for the dispenser. Various options are available, including a digital signal or a rotary ratio-metric output or even a linear ratio-metric output.

The digital version would be a simple reed or Hall Effect sensor mounted to the fixed frame, while the magnet would be attached to the moving lever (Figure 4). With this system, the water or ice is at one filling or flow rate; that is, it is either on or off.

However, using a ratio-metric output Hall Effect sensor provides continuous feedback relative to the exact lever/magnet position on a linear scale. With the exact position being monitored by a microcontroller, the system can dispense the water at various flow rates. A non-contact sensing solution is preferable for improved long-term reliability. A programmable rotary Hall Effect sensor would be ideal for this application.

For instance, when the lever is in its normal open position, the voltage output from the Hall effect sensor could be programmed to 0.5Vdc, while the maximum swing of lever movement would be programmed to 4.5Vdc. In between these values, the water flow rate can be controlled





Advantages of Reed Switches and Hall Effect Sensors

REED SWITCHES

- Switch activation does not require physical contact
- Switch contacts are within a hermetically sealed capsule
- Resistant to moisture, dust, and other foreign objects
- Wide operating temperature range
- Reliable switching
- Long lifetime

HALL EFFECT SENSORS

- No physical contact required to operate the sensor
- Wide operating temperature range
- Digital or analog options for output signal
- Programmable on both digital and analog applications for tight output tolerances
- Effective for high-speed applications
- Encapsulation provides additional protection against mechanical stresses
- Long lifetime and reliable sensing for millions of operations

based on the exact position that the lever arm is positioned.

Drawer and Compartment Cover Position Sensing

A number of potential sensing applications are centered on the various compartments within a refrigerator and freezer. Compartment doors for butter or drawers for produce, meats, and deli foods can also be fitted with sensors for detecting opening or closure.

All of these sensors can be a reed or Hall Effect element with a digital output. The magnet would be mounted in the moving tray or drawer, while the sensors would be in a fixed position on the framing. If the tray or draw is not closed properly, a light could be activated on the unit to alert the user to the problem.

Ice Bucket Fill-Level Sensing

Refrigerators/freezers equipped with an internal ice maker and bucket typically use a mechanical arm over the ice bucket to detect when the bucket is filled to the top and turn off the icemaker.

Currently, this function is controlled with a mechanical switch and valve. In appliances containing micro-controllers, a reed sensor can be fixed to the frame and a magnet can be attached to the arm, allowing a more reliable sensing mechanism than the existing mechanical units.

Temperature Control Dials Position Sensing

In older refrigerator/freezer combo designs, both the freezer and refrigerator compartments have rotary temperature adjustment dials, which are usually resistive film or potentiometer-type adjusters.

In micro-controller equipped systems, a non-contact sensing solution would be preferred for improved long-term reliability. A

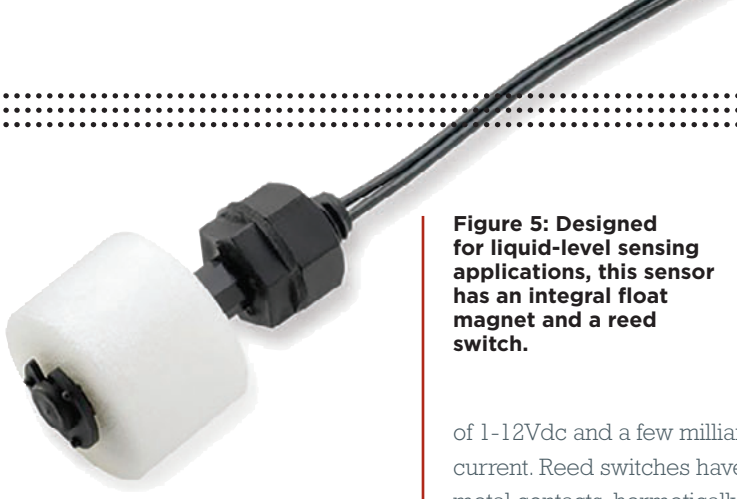


Figure 5: Designed for liquid-level sensing applications, this sensor has an integral float magnet and a reed switch.

programmable rotary Hall Effect sensor is ideal for this application; with 0.5V to 4.5Vdc output over 360 degrees of rotation.

Drain Pan Level Sensor

Most refrigerators have a shallow drain pan at the bottom for catching leaking water from the refrigerator or freezer compartment. Because this pan is typically not readily visible, it can be difficult to detect a leak until the water overflows and leaks out on the floor. A reed level sensor would be of great benefit for this application (Figure 5).

This digital output sensor can detect when the water level is too high in the drain pan and the controller would activate an alarm or light.

When to Use Reed vs. Hall Effect Sensors

A reed switch is a magnetically operated switch that in most situations is normally open when no magnetic field is present. When a magnetic field in proper alignment and of sufficient strength is present, the contacts of the reed switch will close and complete the circuit.

Reed switches and Hall effect sensors are magnetic switching devices, sometimes called "contactless" because the actuator/magnet does not need to make physical contact with the switch to change the state, unlike a micro-switch or a mechanical switch.

Reed switches are a perfect technology for switching microprocessor electrical loads of 1-12Vdc and a few milliamps of current. Reed switches have precious metal contacts, hermetically sealed within a glass envelope and filled with nitrogen gas. The switch can go through many millions of operations with no degradation or contact wear.

A digital Hall effect sensor is a semiconductor with unlimited life when driven by the proper voltage and current. Reed and Hall effect devices are long lasting and very reliable, even when used in applications with high humidity and varying temperatures.



Ryan Sheahen *is the Global Product Manager for magnetic sensor products within the Electronics Business Unit at Littelfuse. Ryan joined Littelfuse in 2011. When Littelfuse acquired Hamlin in 2013 he worked on the integration team and has been involved in the magnetic sensor business ever since. Ryan earned his BS in Mechanical Engineering Technology from Purdue University.*

Learn more about Magnetic Sensors and Reed Switches: ***Littelfuse.com/magnetic***

Download a complementary Sensing Products Selection Guide courtesy of Littelfuse: ***littelfuse.com/SensorsGuide***





Cutting to the Chase on Thermal Insulation Selection

A Material Converter's Perspective

BY JOE BLISS

Thermal insulation… whether you're an appliance OEM or an HVAC systems designer, it can be a challenging subject. After all, knowing which thermal insulation would be best for your application out of what can seem like hundreds of options can be a time-consuming exercise.

One resource to be considered in your search for the perfect insulation is your flexible materials converter. Converters work directly with many different thermal insulation manufacturers to identify and source the raw materials needed to make die-cut and custom-engineered insulation panels and gaskets for customers. Therefore they have a unique perspective on challenges design engineers are trying to solve and the breadth of available solutions.

And, while a material manufacturer may tend to limit their focus – and recommendations – to their own products, converters can present our customers with a much broader set of options.

Getting Started: Identifying the Factors that Impact Material Choice

The first question when asked for material recommendation is, "How and where will it be used?" With thermal insulation, this leads to follow-up questions regarding the method of heat transfer.

Environment

Asking where and how the thermal insulation is going to be used may sound like a basic question, but it is, in fact, foundational. Factors like temperature, moisture and vibration can all wreak havoc on yinsulation if the right material isn't chosen. And because we work in so many industries, you might be trying to solve a problem that is new to HVAC or appliances that has been seen previously in automotive and/or industrial applications.

Things you'll want to consider include:

• **Intermittent vs. Continuous Temperature Requirements** – When looking at temperature

ratings it is critical to distinguish between intermittent and continuous temperature exposure. While some materials will withstand consistent exposure to high temperatures (continuous), there are lower temperature rated insulations that may be appropriate for occasional exposure to higher heat levels (intermittent). The lower temperature insulations often come with a lower price tag and are more than adequate for the end use application.

• **Exposure to Moisture** – Common insulation materials are hydrophilic, meaning they tend to absorb moisture, often leading to a loss of their form and thermal performance over time. But in some applications, where high moisture content or direct exposure to fluids is a possibility, this is not sufficient. If this is the case, consider the use of a hydrophobic or water-resistant material. Better yet, invest in an insulation that's shielded from the moisture completely by some type of physical barrier or coating.

• **Vibration** – While often overlooked, continuous, periodic and sustained movement can physically break down the fibers of an insulation over time, leading to declining performance and eventual failure. Insulation that will be subject oscillation, shaking, or other continuous movements should either be shielded or isolated from the movement or be constructed of a material able to withstand or absorb the vibration energy.

Heat Transfer

The method of heat transfer is important because different types of heat transfer require different solutions. Radiant heat, for example calls for an insulation with an emissive surface – shiny metal foil for example – that will reflect the unwanted heat away, preventing transfer into unwanted areas. Convective and conductive heat, on the other hand, both require insulation materials capable of withstanding direct contact with heated surfaces without breaking down.

Considering this at the outset of your material selection will help avoid miscues down the line.

Common Types of Thermal Insulation

Now that we've identified the critical performance parameters for the thermal insulation application, it's time to weigh our options.

Before selecting a material first look at insulation weight and density. These two characteristics will affect the thermal conductivity of the insulation material. In general, the higher the weight and density, the better insulator it is. However, these materials typically cost more and it's not always necessary to invest in the heaviest or most dense insulation. As such, you'll want to weigh your performance needs before investing in a heavier, more dense thermal insulation.

Ceramic blankets and papers

If you're in need of high-temperature performance and resistance, ceramic insulation materials are a natural fit. Ceramic blankets are flexible, lightweight, and perform in temperatures up to 2,000F (1093C). Ceramic papers offer similar benefits while offering a thinner profile for use in areas where space is at a premium.

Fiberglass

Woven fiberglass insulation is a common thermal and acoustic insulation option. Fiberglass insulation is available in both flexible and rigid forms and can serve as a cost-effective alternative for high-heat materials like ceramic.

Needled mats

Needled mats are non-woven insulation products made of silica, fiberglass, or other fibers. These mats are a versatile insulation option, as they are soft and compressible, come in multiple thicknesses and densities, and feature options with many temperature ratings.

Synthetic blankets

These lightweight, compressible insulations are made from hydrophobic synthetic fibers such as polyester or polypropylene. In addition to providing thermal insulation, synthetic blankets can reduce noise, vibration, and harshness (NVH) to combine acoustical and thermal management in one material solution.

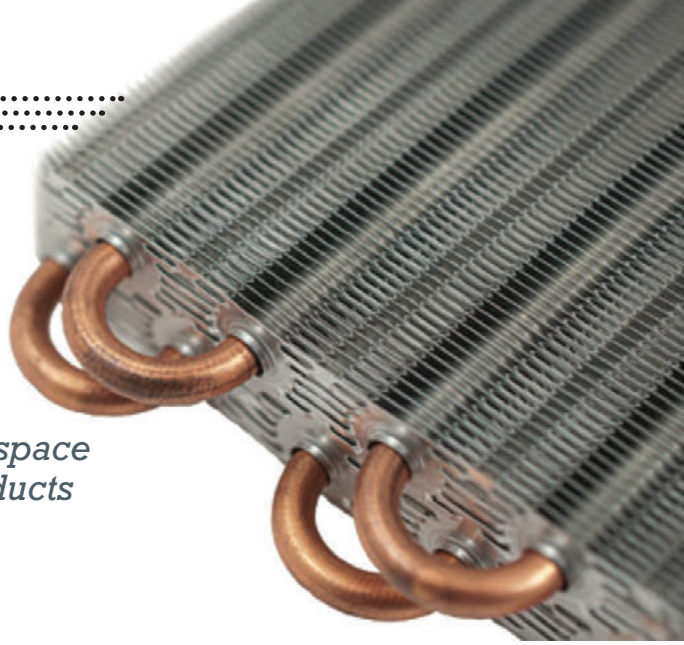
Working with the Right Partner Can Make All the Difference

The applications for heat management solutions can vary greatly, just as the variety of materials used to insulate their components do as well. Given the seemingly endless combinations it is not uncommon to over-spec a product, leading to unnecessary cost increases without a corresponding increase in value. Enlisting the help of a materials converter during the early design phase of your project may j save time and money. On top of this, using a rather non-traditional resource in your project planning may also open your eyes up to a much wider range of materials and applications than had previously been considered.



Joe Bliss *Chief Executive Officer at JBC Technologies, Inc JBC Technologies is a full-service manufacturing partner that converts flexible materials into custom die cut parts for leading manufacturers around the globe. To learn more, go to* ***www.jbc-tech.com***.

Heat-Exchanger Simulations Fast-Track Adoption of MicroGroove Copper Tubes



Powerful algorithms help to explore design space of ecofriendly products and to discover products with superior performance.

BY YORAM SHABTAY AND KERRY SONG

Computer simulations and design case studies illustrate how to design high-efficiency heat exchangers using smaller diameter copper tubes. The International Copper Association has supported research initiatives both in the USA and China for more than a decade. The main purpose of this research is to explore the design space for coils made from smaller-diameter copper tubes to work with new refrigerants, charge limitations and energy regulations.

This white paper outlines the design principles that serve as a foundation for the development of modern software tools for simulating the performance of smaller diameter copper tubes in ACR applications. It also describes the latest versions of two widely available simulation tools, including HXSim from the International Copper Association and CoilDesigner® customizable software tool from The Center for Environmental Energy Engineering (CEEE) at the University of Maryland. Finally, several case studies demonstrate the use of multi-objective genetic algorithm (MOGA) in the optimization of heat exchangers in various product categories.

Pioneering Work in China

Early in the development of smaller diameter copper tubes for heat exchangers, designers were guided by general principles, or "rules of thumb," and fin designs were not optimized for smaller diameter tubes. Progress was made in China by a research consortium that used a knowledge-based evolution method (KBEM) to eliminate unfeasible or impractical designs and simulations were performed, allowing for more efficient sampling of the design space [1-4].

From this research, various design principles emerged of great value

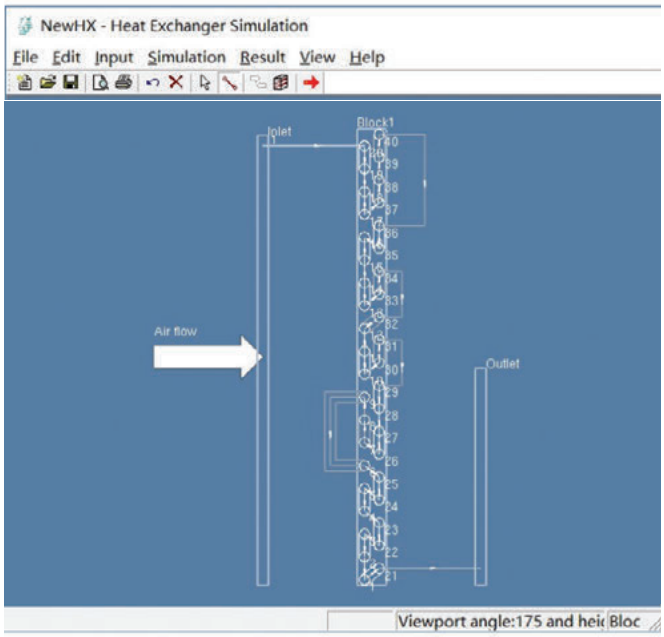


Figure 1: I-type heat-exchanger in 2D view.

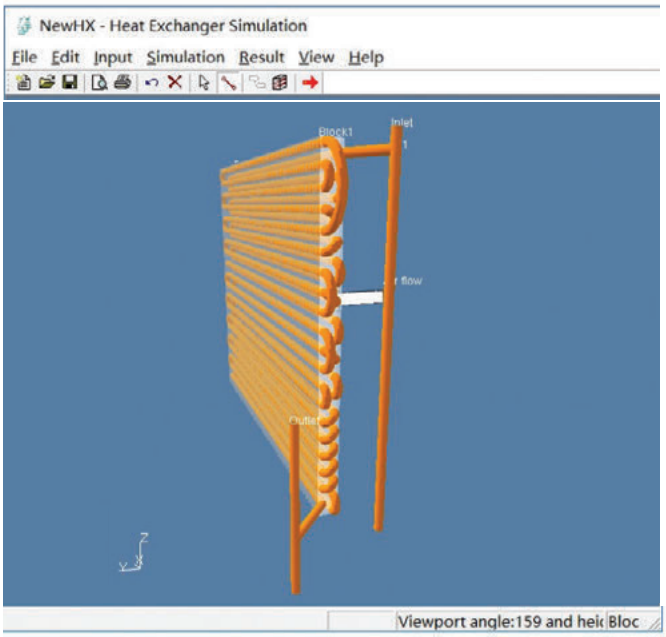


Figure 2: I-type heat-exchanger in 3D view.

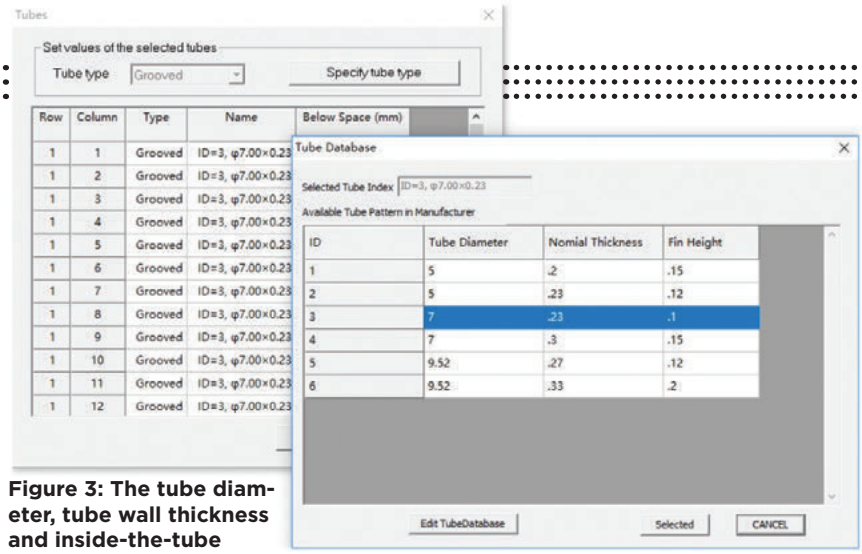


Figure 3: The tube diameter, tube wall thickness and inside-the-tube enhancements can be varied.

to anyone seeking to optimize material usage in air conditioning and refrigeration applications, whether for an evaporator or a condenser. The design and optimization of heat exchangers require the use of computational fluid dynamics (CFD) methods to analyze the airflow around the tubes and fins and also involves computer simulations of refrigerant flow and temperatures inside the tubes. The research consortium refined useful design principles as applied to smaller diameter copper tubes. These principles were developed into a step-by-step procedure that simulates and optimizes every aspect of the heat exchanger design, from tube spacing to fin type and tube circuitry.

This methodical approach to the design of heat exchangers using smaller diameter copper tubes is summarized by the following steps.

Step 1: Determine the best ratio of transverse tube pitch to longitudinal tube pitch by fin efficiency analysis.

Step 2: Optimize transverse tube pitch and longitudinal tube pitch by analysis of performance and material cost.

Step 3: Optimize fin pattern by comparing performances of fins with different patterns through CFD-based simulations.

Step 4: Test the performance of heat exchanger with smaller diameter tubes.

Step 5: Optimize the Tube Circuitry

These steps in the design of heat exchangers for air conditioning and refrigeration applications using smaller diameter copper tubes as described here are intended as a general guideline. Specific choices and recommendations are not given here, since such choices may depend upon other components in the system design.

Simply put, an air conditioning or refrigeration system consists of a compressor for work input; and condenser and evaporator coils for heat output and input, respectively. Maximizing the heat exchanger efficiency while minimizing the physical envelope and materials usage is the goal of most heat exchanger engineers.

Much attention has been focused in recent decades on refrigerants and valves for controlling and regulating refrigerant flow. Yet in the past twenty years, significant advances have also been made in the design of evaporator and condenser coils. These advances have been motivated by the conflicting needs to increase energy efficiency while also reducing materials usage.

It has long been understood that smaller diameter tubes increase the local heat transfer coefficient (HTC or "alpha") that governs the heat transfer between the refrigerant and the inside of the tube wall. The challenge has been to fabricate smaller diameter tubes and assemble them into heat exchanger coils. The proving ground has been the highly competitive, high-volume manufacture of residential air conditioning (RAC) systems, including window-type air conditioners as well as split units. The same design principles apply as well to larger commercial units, heat pumps, and distributed heating units.

Initially, prototypes were made simply by replacing larger-diameter copper tubes with smaller diameter copper tubes. The footprint of the heat exchanger in the product was unchanged and the fins in the coil designs were not optimized to the smaller diameter tubes. This could be referred to as the "cut-and-try method." Nonetheless, the results were immediate and dramatic and this intensified interest in further development.

Consider that if tube diameter is halved then the cross sectional area is cut by 75 percent. Besides reducing the amount of tube material, refrigerant volume could also be reduced. Furthermore, it is well known from

Table 1: Meanings of Parameters in Dimension Input Window

Parameter	Unit	Remark
Block type	—	I, L or C
Rows	Number	The number of rows of tubes in the heat exchanger
Depth	mm	Depth of fin-and-tube heat exchanger
Height	mm	Height of heat exchanger
Length	mm	Length of heat exchanger
Ambient Temperature	°C	Ambient Temperature
Fin type	—	Input by clicking button "Fins"
Fin pitch	mm	For variable fin pitch, click button "Specify"
Fin name	—	The name of the fin of the block
Continuous fins	—	Continuous planes or separated as bands
Control volume number	—	The maximum number is 10

tube stress analysis that the burst pressure increases as the tube diameter decreases, hence wall thickness could be decreased, resulting in a further savings of material.

Once OEMs fully understood how smaller-diameter copper tubes provide major competitive advantages, they embarked upon systematic approaches to optimize coils for specific products using various refrigerants.

Step 1: Tube Pitch Ratio

An evaporator coil or condenser coil is, of course, a component in a system and the tubes and fins are subcomponents. The first step toward an optimal heat-exchanger design is to select the tube pitch ratio, which may be quite different for smaller-diameter tubes compared to conventional tubes because the airflow around the tubes is not obstructed as much for smaller tubes.

If there are two rows of tubes then the ratio (P_t /P_l) between transverse and longitudinal tube spacing must be approximated before any further steps can be taken. Initially, values commonly used in heat exchanger designs are selected for fins with high efficiency with operating conditions such as airflow and tube-wall temperature as defined by the applications. The tube pitch ratio is then optimized for the particular application using CFD calculations.

Step 2: Tube Spacing

How far apart should the tubes be spaced in a multi-row design? The outside air pressure drop must be equal to or less than the design criterion; if the tubes are spaced too closely, this air pressure drop may be too high. The objective is to maximize performance while minimizing the cost. An overly large fin size would cost more to manufacture because it uses more fin material. It would also result in a heat exchanger that is larger-than-necessary. For evaporator coils, the condensate film that forms on the fin influences the choice of fin size. Tube spacing dictates the ''fin size'' that will be used in fin-design simulations. In most cases, the tube pitch ratio and tube spacing are interrelated.

Step 3: Fin Design

The next step is to optimize the fin pattern. The two most common types of fin patterns are the louver fin and the slit fin (or slotted fin). The CFD method is used to simulate both fin patterns. For the louver pattern, the independent variables are the louver angle and the louver number; the louver height and pitch are determined by these independent variables. For the slit pattern, the slit height is determined as one-half the fin pitch, so the only independent variable is the slit number.

It should again be stressed that the fin patterns that worked best for larger diameter tubes are not optimized to smaller diameter tubes and related fin sizes. Thus it is necessary to re-examine the design space for all types of fin patterns using CFD simulations. Only in this manner can the fin pattern be optimized for smaller diameter tubes. Ease of manufacture and assembly can also be a factor in the selection of the fin pattern.

The final fin pattern design that is selected may be specific to the final application. The objective in all pattern designs is to maximize the heat transfer capacity while meeting the requirement for a low air pressure drop. Of course, efficient heat transfer through the coils results in higher energy efficiency for the system because the refrigerant releases more of its heat in the condenser and absorbs more heat in the evaporator. Other criteria like tube-side pressure drop are examined and changes to circuitry are made if needed.

Step 4: Build and Test

At this stage, a reality check is necessary. An actual heat exchanger needs to be built and thoroughly tested in a laboratory wind tunnel. The heat transfer capacity can be experimentally measured as the refrigerant and air flow rates are varied. The former controls the internal rate of heat transfer and the latter determines the external rate of heat transfer. Heat transfer through the tube wall is a small factor due to its high conductivity and small thickness. The various components of the heat transfer can be represented as a circuit diagram.

Today's CFD simulations are very good. Case studies specifically on designs using small diameter copper tubes have been presented at numerous international conferences [5-6] including most recently at the 2019 IIR International Congresses of Refrigeration in Montreal [7].

The results of a well-designed simulation can be expected to agree well with experiment. Nonetheless, there is no substitute for the real thing. The experimental measurements can be used to develop prediction correlation equations, which can be used in further refining the heat exchanger design simulation program.

Step 5: Tube Circuitry

Tube circuitry simulations answer the questions about how many separate tube paths (branches) should be included in the circuit and what should be the length of each branch. If the paths are too short then the refrigerant might not reach the target temperature; if too long then the inside pressure drop may be too great, which is an important consideration as tube diameter decreases.

Temperatures vary throughout the heat exchanger as the refrigerant passes through the various circuit branches. Branches can be placed in the first or second row. Tubes at similar temperatures can be placed farther apart or closer together. The problem of optimization can become a complicated puzzle indeed. Fortunately, there are sophisticated software programs to do hard calculations. The software is based on the differential equations governing

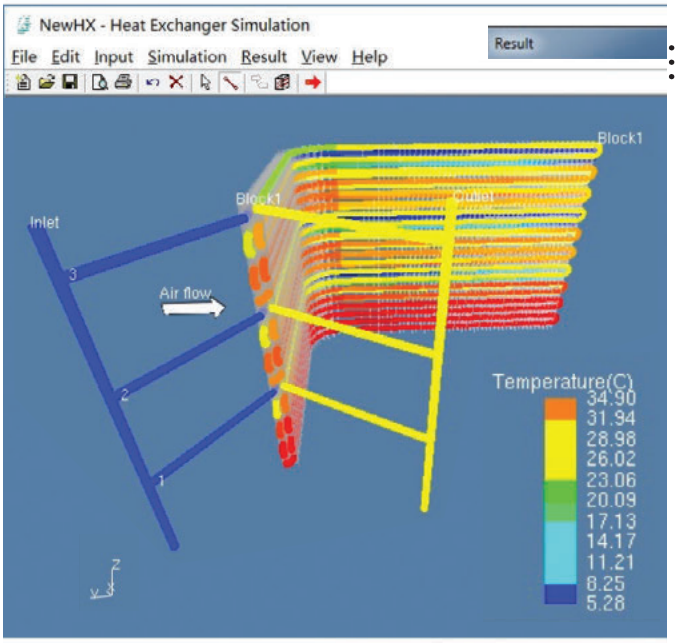


Figure 4: Simulation results in color gradation for an L-Type heat exchanger.

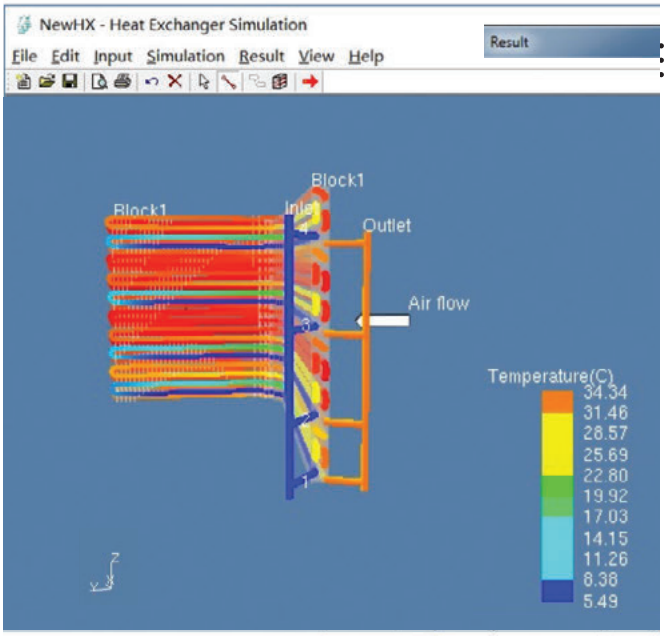


Figure 5: Simulation results in color gradation for an L-Type heat exchanger.

heat transfer and mass flow through the tube branches. The design space of possible tube configurations can be quite large so a knowledge-based search method is commonly used to reduce the search space.

Once the fin pattern and tube circuitry have been optimized then the heat exchanger is ready for use in the product design. The time to market for new products can be shortened by using the design principles outlined above.

Technologies for manufacturing smaller diameter copper tubes are now available as well as the equipment for making coils using such tubes. These technologies have been developed and proven in the highly competitive manufacture of residential air conditioners. The same manufacturing technologies can be applied to a wide range of air conditioning and refrigeration products. The only limitation is the imagination of the designer.

The HXSim Platform

The above fundamental design elements are now built into a user friendly package of simulation tools. Imagine a simulation program that allows one to build a coil from the most basic elements and then predict the performance in intricate detail. Furthermore, imagine a practically limitless choice of design criteria. Then imagine that this software tool could be run on a desktop computer via a user-friendly graphical user interface (GUI) and that it comes with an easy-to-follow user's manual. And, finally, just imagine that it is available at a nominal charge. That in a nutshell is the HXSim "Small Diameter Copper Tube Air Conditioning Heat Exchanger Simulation Tool."

According to the manual, the main function of HXSim is to give accurate calculation results for predicting the capability of small-diameter copper-tube air conditioning heat exchangers in steady state conditions.

Once the user inputs the coil design parameters, the software calculates such quantities as heat exchange capacity, refrigerant-side pressure drop, and airside pressure drop; and it displays the results in easy-to-understand graphic or tabular formats.

The GUI makes it easy to enters data and observe simulation results. Both 3D and 2D options are available (Figs. 1 and 2).

HXSim can simulate fin-and-tube heat exchangers for a variety of refrigerants and types of heat exchangers. The user can vary the tube size, fin design, and tube circuitry as well as many other parameters. The tool gives the heat exchanger engineer deep insights into the interrelationships between various coil design parameters.

This powerful software tool was developed at Shanghai Jiao Tong University (SJTU) for many years under the auspices of the International Copper Association. The project was overseen and coordinated by the renowned Professor Guoliang Ding of the Institute of Refrigeration & Cryogenics in Department of Power & Energy Engineering at SJTU.

HXSim represents the next big step in simplifying the design of advanced MicroGroove heat exchangers. Professor Ding has continued to spearhead the development of heat exchangers using smaller diameter copper tubes in a variety of air conditioning and refrigeration products as well as heat pumps.

Inputting the Design Parameters

The latest version of HXSim (version 3.0) is well documented with a user manual submitted by Professor Guoliang Ding. The manual is available for download from the technical literature webpage of the microgroove.net. [8]

When using the program to design a MicroGroove heat exchanger, the most basic input has to do with the type of refrigerant, the type of heat exchanger and the heat exchanger dimensions. The three main "Types" of heat exchanger blocks are the I-Type, L-Type and C-Type. (The most basic block shapes roughly correspond to the shapes of the letters I, L or C.)

The detailed meanings of the dimension input window are shown in Table 1. In these inputs, the "Row number" is of first importance. Only after inputting the row number can the column number of each row and the tubes in each column be defined.

Next the designer can input the row spacing and the column numbers for the tube locations. Then the fin-type can be selected and data can be entered on the joints. The "Connect Tubes" function is a vital step, which can also be accomplished through the easy-to-use 2D or 3D graphical user interface.

The program allows the user to select the inlet airflow, which does not need to be uniform across the heat exchanger. A number of variables are available with respect to the inlet airflow.

A database of tube types as well as fin types is available for use. The outer diameter of the MicroGroove tubes may be as small as 4 mm. The tube wall thickness and inner tube enhancements can also be varied. See Figure 3.

In summary, users can input parameters such as dimensions of heat exchanger, tube and fin geometry, refrigerant circuitry and operating conditions through the interactive GUI. The details of the heat-exchanger shape, tubes, fins, refrigerant and air-flow are entered via data input dialog windows. Clicking the "Ok button" checks the values and closes the window. A warning dialog shows if the input data entered into some edit box is not apropos.

Outputting the Performance Results

Once all the inputs have been provided, the user is ready to run a simulation. Figure 4 and 5 shows how simulation results can be presented as a three-dimensional colored graph. Actually, a much finer analysis is available with steady-state values of temperature and pressure available at practically any point in the path of the refrigerant.

The simulation package will output calculated quantities such as heat exchange and outlet conditions of both refrigerant and air. The calculated results can be displayed in tables and charts as well as 3D colored visualization of the properties at every location in the coil. It is also possible to print 2D and 3D heat exchanger graphs. Results can be saved and files can be serialized allowing for the application of various optimization algorithms.

The following menu items are available only after the simulation of heat exchanger is accomplished.

"Chart" provides an access to see both inlet and outlet state parameters of air/refrigerant in every control volume of every tube through a selected refrigerant path in charts.

"Table" provides an access to see both inlet and outlet state parameters of air/refrigerant in every control volume of every tube through a selected refrigerant path in a whole table.

"Graph" provides an access to open the results window which shows the simulation results.

Additionally, the menu item "Cost" provides an access to open the cost window which shows the heat exchanger cost. This menu item is available independently of the simulation results.

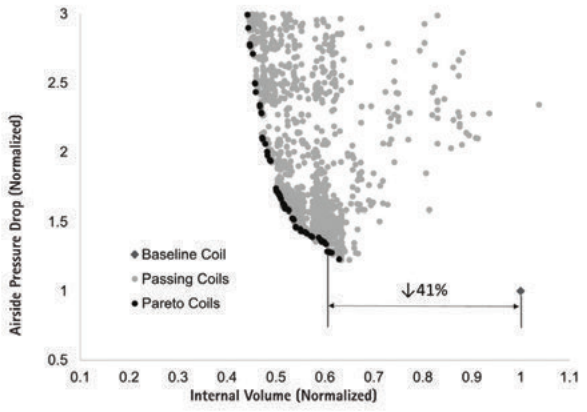
Available from MicroGroove

The International Copper Association wants you to become an expert in the design of heat exchangers made from smaller-diameter copper tubes. The HXSim software package makes it easier than ever to grasp the relationship between

Table 2: Optimization Results for Drop-in Replacement of Window Air Conditioner

Design	Tube Material (kg)	Fin Material (kg)	Percent Material Reduction Simulated	Percent Charge Reduction Simulated	COP Simulated (Measured)	Percent COP Improvement Simulated (Measured)
Baseline	1.8	2.5	—	—	2.60 (2.86)	—
Slit fin, 17 fpi	1.4	2.0	21	24	2.76 (2.97)	6.1 (3.8)
Louver Fin 15 fpi, 3 row	1.0	1.3	47	46	2.64	1.5
Louver Fin 13 fpi, 4 row	1.3	1.4	37	10	2.77	6.5

Figure 6: The best 5 mm design reduced internal tube volume by 41 percent.



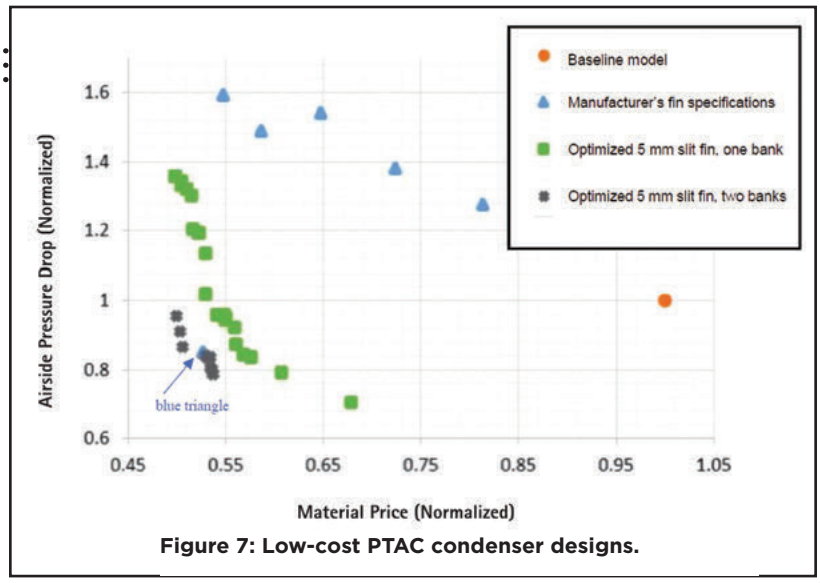


Figure 7: Low-cost PTAC condenser designs.

various design parameters. It helps to strike a perfect balance between cost limitations and performance objectives.

Running HXSim simulations on proposed designs allows one to accurately predict the performance of the coils before building and testing prototypes and investing in the tooling to manufacture coils in volume.

HXSim is not the only simulation tool available on the R&D marketplace today. Many coil manufacturers and heat transfer engineers have developed their own specialized software programs for simulating the performance of heat exchangers. ICA has supported the development of tube correlations through contracts with many universities and research laboratories.

Nonetheless, for an easy-to-use and inexpensive, yet powerful and accurate, tool for the design and simulation MicroGroove coils, the HXSim platform can't be beat. For more information on HXSim, contact the MicroGroove Team Leader or one of the MicroGroove team members.

CoilDesigner Simulation Tool

Another option for OEM product designers is the CoilDesigner® software, a proprietary heat exchanger simulation and design optimization tool developed by the Center for Environmental Energy Engineering (CEEE) at the University of Maryland. CoilDesigner is a highly customizable software tool that allows designers to simulate and optimize the performance of heat exchangers. Using CoilDesigner simulations, OEM users can shorten product development costs and quickly bring products to market.

Optimized Thermal Systems, Inc. (OTS) has an exclusive license agreement with the University of Maryland to provide customized versions and assist in the development of CoilDesigner software [9]. OTS works with various HVAC&R designers around the globe to optimize heat exchanger geometry, including investigation of the use of small diameter copper tubes. CoilDesigner includes the latest heat transfer and pressure drop models published in the open literature and users can also plug-in proprietary models.

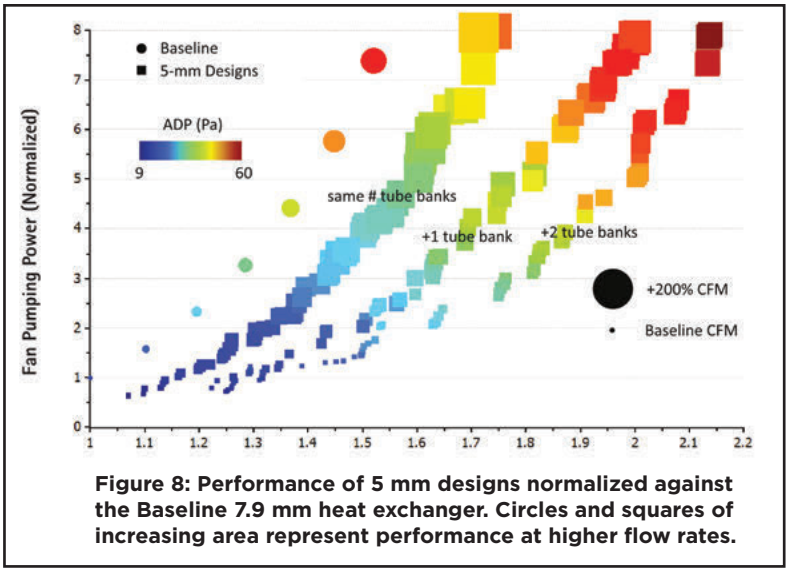


Figure 8: Performance of 5 mm designs normalized against the Baseline 7.9 mm heat exchanger. Circles and squares of increasing area represent performance at higher flow rates.

Collaboration

OTS and the International Copper Association, Ltd. (ICA) developed educational materials to broaden the exposure of students, academics and professionals to the concept of tube-fin heat exchangers using small diameter Microgroove™ tubes. The OTS-ICA educational program engaged people from various institutions and backgrounds in a collaborative effort to advance the art of tube-fin heat exchangers. Comprehensive training materials were developed to present the benefits of tube size reduction in the context of tube-fin heat exchangers. Participants were also given a demonstration and trial version of CoilDesigner® software, allowing them to explore the performance of tube-fin heat exchangers with small diameter tubes using novel correlations.

As a result of the OTS-ICA collaboration, webinars were developed that focus on air-to-refrigerant heat exchanger design, parameterization and optimization. Three webinars remain available for viewing free of charge and are an excellent education resource for anyone seeking a high level of proficiency in the design of heat exchanger coils:

1. Effective Design of Small Diameter Copper Tube-Fin Heat Exchangers

2. Construction of Small Diameter Copper Tube-Fin Heat Exchangers

3. Advantages of Small Diameter Copper Tube-Fin Heat Exchangers

Information about the OTS-ICA educational outreach program and webinar series is available on the microgroove.net website [10].

Correlations

ICA worked with Optimized Thermal Systems Inc. (OTS) to implement the newly developed correlation equations into its software design tool.

Airside heat transfer around smaller diameter tubes can be modeled with unprecedented accuracy, opening the door to new, more energy efficient heat exchanger designs [11-12]. Airflow around smaller diameter tubes faces less resistance than airflow around traditional tubes. Research supported by ICA and conducted by OTS compares the performance of slit fins and louver fins for smaller diameter (3 mm to 5 mm) copper tubes [13]. As a result, CoilDesigner can simulate the performance of coils designs made with MicroGroove tubes. Research on airside and refrigerant-side correlations, particularly for 5-mm MicroGroove tubes, has been made readily available to HVAC&R system designers and heat exchanger engineers.

MOGA: The Next Big Thing

MOGA is a specific type of algorithm within a branch of the scientific field of "complexity." More specifically, MOGA is a Multiple-Objective Genetic Algorithm. The application of MOGA methodology has a long history in many branches of science and technology. Only recently has MOGA moved to the forefront in the design community as a consequence of the abundance of computing power at low cost. When applied to heat exchanger design, MOGA frees the designers to do creative research encompassing a design space envelope rather than focusing on the task of searching for a single optimal design.

MOGA systematically varies the parameters of a coil design and simulates the performance for each selected set of parameters. Genetic Algorithm (GA) is a type of evolutionary algorithm. A population of possible solutions is evaluated in each iteration. In a Multi-Objective (MO) algorithm, the decision or selection is made from the resulting Pareto space after the search is complete. Heat exchanger designs that more closely meet the design objectives are selected from the resulting options. Typically there are multiple constraints and objectives in the design of heat exchangers and the design space to be explored through simulations is very large.

A Multi-Objective Genetic Algorithm (MOGA) was used in sampling the design space for several of the MicroGroove case studies developed by OTS in collaboration with ICA and various OEMs. A 2019 paper titled "Optimization of copper-tube coils for energy efficiency and charge reduction in heat pumps, air conditioners and refrigerators" reviewed five simulation studies using the Multi-Objective Genetic Algorithm [7].

Genetic algorithms were originally developed by Holland (1975) [14] and have been reviewed in textbooks by Goldberg (1989) [15] and Engelbrecht (2007) [16]. Evolutionary algorithms and specifically genetic algorithms (GA) are widely used in many fields. These algorithms are based on ideas about natural selection and natural genetics as originally developed in the 1960s and 1970s by John H. Holland at the University of Michigan. Interest in this multidisciplinary subject has only increased in recent years as computer simulations have improved in accuracy. "Complexity: Very Short Introduction" by John H. Holland describes the broad branch of science of which MOGA is just one part [17].

MOGA is an especially powerful approach toward optimization of designs in which there are multiple constraints and objectives. A description of the use of MOGA in the optimization of heat exchangers was presented by Li et al. (2018) [18]. MOGA allows for a large space of design solutions to be searched in a computationally efficient manner. The system performance can be simulated for each candidate solution and if the performance improves then it can be the basis for further mutations, i.e., alterations of variables.

MOGA ushered in a new era of design in many fields and especially in heat exchanger design as evidenced by the case studies presented in this paper. Optimized heat exchanger designs that would otherwise be missed can be identified through the combination of accurate simulations and MOGA. Five manufacturer-driven case studies in design optimization are presented here to illustrate the value of optimization as applied to a new generation of tube-fin heat exchangers made from MicroGroove smaller diameter copper tubes.

MOGA Case Studies

Case studies presented at ICR 2019 [7] included (1) heat-pump condensers to replace microchannel tubes with smaller diameter copper tubes; (2) a window air-conditioner condenser to improve system efficiency while reducing cost and refrigerant charge; (3) a refrigerator-freezer condenser to reduce hydrocarbon refrigerant charge; (4) the condenser of a packaged terminal AC system to minimize raw material costs and airside pressure drop while maintaining performance; and (5) an evaporator coil for a heat pump water heater to

maximize capacity and minimize fan pumping power.

These diverse case studies demonstrate the advantages of smaller diameter copper tubes and the value of MOGA for design optimization. In most applications, MicroGroove heat exchangers can clearly outperform heat exchangers made from larger diameter copper tubes and performance can be comparable to microchannel heat exchangers. Results for specific applications are summarized as follows:

(1) Heat-pump condenser. The MOGA-optimized designs were similar to the baseline microchannel coil about airside pressure drop and capacity.

(2) Window AC condenser. MOGA designs increased the efficiency of the heat exchanger while reducing materials usage and refrigerant charge. MOGA designs improved the COP by as much as 15 percent and reduced material usage by more than 60 percent (Table 2).

(3) Refrigerator-freezer condenser. Hydrocarbon refrigerant charge was dramatically reduced in the 5 mm designs. MOGA designs reduced the internal tube volume up to 41 percent along with a 57 percent reduction in overall coil volume compared to the baseline 6.25 mm copper tube designs (Figure 6).

(4) PTAC condenser. Raw material costs and airside pressure drop were reduced while maintaining performance. MOGA designs provided as much as 50 percent savings in raw material costs while keeping the pressure drop close to the baseline. The best design reduced the overall internal volume by 62 percent (Figure 7).

(5) HPWH evaporator. MOGA was used to show that capacity could be doubled by increasing fan power; and that 5 mm designs delivered more capacity than the 7.94 mm baseline heat exchanger for given fan power (Figure 8).

The use of MOGA facilitated the optimization of heat exchanger performance using algorithms that mimic evolution in nature by carrying forward the traits of successful designs into future populations. MOGA has proven effective in the optimization of MicroGroove heat exchangers for commercial and residential air-conditioners as well as refrigerators, heat pumps and hot-water heat pumps. ●

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***Yoram Shabtay**, President of Heat Transfer Technologies, has extensive background in heat exchangers development and production and has been working with the ICA for over two decades.*



***Kerry Song** is a Project Manager with the International Copper Association. He is also the Secretary-General of Refrigeration and Air-conditioning Heat Exchanger Technology Alliance in China.*



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	Trends	Product needs
Environmental, health and safety	**Safety**	**Non-flammable components**
	Sustainability, reduced environmental impact	Products which elimiate or reduce the need for heat cure
High throughput	Consolidation, trends towards more versatilr materials that are certified for a wider range of end uses to reduce the number of different products that must be handled at the job site	One product fits all, flexible mixing ratios
Lower processing costs	Lower energy consumption, reducing the need of heat curing	RTV products
Lightweight materials	Increase of demand of adhesives applications in transportation; the trend towards lightweight cars to facilitate wind resistance and enable high speeds	Adhesives with strong bond to several substrates



Figure 1. Trends and product needs from environmental to lightweight materials.

Improving Appliance Assembly with Advanced Silicone Adhesive Technology

BY BURAK AKIN AKSOY

Appliance manufacturers continue to look for new ways to boost productivity, improve flexibility and reduce costs—all while ensuring that their end products will deliver reliable performance. This search extends to the materials used in the assembly process.

Adhesives and sealants can have an important influence on these goals. Cure time is an obvious factor in productivity: faster curing accelerates throughput. Flexibility is affected by a material's ability to bond to multiple substrates—often used for aesthetic reasons—and under varying conditions. In contrast, if an appliance requires many different types of adhesives and sealants, with a range of mixing ratios, bond strengths, cure times and storage specifications, this complexity can add costs, generate waste and interfere with streamlined manufacturing.

Today's buyers would rather have one product suitable for all or most sealing and bonding applications (Figure 1), allowing them to simplify the supply chain and the assembly process.

Beyond these challenges, many companies are seeking to improve the sustainability of their products by choosing materials that support energy conservation, weight reduction and other environmental goals. Adhesives and sealants can play a role here, as well. For example, there has been an increase in demand for adhesive applications that eliminate the need for heavy mechanical fixations.

This article assesses the ability of a two-part, alkoxy cure, room-temperature-vulcanizing (RTV) silicone material to improve assembly and contribute to sustainability. This material offers early, primerless adhesion to multiple substrates without added heat and allows for flexible mixing ratios. The article compares this materials to traditional RTV sealants and adhesives in areas such as cure speed, adhesion development speed, mixing ratio flexibility, shelf life and safety.

Limitations of Existing RTV Products

By eliminating the need for oven acceleration, RTV adhesives and sealants have supported greater sustainability and lower processing costs in sealing and bonding applications. However, current RTV solutions have certain limitations in terms of cure speed, adhesion development and other factors.

In general, there are two categories of RTV materials: those made of one component and those comprised of two components. Each type has certain advantages when considering various market demands.

In packaging, delivery and storage, 1-part RTV sealants often exhibit advantages over existing 2-part products. For example, 1-part RTVs generally have a longer usable life. Additionally, they are more likely than 2-part RTVs to be labelled non-flammable and to be available in cartridges, not only in drums and pails.

Further, 1-part RTVs confer some advantages in dispensing and application because the equipment they require is less complex. To achieve faster cure speeds for 2-part RTVs, equipment often includes heat tunnels.

Property	Unit	1-Part RTV	2-Part RTV	ASTM
Color		White, grey, black	Grey, black	
Appearance		Non-slump paste, viscous liquid	Non-slump paste	
Extrusion rate/viscosity	g/min/mPas	185-350	18,000-350,000	D2452
Skin-over/snap-time	min	5-25	6-9	
Tack-free time	min	15-50	11-18	MIL-S-8802E
Cure in depth 24 hr, 230C, 50% RH	mm	2	Not applicable	
Specific gravity		1.04-1.55	1.27-1.33	D0792
Durometer hardness, Shore A		19-55	35-45	D2240
Tensile strength	N/mm^2	1.2-3.6	>1.8	D412
Elongation at break	%	340-680	>200	D412
Lap shear strength (different surfaces)	N/mm^2	1.1-1.4	>1.0	D1002

Figure 2. Sealing and bonding – Room-temperature vulcanization: typical properties

Also, they require precise control over mixing ratios. For correct metering, different pumps are typically needed. This is one reason why 2-part RTVs are not typically supplied in commercial cartridge systems.

However, despite their advantages in dispensing and application, 1-part RTVs require a special storage area for curing finished parts, calling for specific temperature and humidity conditions that can add costs for infrastructure and monitoring.

When it comes to cure rate, 2-part RTV materials have a clear edge over 1-part RTV products. Cure rate is measured in terms of the time (in minutes) required for a material to form a non-tacky surface film. Tack-free time (TFT), measured from the start of the cure, is the period required for the material to become sufficiently robust that it can resist damage by touch or settling dirt.

While 1-part RTVs can range in TFT from 20 to 50 minutes, 2-part RTVs can have a TFT as low as 11 minutes (Figure 2). When subjected to inline pressure leak testing—which, among other factors, also depends on cure rate—2-part RTVs may withstand testing much earlier than 1-part RTVs.

Current RTVs have significant room for improvement. For example, even though 2-part RTVs surpass 1-part RTVs in TFT and adhesion development speed—crucial for reducing assembly, fixture time and energy usage—it was determined that the performance of current solutions is limited in those areas. Either they are too fast, which makes their processability in series production environments problematic, or they meet the processability conditions but cure more slowly than expected. Because many are very limited in their mixing ratio flexibility and face challenges to meet a wide range of processability requirements.

Some 2-part RTV products on the market also have limitations due to the flammability and/or the shorter shelf life of their components, factors which determine cost of use.

Faster Curing for Higher Throughput

Addressing many of the limitations of current RTV materials is a novel alkoxy cure, non-corrosive, 2-part RTV adhesive that develops early primerless adhesion to various substrates used in appliance assembly. The product bonds glass to unpainted metal, glass to painted metal and glass to plastic in ovens, refrigerators and small home appliances.

A very fast cure speed, reaching Lap Shear Force values above 0.3 MPa after only 10 minutes, allows rapid handling of bonded components to accelerate throughput. This product delivers bond strength in five minutes and 100 percent cohesion in just 30 minutes. In contrast, many conventional 2-part RTV adhesives require up to eight hours for full cohesion.

The novel fast-curing adhesive can also improve productivity thanks to a variable 2:1 to 4:1 volumetric mixing ratio. For example, customers can use the standard 2:1 ratio to complete an assembly very quickly. But if they need to handle bigger parts, this very fast cure speed will become a problem (the recommended processing time is a maximum of two minutes after application, i.e., they have to apply the adhesive and move to next step in assembly before two minutes elapse.) In cases where customers need more open time, they can change to a 4:1 mixing ratio, which will increase the open time to four minutes. In contrast, the mixing ratios of traditional 2-part RTVs do not provide such flexibility. Typically, customers need to use different adhesives for significantly different part sizes.

Lap Shear Force (MPa), Glass-St. Steel	New fast adhesive	Reference 1	Reference 2
10 min	0.43	0.4	0.08
15 min	0.63	0.64	0.14
30 min	**0.95***	0.67	0.45
1 hr	1.03	0.66	0.56
2 hr	1.00	**0.57***	0.74
4 hr	0.81	0.69	0.81
8 hr	0.86	0.72	**0.82***
1 day	1.24	0.70	1.06
7 days	1.51	1.03	1.10

Figure 3. Cure speed and early adhesion development

* Highlighted cells indicate the first time when a 100% Cohesive Failure on Stainless Steel (Primer-less) is recorded.

Sustainability and Cost Control

Room temperature curing avoids the need for oven acceleration, helping to reduce infrastructure costs and lower energy consumption in support of greater sustainability.

Another cost factor is shelf life. In comparison with conventional 2-part RTV materials, whose shelf life can be as short as five months, the novel fast-curing product offers a 12-month shelf life for both components when they are stored at or below 30°C in the original unopened containers. This extended useful life can avoid wasted material and permit bulk purchasing.

Still another cost consideration relates to the way the adhesive is supplied. Unlike other 2-part RTV products, the novel adhesive is supplied in dual cartridge kits, as well as pails and drums. Cartridge kits allow customers that are working on a niche project, whose low production numbers do not justify capital investment in an automated application line, to perform assembly manually.

Performance Properties

We compared the performance properties of this novel 2-part RTV adhesive with those of two traditional 2-part RTV products with comparable mixing ratios but very different cure and adhesion development speeds. We measured initial properties after application and mechanical properties after curing for seven days.

The fast-curing silicone adhesive achieved high lap shear force and early adhesion development (Figure 3) values. It reached 0.3 MPa after only 10 minutes, which is much higher than one of the comparison adhesives. (The other competitive material did show a similar value but cannot develop further until full cure, and demonstrates lower lap shear force performance after seven days.)

At 30 minutes, the fast-curing adhesive had developed a lap shear force of 95% on primerless stainless steel, compared to eight hours for the traditional 2-part RTV products.

In the area of heat resistance, this fast-curing adhesive performs well, withstanding temperatures up to 180°C and even shorter peaks at higher temperatures. Higher temperature resistance is critical for some appliance applications such as ceramic hob assembly, oven door assembly and/or microwave oven assembly.

Broad Range of Appliance Applications

This fast-curing adhesive product is useful for a wide range of appliance applications:

- Bonding glass oven doors
- Sealing and bonding stovetops
- Bonding inner and outer microwave windows to the frame
- Bonding refrigerator interior door gaskets, door/glass doors and interior drawers and shelves
- Sealing the tub and bonding the base (metal on plastics) in dishwashers
- Bonding control panels, door gaskets, and door and pump assembly in washers
- Bonding control panels, door gaskets, door and pump assembly and top lids in tumble dryers
- Sealing hoses and bonding plastic components with brushes in vacuums

This product is also suitable for other industries requiring fast-curing adhesives and sealants, including automotive electronics; industrial sealing, gasketing and bonding; and aerospace cargo door sealing and general maintenance.

Support for Market Trends

The adhesives and sealants market was valued at $56.4 billion USD in 2018 and is projected to reach $73.8 billion by 2024, according to a Markets and Markets report published in September 2019.1 This growth is being driven by the appliance industry and many other sectors, which share common requirements for higher throughput, lower processing costs and greater sustainability.

By choosing an advanced 2-part RTV silicone adhesive with an accelerated curing time, appliance OEMs can make important strides toward these goals. This technology not only avoids the energy impact of oven-accelerated curing, it delivers very fast cure times that enhance productivity. Further, this adhesive's ability to bond many different materials, combined with its extended shelf life, allow companies to streamline their supply chains and simplify procurement, storage and handling.



***Burak Akın Aksoy**, Technical Service and Development Scientist for Dow Consumer Solutions in Wiesbaden, Germany.*

Better Ways To Heat and Cool Buildings

BY GARY DAGASTINE

The heating and cooling of buildings accounts for nearly 50 percent of energy consumption in Europe, spurring researchers to find alternatives to conventional technologies.

One enticing possibility is to use adsorption-based heating and cooling systems driven not by electricity, but by heat. Because heat could come from solar collectors, from waste heat generated by industrial facilities, or from combined heat and power units, this adsorption technology offers the possibility of significantly reducing electricity consumption and associated CO2 emissions. The technology can be used not only as a highly efficient heating system that uses gas-fired heat pumps to multiply the heat delivered to a building, but also for the compact storing of energy for a long period of time.

In brief, heating and cooling systems based on this principle use a working fluid in an adsorption/desorption cycle where the fluid's state is altered from liquid to gas and vice versa numerous times (see the sidebar on page 28 for more details). With this technique, special heat exchangers can be built that act as thermal compressors by periodically heating and cooling an adsorbent material at different temperatures and pressures. These systems can replace electrically driven mechanical compressors in heat pumps and chillers with the extra benefit of offering heat storage capacity, which can store up to three times the energy stored using traditional hot water systems.

Optimizing Thermal Transfer and Storage

The development of adsorption-based heating systems and chillers is complex. They have discontinuous operating cycles, varying peak energy fluxes, and their dynamic behavior is determined by complex and coupled heat and mass transfer phenomena.

Although some adsorption-based systems are already commercially available (see Figure 1), to realize their full potential on a larger scale the technology must become far more efficient, more compact, and cheaper to produce.

One of the world's leading research organizations in this field is the Fraunhofer Institute for Solar Energy Systems (ISE) in Freiburg, Germany. With a staff of some 1,300 employees, it investigates all aspects of solar energy transformation, storage, and use. It is part of a network of more than 65 Fraunhofer research institutes in Germany that specialize in different aspects of applied science.

Eric Laurenz and Hannes Fugmann, researchers at Fraunhofer ISE, are part of a 20-person group led by Lena Schnabel that is developing higher-efficiency heat exchangers for adsorption systems. Laurenz studies how water vapor and heat flows through porous structures with the goal of optimizing system size and efficiency, while Fugmann conducts design studies involving non-isothermal fluid flows and heat conduction in solids in order to develop better heat exchanger architectures.

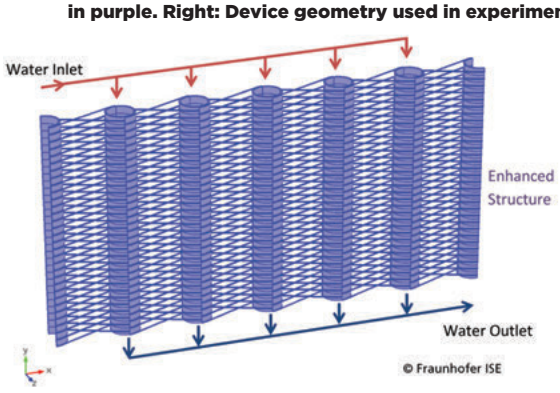
"Analytical methods are inadequate for our work because of the strong nonlinear couplings between the heat and mass transfer involved," Laurenz said. "We need to use numerical tools such as COMSOL Multiphysics® to simulate the cyclic loading and unloading of the sorbent and take into account the temperature and mass distribution in both space and time. With these tools, we can make sure that the simulation will correctly capture the dynamics of adsorption and desorption."

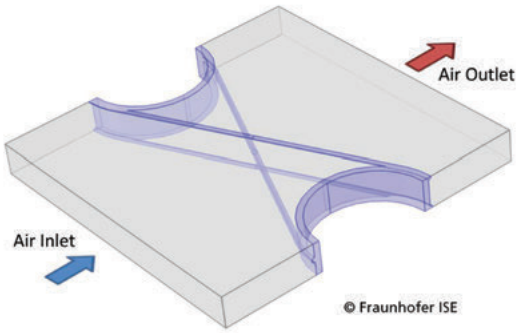


Figure 1. Example of a commercially available adsorption-based chiller.

As a general approach, the team uses a combination of simulation and well-defined, small-scale experiments to build large-scale models that can accurately predict the complex real-world behavior of the physics being investigated. With the small-scale models, the team can fully model the physical mechanisms in detail, while on the larger scales, complexity can be reduced to save on computational time. This approach can significantly reduce the need to build full-size physical prototypes, saving both time and money.

Figure 3. Left: Device geometry showing warm water entering the tubes. Cold air is passed across the tubes, cooling the water as it flows through the tubes. Middle: Simulated geometry showing the cold air entry and warm air exit. The wire structure and the tubes are shown in purple. Right: Device geometry used in experimental testing.







Validating the Adsorption Process

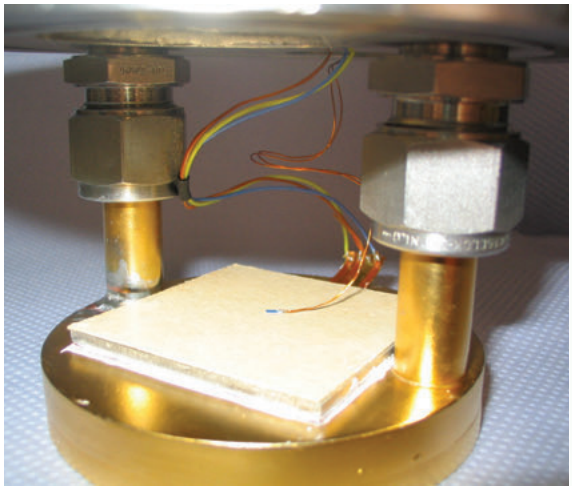
One of the key objectives for improving adsorption heat exchangers is to optimize the uptake speed and capacity of the thin sorbent layers used in the system. In one investigation, simulation was used by Lena Schnabel and Gerrit Füldner to build a model that captured the heat and mass transfer interplay dynamics happening in the sorbent layer. With the help of the model, the group was able to fully understand the measurements obtained from the experimental setup shown at left in Figure 2.

"Only by comparing experimental and simulation results using parameter estimation were we able to determine the transport coefficients that could not be measured directly," describes Laurenz. "This data was then used in our more complex simulations of the system."

Schnabel's group first started using COMSOL Multiphysics nearly ten years ago. More recently, however, the group has started to use models with varying levels of detail to estimate transport parameters and to simulate the cyclic behavior of complete systems under dynamically changing operating conditions. The ability to easily simulate coupled physics in complex and dynamic systems has proven indispensable for much of their research at Fraunhofer ISE.

Enhanced Heat Exchanger Designs

In his work to optimize heat exchanger architectures, Fugmann performs basic research on heat exchanger designs, including chillers and heat pumps. Some of his geometries are designed to increase heat transfer surface area using wire structures such as those shown in Figure 3, as opposed to the more traditional fin-and-tube heat exchanger designs. In these novel architectures, a wire structure is woven or knitted around a series of tubes, separating the



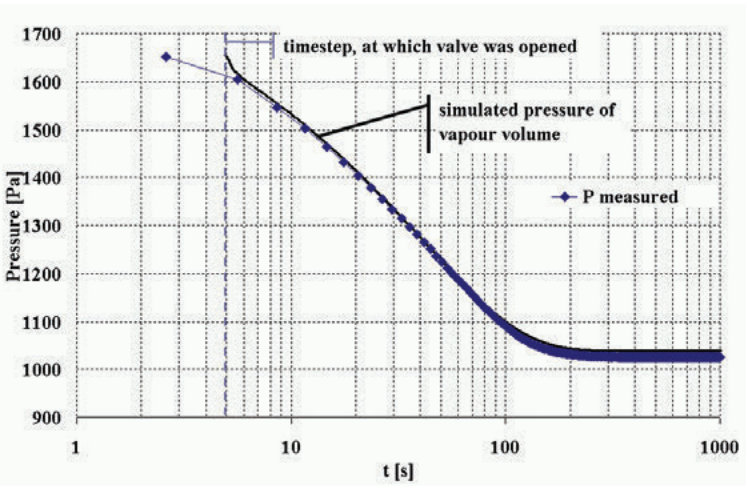


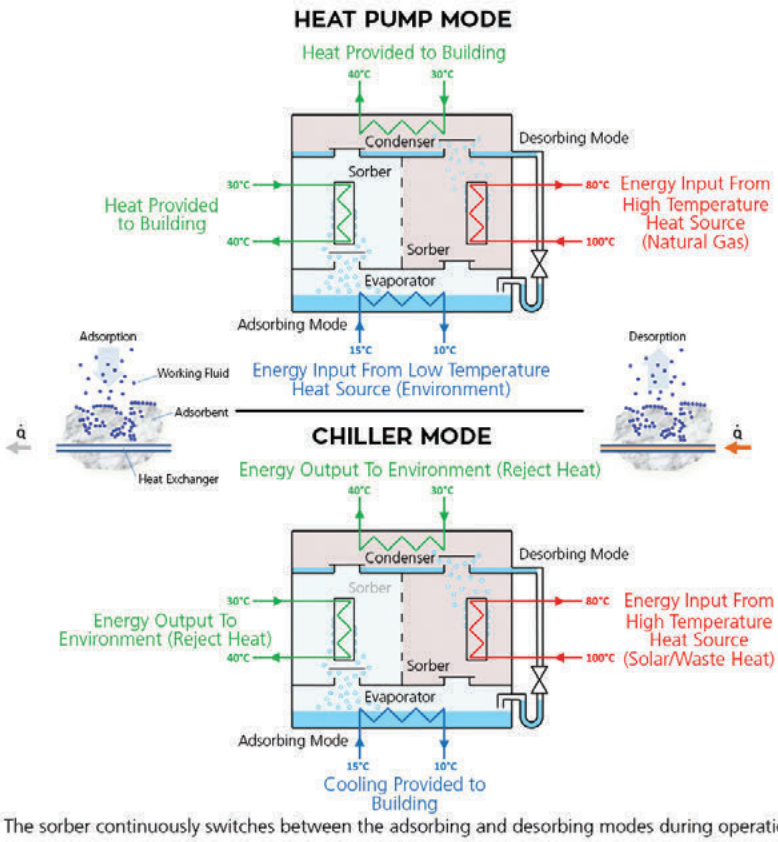
Figure 2. Left: Experimental setup used to validate COMSOL® software models of adsorption kinetics, consisting of a thin 50x50 mm2 layer of zeolite sorbent on an aluminum carrier, placed on a cold plate in a dosing chamber and monitored with temperature and heat flux sensors. Right: Graph showing excellent agreement between simulated and measured water vapor pressure in a zeolite sorbent test setup at Fraunhofer ISE.

Using Adsorption For Heating and Cooling Systems

A schematic of the two-step cycle used to design adsorption-based chillers and heat pumps is shown in the figure below. To explain, let's look at what takes place during the heat pump mode. The cycle is composed of one adsorption and one desorption step. During the adsorption step, the working fluid is evaporated at a low temperature. At the same time, the working fluid is adsorbed by an adsorbent at a medium temperature, where the heat released can be used to heat a building.

Once the sorbent is saturated, the process is inverted and the desorption step starts. The sorbent is heated to a high temperature, thereby desorbing the working fluid. Next, the working fluid is condensed at a medium temperature, and the released heat of condensation can be used to heat a building.

In summary, for heating applications (heat pumps) the building is heated while energy is removed from the environment. Conversely, in cooling applications (chillers), the building is cooled down while heat is released to the environment. When the cycle is interrupted, the potential heat of adsorption can be stored loss free. Depending on the desired application, adsorption can be used to heat or chill a building, while the environment acts as either a heat source or sink.



The sorber continuously switches between the adsorbing and desorbing modes during operation

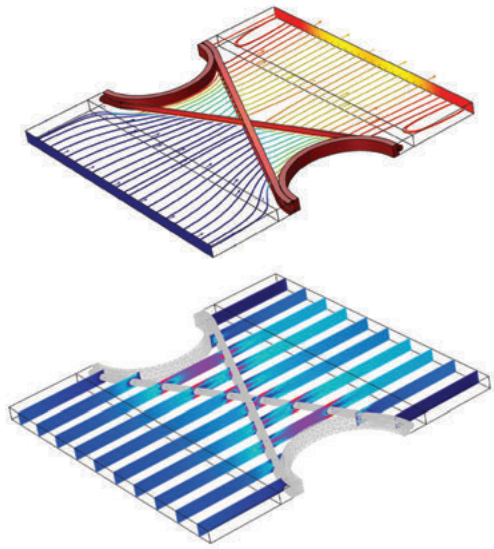


Figure 4. Top: Simulations showing velocity streamlines and the temperature distribution in air, in the tube wall, and in the wire connecting the two tubes (red: warm; blue: cold). Bottom: Simulations showing the velocity magnitude in air (red: high; blue: low).

two fluids in the heat exchanger. In an experimental setup for a gas-to-liquid wire heat exchanger, hot water flows within the tubes while cold air flows between the tubes and across the wires.

"We found that if we use wire structures, we can achieve a higher heat transfer coefficient with a larger surface, as well as significantly reduce material usage," said Fugmann. "We are able to do this without noticeably increasing the pressure drop, and the flexibility of the wire structures also gives us the ability to easily adapt the geometry depending on the operating parameters of the design."

Using COMSOL® software, Fugmann performed parametric sweeps to investigate specific pressure drops, heat transfer coefficients, material usage, and other analyses of the design's geometry. Figure 4 shows the temperature distribution and the velocity magnitude of an optimized geometry of the wire structure and the tubes.

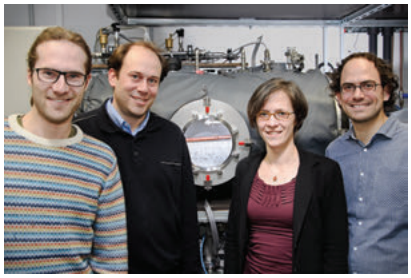
Fugmann describes the device:

"From the measurements, we found that the bonded connections between wires and tubes yield a high and dominating heat resistance. By understanding the limitations of heat transfer in the wire structures, we can further optimize the design."

Due to their higher heat exchange surface per volume, the wire structures are also analyzed experimentally and numerically at Fraunhofer ISE for use as sorptive-coated structures and as surface enlargement for heat exchangers in thermal storages.

Looking Ahead

"Our immediate goal is to increase knowledge and competence in these areas so that we can help both our customers and others at Fraunhofer ISE who are developing different aspects of adsorptive climate control systems," said Laurenz. "Longer-term, we look forward to the day when such technologies are in widespread use in society, helping to reduce the load on the electrical grid and conserve the earth's resources." ●



The Fraunhofer ISE team includes (from left) Hannes Fugmann, Gerrit Füldner, Lena Schnabel, and Eric Laurenz. They are standing in front of an experimental setup for the dynamic characterization of adsorption heat exchangers. The setup is used to generate experimental data for simulation-based parameter estimation.



Gary Dagastine *is a writer/editor and PR professional at Dagastine & Co. Public Relations. He can be reached at* ***linkedin.com/in/gary-dagastine-270a83b***

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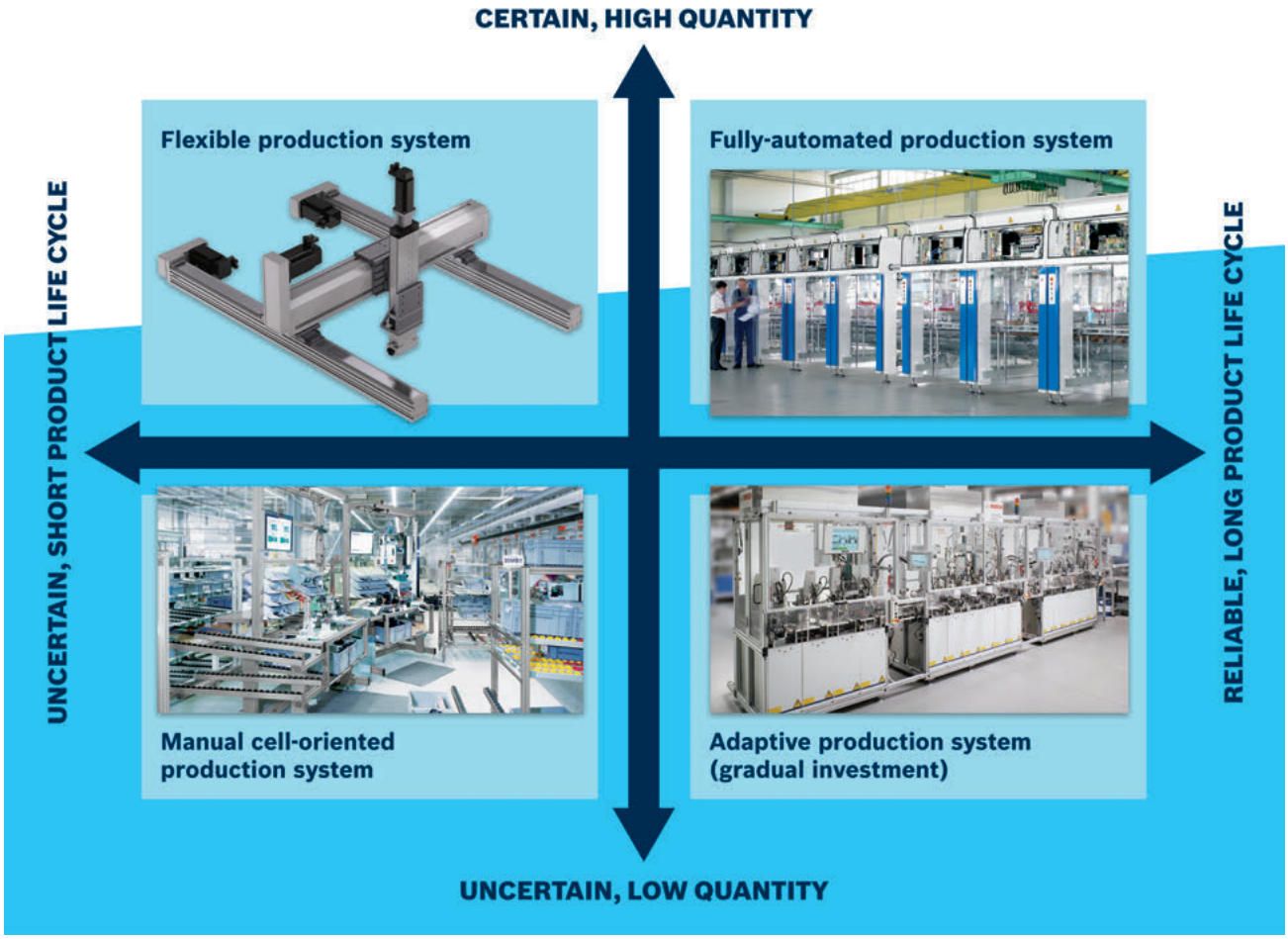
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Key Tips For Automated Conveyor Systems in Your Assembly Operation

BY MARK DINGES & GERALD BERZINS

Whether the product being manufactured is a mobile phone or an HVAC unit, the assembly processes will likely require some combination of manual and automated transfer operations. A simple but effective way to determine if a transfer operation should be automated is to consider two factors: production volume and product life cycle. A product with low or uncertain production volume and a short life cycle is often better suited for a manual transfer operation. Conversely, a product with high, stable production volume and a long life cycle is a good candidate for an automated transfer solution.

When the expected volume and product life cycle make automated transfer attractive – or even necessary – for an assembly operation, the work of choosing the right conveyor system begins. But before you start exploring conveying options and specifications, the first thing you should do is address the benefits you expect to achieve by using an automated, conveyor-based transfer system for a given process.

In some cases, automated transfer is implemented because the costs of manual transfer – including scrap or rework – are too high or too variable. Or, it may be that manual transfer operations simply can't keep up with increased volume or throughput levels. In other cases, automated transfer enables improvements in the working environment – in the form of fewer safety hazards, better access to materials, and improved ergonomics

– which have been proven to increase productivity and quality

Application Requirements: Product versus Process

Once the expected benefits of implementing an automated conveyor system have been determined, it's time to begin defining the application requirements. Conveyor systems are inherently complex, and the task of choosing from among dozens of conveyor types and hundreds of configurations can seem daunting. But breaking the application down into two parts – product requirements and process requirements – can help simplify the analysis and guide you to the best-fit solution.

Product Requirements

Although it's common practice to start with the conveying process itself, it's important to define the product requirements first. In some cases, the physical features and nuances of the product (size, fragility, etc.) can be the determining factors when deciding which type of conveyor is best for an application. Be sure to address these questions:

- **Type** - What type of product will the conveyor be handling? Different products and industries have unique handling requirements or challenges.
- **Size** - How large, physically, is the product being conveyed?
- **Shape** - Does the product have any oversized dimensions (extra tall, for example) or protrusions that might interfere with the conveying system?
- **Weight** - How much does the product and any associated fixturing weigh? Will the weight change at any point during transport (i.e., as additional parts are assembled)?
- **Orientation** - How should the product be oriented on the conveyor? For example, should one side face a

Insights and Considerations

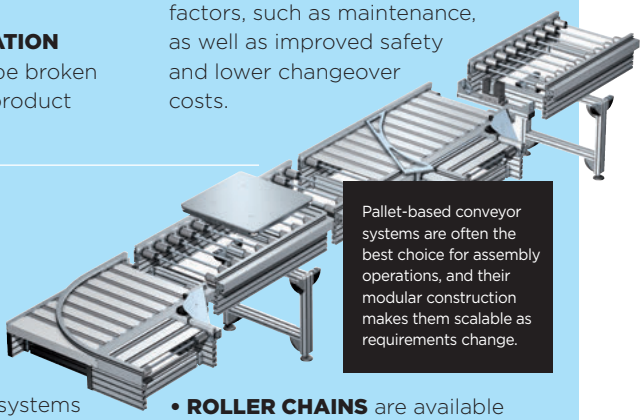
• **A SIMPLE WAY** to determine if a transfer operation should be automated is to consider two factors: production volume and product life cycle.

• **WHEN THE DECISION LEADS TO** automated transfer, consider what benefits you expect to realize by using conveyor-based transfer – for example, reduced costs, increased throughput, or a better working environment.

• **TRANSFER APPLICATION REQUIREMENTS** can be broken down into two parts: product requirements and process requirements.

• **PALLET-BASED CONVEYOR SYSTEMS** are often the best choice for assembly operations, and their modular construction makes them scalable as requirements change.

• **When determining the ROI** for an automated transfer system, include ongoing factors, such as maintenance, as well as improved safety and lower changeover costs.



Pallet-based conveyor systems are often the best choice for assembly operations, and their modular construction makes them scalable as requirements change.

Conveying Options for Assembly Operations

Automated conveyor systems can generally be categorized according to the type of conveying media they use: belt, flattop chain, roller chain, or powered rollers..

• **BELT MEDIA** (flat or toothed) is ideal for lighter payloads and can transfer materials over long distances at high speeds.

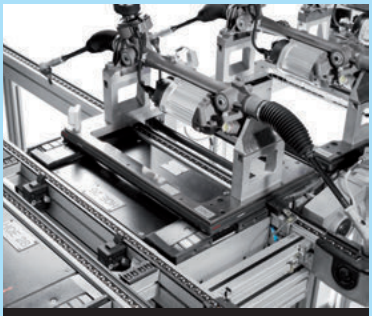
• **FLATTOP CHAINS** can support heavier payloads, and their side-flexing design makes them ideal for use with curves and for maintaining leading-edge pallet orientation. Flattop chain caps commonly overlap each other, which makes this media very "fastener-friendly."

• **ROLLER CHAINS** are available in many designs (steel, plastic, accelerating) and can be used in the most challenging environments. The power-and-free design creates a low-friction surface, allowing roller chains to convey heavy payloads. Some roller chains are also bi-directional, making them suitable for reversing applications such as spur stations on a production line.

• **POWERED ROLLER CONVEYORS** generally have the highest payload capacities and offer the most robust conveyance solutions. They're also very quiet in operation and have low maintenance requirements.



Flattop chains can support heavier payloads, and their side-flexing design makes them ideal for use with curves and for maintaining leading-edge pallet orientation.



Roller chains are available in many designs (steel, plastic, accelerating) and can be used in the most challenging environments. The power-and-free design creates a low-friction surface, allowing roller chains to convey heavy payloads.

Alternative Conveying Technologies for Extreme Transfer Requirements

When the conveying requirements include high speed and high positioning accuracy, a relatively new type of conveyor system, based on linear motor technology, can fit the bill. Linear motor-driven pallet conveyors provide extremely fast transport with very good positioning accuracy. They can also be configured to meet stringent cleanroom or vacuum requirements and can operate with multiple, independently controlled pallets.

While linear motors are often regarded as specialized solutions for applications such as semiconductor and electronics manufacturing, they can also provide the perfect solution for much more common assembly operations.

In one case, a manufacturer of safety components for vehicles uses Bosch Rexroth's ActiveMover linear motor-driven conveyor system to move workpiece pallets independently of each other to precisely defined positions. The conveyor is made up of straight sections and 180-degree curve modules, making a closed oval that totals 22 meters. Pallets can travel to each station independently, and sometimes travel to multiple positions within one station. And the system can work autonomously for 45 minutes before manual intervention is needed. With the capability to move pallets independently, speeds of up to 150 m/min, and accelerations of up to 40 m/s2, the ActiveMover pallet conveyor system helped the customer significantly reduce cycle times.



Linear motor-driven pallet conveyors provide extremely fast transport with very good positioning accuracy. They can also be configured to meet stringent cleanroom or vacuum requirements and can operate with multiple, independently controlled pallets.

particular direction in relation to the direction of movement?

• **Fragility** - Is the product sensitive to shocks? Is it perishable?

Process Requirements

Process requirements are those that determine how the conveyor will move, such as elevation changes or curves, and the environment in which it operates. Many of these requirements are dictated by the manufacturing facility and production goals. The following criteria should be considered:

• **Distance** - How far will the product be moved? What is the distance between workstations or operations?

• **Path** - Does the transport path require curves, elevation changes, stops, or diversions?

• **Speed** - Does the transfer require slow and steady movements or short, rapid moves?

• **Positioning Accuracy** - Does the operation require precise positioning? Or is the positioning tolerance relatively low?

• **Ambient Environment** - Will the conveyor work in an extremely high- or low-temperature environment? Will there be dust, water, or other contamination in the environment? Does the conveyor need to be cleanroom, vacuum or dryroom compliant?

• **Ergonomics** - If personnel are working with product directly on the conveyor, what should its height be? What safety mechanisms are required?

• **Footprint** - What floor space is available for the conveying system? Will it need to fit within an existing production layout?

What Assembly Applications Have in Common

Regardless of the product being transferred, there are some commonalities that can be found among most assembly applications. First, assembly operations typically require access to the part from more than one side, and they often require custom fixturing to hold or secure the part. Payloads can range from as little as a few grams, often the case for electronics assembly, to several kilograms for appliances, to hundreds of kilograms, as in many automotive processes.

The conveying path for an assembly operation is often two-dimensional, with little or no elevation change. But the required positioning accuracy may be very high, since the assembly operation depends on the precise location of the part.

Given these criteria, pallet-based conveyor systems are often the best solution for assembly applications. Pallet-based conveyors, such as the Bosch Rexroth TS Transfer System, are available in a range of sizes to accommodate the size, shape, and weight of the part being transferred. And they're available in belt-, chain- and roller-driven designs to provide the required transfer speed and positioning accuracy. Pallet-based conveyors are ideal for two-dimensional transport paths with 90- and 180-degree curves, and they can even feature vertical line

elevation changes.

Another factor to consider when selecting an assembly conveyor is the scalability of the system. For example, if the product volume can potentially increase from 1,000 units per month to 10,000 units per month within a short timeframe, it will be simpler and more cost-effective to have a system that you can adapt to the new requirements – one that is scalable – rather than starting over with a new conveyor platform. Pallet-based conveyors are modular in construction, making them relatively easy to scale or reconfigure when production volumes or product requirements change.

Making the Case for an Automated Conveyor System

Once you've chosen the best conveyor system for your assembly application, the final step in the analysis is to weigh the benefits versus the other alternatives and demonstrate its return on investment (ROI). You defined the benefits by answering the question posed at the beginning of the analysis: "What benefits do we expect to see by using an automated, conveyor-based transfer system for this process?" Framing the answer in terms of the alternatives – i.e., manual or semi-manual transfer – is an easy task if the benefits have been clearly defined.

The return on investment, by definition, is an objective measure of the investment and quantifiable returns. It's important to remember that the investment includes not only the initial purchase price, but also the installation, operation, and maintenance costs. Likewise, the return includes additional sales and profit from increased throughput, in addition to reduced scrap and rework costs, reduced labor costs through better ergonomics and increased safety, and lower changeover costs when product or production requirements change.

And in some cases, the "hard" quantifiable ROI factors can be supplemented by "soft" ROI factors. One example is differentiation from the competition. Customers tend to view more favorably those manufacturers who embrace technology to improve quality and reduce costs. This is especially true when the product is complex or high value. Using a world-class system that incorporates high levels of automation can demonstrate to customers that you are committed to producing the best product possible at the lowest cost. ●



Gerald Berzins *is an Applications Engineer at Bosch Rexroth US helping customers find the right conveyor for their applications. He has 30+ years of experience in the industrial sector of assembly automation. He holds a BSEE from Western Michigan University and an MBA from Indiana University.*



Mark Dinges *is responsible for the TS Pallet Based Assembly Conveyor platform at Bosch Rexroth U.S. He has more than 23 years of global experience in the field of product management with B2B and B2C experience in the industry sectors of assembly automation, fast-moving consumer goods, and electrical component manufacturing. He holds a BA degree from Grand Valley State University, MA degree from European University, and Product Management Professional Certificate from the University of Wisconsin.*





The Move to More Earth-Friendly Air-Conditioning Refrigerants

BY THOMAS PARKER

Today, heavy-duty truck and off-highway vehicle manufacturers face a multi-million- dollar switch to a more environmentally friendly, but more expensive and more flammable refrigerant -- R-1234yf. Car and light-truck makers in the U.S. already have moved to the more expensive hydrofluoroolefin (HFO) R-1234yf refrigerants from previous hydrofluorocarbons (HFCs) such as R-134a to meet EPA requirements prompted by global-warming concerns. However, similar standards are not yet in place for commercial vehicles.

INFICON, a global supplier of leak-detection equipment, believes a changeover to HFOs for heavy-duty trucks and off-highway vehicles is inescapable and soon will require the adoption of more stringent AC-system quality-control checks as well.

Most heavy-duty trucks are equipped with air conditioning, but INFICON estimates that today more than 80 percent of all farm combines and tractors, as well as construction, mining and other off-highway vehicles come equipped with AC systems as well. North American production of heavy-duty Class 8 trucks totaled approximately 350,000 units last year, while off-highway-vehicle production reached 130,000 units or more during the same period.

Without government requirements there has been little pressure on OEMs to change over to HFO refrigerants or adopt tighter leak-detection methodology for quality control and safety reasons. New regulatory requirements and a changeover to new refrigerants will make leak testing more important than ever.

INFICON research indicates that fewer than 20 percent of the heavy-duty trucks, farm tractors and other off-highway vehicles receive thorough leak-detection tests on their AC systems before they leave the factory. However, newer, more environmentally friendly refrigerants are not only more flammable, but those refrigerants also can form dangerous acids if placed in contact with water vapor through ingress leaks. Moving forward, there will be increased demand to test the



Virtually all heavy-duty equipment is likely to face requirements to switch to more environmentally friendly refrigerants.

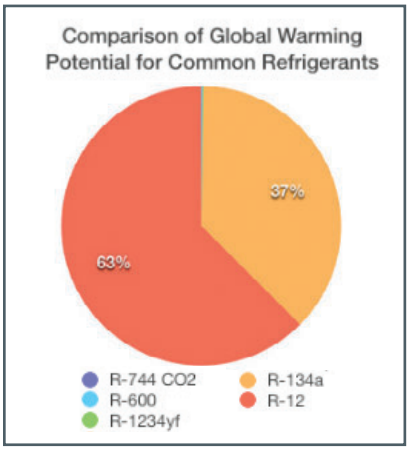
AC systems on these vehicles before they ship to assure product quality.

HFO refrigerants definitely are more environmentally friendly than the HFCs they replace. For instance, the newer automotive refrigerants have a rating of just four on an industry-accepted Global Warming Potential (GWP) scale, while HFCs are rated at more than 1,300. What this means is that, although nearly 10 times more expensive, an HFO's life cycle in the atmosphere is only about 11 days compared to up to more than 200 years for an HFC.

This is where forward planning becomes critical. INFICON believes that a change to HFO refrigerants could take from two up to four years once government regulations are in place although at least one heavy-duty manufacturer already is making the switch.

While changes made to meet car and light-truck refrigerant standards might prove helpful, industry experts point out that they do not fully take into account heavy-duty and off-highway customer requirements such as the need to accommodate extreme duty cycles.

There are changes that will need to be made to the engine cooling system, for example. As a refrigerant, R-1234yf is 10-12 percent less effective than typical HFCs. To compensate for the loss in efficiency an additional internal heat exchanger might be required that can be built into the suction and discharge hoses. AC hoses also might need to be improved or replaced, and different viscosity oils and new lubricants may be called for.





Experiences and procedures developed in the light duty vehicle market are unlikely to apply to the heavy-duty market.

Early leak detection is important at every stage of the manufacturing process, but especially on the final assembly line. INFICON recommends robotic or operator-managed helium-based leak tests for every AC system component, including heat exchangers, AC hoses, connectors, compressors and O-ring connectors. INFICON tries to understand each customer's corporate culture and their specific product needs, then develop a leak-detection system that meets those needs. We also will assist in training employees on the use of leak-detection equipment and implementation of the leak-detection program itself.

Manufacturers should perform a refrigerant-only "sniff" test on the final assembly line to ensure that engine-run tests haven't created additional leaks. In fact, this offers an opportunity to test for fuel and hydraulic leaks, as well.

With or without future government mandates, we believe truck and off-highway equipment manufacturers will need to prepare for the replacement of HFC refrigerants in the near future and that tighter leak-detection procedures will need to be included in the changeover.



Check AC systems at final assembly ensures quality and potentially lowers warranty costs.

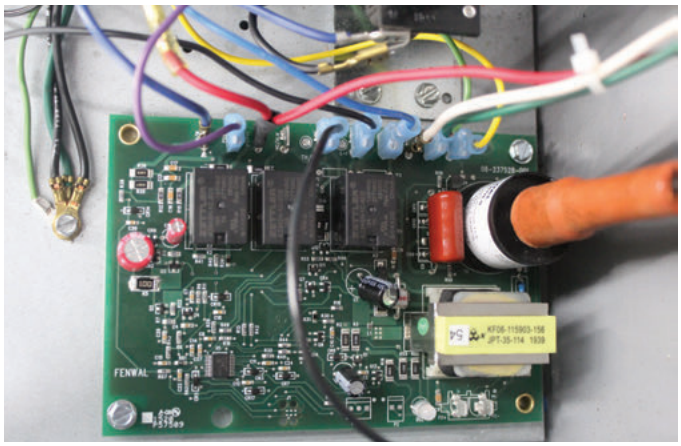
INFICON offers a variety of "sniffer" leak detectors suitable for both manual and robotic applications. Its compact HLD 6000 model, for example, was specifically developed for the detection of refrigerant leaks. INFICON's multi-gas ECOTEC E3000 also can detect refrigerant leaks in demanding production environments and can be used to detect fuel leaks as well. ●

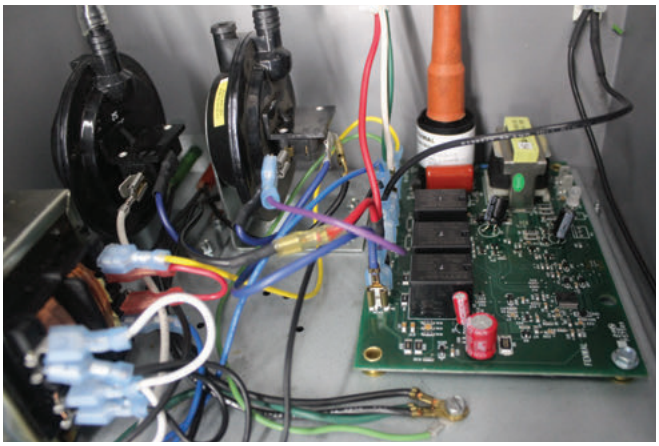
Hand held sniffer probes simpify testing.





Thomas Parker *is responsible for INFICON's automotive sales in North America. Considered an industry expert on leak detection for automotive parts, systems and final vehicle assembly processes, he has been a speaker at a variety of major automotive conferences and symposiums.*





Examples of effective wire management: Ground wires grouped together with minimal wire intersections.

EMI and Gas Ignition: The Impact of Electrical Noise

BY MARC SILVERSTEIN

Gas-¬fired appliances can benefit greatly by using direct spark ignition (DSI), provided engineers know how to address potential electrical noise challenges.

Direct Spark Ignition (DSI) is fast, straightforward and cost-effective, making it the method of choice for the majority of gas-fired systems. But it is not without its challenges. Because the DSI process works by creating a high-voltage spark, DSI controls inevitably generate small to substantial amounts of electromagnetic interference (EMI), or "noise," during their trial for ignition. This electrical noise can interfere with the ignition control and nearby electronic components, affecting system performance and reliability.

Designing for EMI

Because the effects of EMI can vary with environmental conditions and seemingly small physical changes, EMI is not easy to observe or predict, making it difficult to troubleshoot appliance performance. As technology advances, surface-mount components become more prevalent, circuit board size and materials change, and impact from EMI becomes more challenging. Proper system design and installation are crucial in order to avoid extensive (and expensive) testing and trouble-shooting on the assembly line and in the field. Fortunately, it's possible to create reliable systems that minimize the naturally occurring noise produced by the lighting phase of the control.

Minimizing EMI: Best Practices

The techniques used to effectively minimize EMI will depend upon the available space and internal configuration of a given system. The main considerations are cable length, cable type, cable positioning and grounding. To prevent generating excessive spark energy, engineers must also consider the time needed to light the burner.

Because high-voltage cables radiate electrical interference, direct-spark installations should use the shortest practical cable length for the specific application. This has the added benefit of maximizing the energy provided to the spark gap.

Although they are more costly, suppression-type spark cables with UL 3257 or SAE J2031 ratings are preferable to copper high-voltage wires as they significantly reduce noise emission. Keep in mind that the resistive nature of suppression cables reduces available spark energy. Suppression cables should be kept as short as possible (less than 36 inches.)

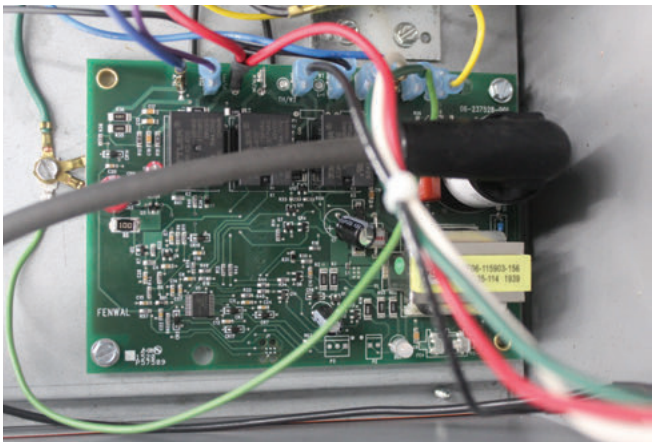
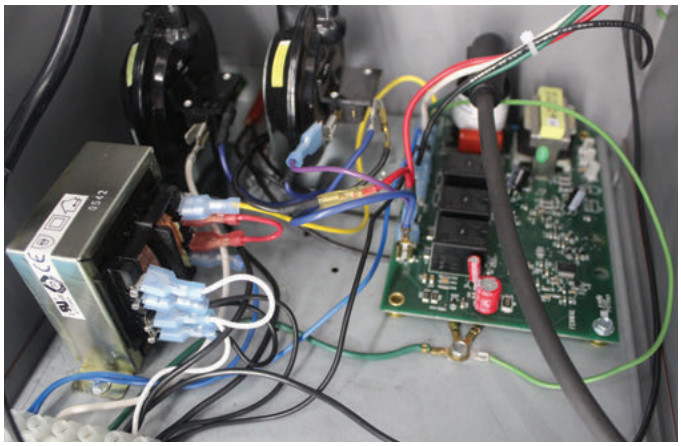
Modern gas ignition controls are not position-sensitive, so they may be mounted in the orientation that facilitates the most direct wiring and shortest runs. High-voltage and low-voltage cables should be run separately and not cross over the control or any other electrical components or wiring.

When high-voltage and control cables must cross paths, make sure they do so at right angles to minimize their contact with one another. Provide as much air gap as practical. To reduce the possibility of signal interaction, avoid long parallel runs and bundled wires. The shortest, straightest distance to the control is always preferable.

In appliances, such as ovens and griddles, that require more than one ignition control system, install the controls as independent systems utilizing the aforementioned best practices. Provide space between the controls and orient them to allow optimal wiring configurations for each unit. The power and ground to each control should be run separately—avoid "daisy-chaining"—with each ground line tied back individually to a common ground point.

Other factors that can greatly affect the proper operation of a direct spark, or any ignition control system include:

1. Providing a single path from each control to a common ground point.

Examples of poor wire management: Ground wires in all directions, poor groupings and several wires crossing a high-voltage spark cable.

This avoids ground loops, which are a common source of electrical noise.

2. Burners and electrodes should have their own ground wire rather than relying on sheet metal or pipe, which can loosen or corrode over time.

3. Ensuring the common ground point is a solid, stable structure uninterrupted by paint, hinges or potentially unreliable mechanical connections.

4. High-voltage spark cables should not be tucked against or lay directly on sheet metal, as the energy will couple into the ground system, reduce spark energy and create noise. This is particularly noticeable on long parallel cable runs along sheet metal surfaces.

5. A burner system optimized to provide the shortest lighting time also generates the least amount of noise. A system that takes 10 seconds to light creates more electrical interference than a system that lights in 3 seconds.

6. Providing detailed manufacturing documentation after system design and layout are finalized to ensure correct installation in the finished product, resulting in consistent performance in the field.

7. Be sure to include instructions for best practices regarding the external wiring for power, communications and other field-wired devices. Long runs of unprotected connection wires, especially low voltage control wiring, can introduce losses or noise to the system. Where long runs cannot be avoided, using an isolation relay or other control device is an effective way to minimize potential field wiring issues.

8. Isolating noisy components on a separate power supply or transformer rather than supplying the entire system from one source. This practice can help in two ways: It may prevent noisy components from sharing wiring with sensitive components, and it may allow all of the wiring for the noisy component to be separated in one smaller compartment of the system.

Confirming Ignition System Performance

Most direct-spark applications will perform reliably when the design team follows the best practices listed above. Regardless, it is important to conduct thorough testing of each application under a variety of conditions to validate system performance. These tests include, but are not limited to:

- Performance over the specified range of input voltages
- Performance over the expected range of spark electrode gaps
- Confirming performance at cold start and hot-relight conditions
- Testing with gas supply shut-off to confirm noise issues do not exist over the full ignition cycle through lockout
- Accounting for expected production variations such as control placement, cable spacing, cable routing or grounding
- Inspecting for component issues related to variations from multiple suppliers for high-voltage cable, electrodes, gas valves, etc.
- Testing of each system configuration over the entire model range

Summary

Designing reliable ignition systems for industrial and residential applications requires adherence to best practices and thorough performance validation. Often, the ignition system is an afterthought in the combustion design process, and this can lead to unnecessary manufacturing trouble-shooting, field issues and customer dissatisfaction. Using a systems approach and working with controls suppliers early in the design process can help reduce manufacturing and service costs and ensure products are reliable and consistently meet customer expectations. ●



Marc Silverstein *is is the Product Manager for Fenwal Controls (fenwalcontrols.com) in Ashland, MA, U.S., a part of Carrier Global Corporation, a leading global provider of innovative HVAC, refrigeration, fire, security and building automation technologies. He has more than 15 years of experience in Product and Program Management for software and hardware technologies.*



Questions to Address in Preparing HVAC Systems For A Return to Work

BY KEVIN COGHLAN

As states begin phased-in reopening, employers around the nation are preparing for a return to the workplace and addressing the many issues that will arise from this transition. One of the most critical components here will be preparing the building space for reentry and assuring occupants that the space is safe. As facility managers work through the environmental issues, many may wonder whether it is necessary to disinfect or otherwise clean their facility's heating, ventilating and air conditioning (HVAC) system to ensure a healthy space for re-occupancy.

The short answer is "it depends." Facility managers accustomed to disinfecting HVAC systems for microbial contamination may be surprised to learn that, in most cases, specialized disinfection will not be necessary to prevent the spread of infection (although there may be some exceptions, as we'll discuss below). To understand why this is the case, it's important to start with the facts about viruses and their survival mechanisms.

Understanding How Viruses Work

The first critical fact to understand is that, unlike mold, viruses are not alive. While mold is a living organism that can multiply and colonize HVAC systems under a specific set of conditions—especially if those systems are poorly maintained—viruses are not. Much like a parasite, viruses depend upon a living host for replication and long-term survival.

Viruses like the novel coronavirus (SARS-CoV-2) are essentially a combination of nucleic acid— usually RNA —within a protein "coat" that depend upon the cellular machinery of their host to create more viral particles. Because viruses cannot reproduce without a host, they cannot multiply on surfaces, such as the inside of an HVAC system.

Viruses like SARS-CoV-2 also cannot remain infectious for very long if they are outside of a host. The virus must move relatively quickly from one host to the next, otherwise they will lose their infectivity. This is why most infections are usually attributable to prolonged or frequent close contact with an infectious person.

Early research indicates that SARS-CoV-2 becomes noninfectious after it is exposed on a surface for approximately three days. In fact, on most surfaces the virus' ability to potentially produce infection decreases within hours. In other words, like other similar viruses, SARS-CoV-2 is highly dependent upon its host to remain infectious.

The Best Disinfectant: Time

For the reasons noted above, viral particles that may linger within an HVAC system or attached to ductwork walls will not lead to reservoirs of possibly infectious residue. In most cases, those particles will remain on the walls of the HVAC, much like dust particles. Unlike mold, they cannot multiply and will not spread. Within a few hours to several days, the viral particles will be rendered noninfectious.

Buildings that have had low occupancy for several weeks — as is the case for many offices and other buildings following social distancing recommendations — will not require specialized HVAC cleaning practices prior to re-entry. In fact, guidelines from the Centers for Disease Control and Prevention note that facilities that have not housed a person with suspected or confirmed COVID-19 in the last seven days do not require specialized cleaning and disinfection of exposed surfaces. This is one instance where the waiting game is the right move.

Exceptions to the Rule

While it is true that many facility managers can relax over concerns about disinfecting their HVAC to reduce transmission of SARS-CoV-2, there are some cases where additional disinfection may be necessary.

For example, dedicated COVID-19 patient wards in hospitals and facilities operating in high humidity environments may require extra attention. The viral load may be quite high inside of an exhaust system

that serves a COVID-19 ward. In high humidity environments, the respiratory droplets and aerosols will not dry quickly, protecting the viral particles from exposure to the environment. Of course, the same principal of time and waiting applies here as well. No one should be allowed to access the inside of a potentially contaminated ventilation system until sufficient time has passed (at least 3 days, but waiting several more days may be prudent for these environments), unless a targeted disinfection of the system has been implemented. In these environments, facility managers should take a more detailed review of filter changes and determine if additional personal protective measures are warranted.

Steps to Take Prior to Re-occupancy

While most commercial office building facility managers will not need to take additional steps to disinfect their HVAC systems prior to occupant reentry, it will be important to evaluate this on a case by case basis. Under some circumstances, a targeted disinfection program may be necessary. It will be up to facility managers to assess their risks based on their understanding of the building's HVAC system and occupancy type and patterns.

All buildings, however, will benefit from an HVAC tune-up. Now, while buildings remain unoccupied or has a low occupancy, is an excellent time to ensure that the HVAC is operating as intended.

Poor HVAC performance can have a major negative impact on indoor air quality, leading to occupant discomfort. Over time, that discomfort might be associated with a "sick building." Poorly maintained HVAC systems could lead to a building closure, particularly at this time when people are more concerned than ever with adequate air circulation. Taking time to address HVAC system performance today can help put building occupants at ease over the next few months.

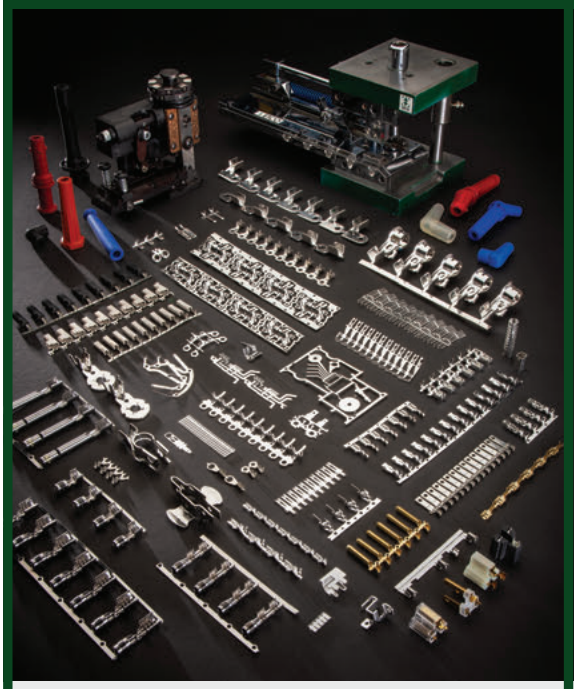
Consider targeted inspection and testing to ensure your building has a clean bill of health before occupants return. Now is an excellent time to determine that the appropriate level of outside air being supplied into the building is in line with design requirements and industry codes and standards, and to take a closer look at your filtration system, humidification and other building elements for proper operation.

This proactive attention to your HVAC system isn't just good for your building—it's also necessary to help address occupant's concerns about coming back into the workplace. In the weeks ahead, facility managers will play a critical role in subduing fears. In the long term, this proactive work will become even more critical in ensuring a healthy environment and protecting occupants' health and safety. ●



***Kevin Coghlan, M.S., C.I.H.**, is Principal Scientist and Chief Operating Officer of Environmental Health & Engineering, Inc., a leader in indoor environmental quality assessment and management. Our services are designed to help building owners and managers develop an effective strategy to addresses people's perceptions about environmental risk in a facility. If you need assistance with preparing your facility for re-occupancy, contact us today, **eheinc.com**.*

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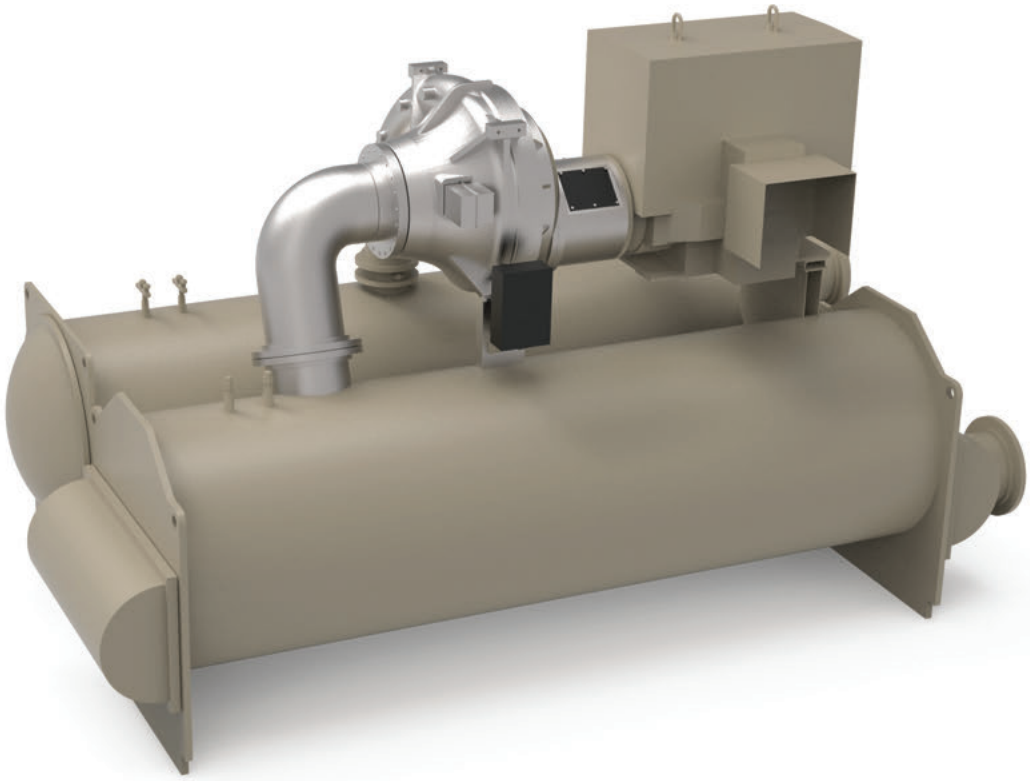
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Hermetic Feedthroughs
For Magnetic Bearing Chiller Compressors

BY CHRIS REMPEL

Magnetic bearing chiller compressors have taken the commercial and military HVAC market by storm. And it's no wonder. These highly-efficient compressors can save significant amounts of energy.

In a study conducted by the U.S. Department of the Navy, centrifugal, two-stage magnetic bearing chiller compressors reduced power consumption by 49% compared to traditional reciprocating or screw designs making them the most efficient compressor designs on the market.

The study attributes some of the energy savings to variable speed drives, which make the compressors more efficient at partial loads. But active magnetic bearings played a crucial role in the efficiency gains as well.

This type of bearing relies on electromagnets to levitate a rotating shaft in space (see Figure 1). Position sensors and controls keep the load balanced and centered within the bearing by continually varying the current to the electromagnets as the shaft rotates. With the shaft "floating" within an air gap, magnetic bearings are noncontact, and they don't require oil or other lubricants.

The magnetic bearings contributed to compressor efficiency by eliminating the energy losses associated with bearing friction.

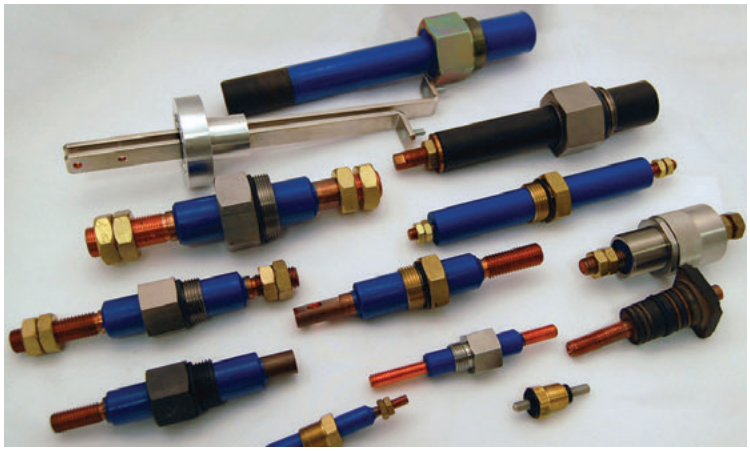
Magnetic bearings have other advantages too. They reduce the wear of internal components, increasing the longevity and reliability for longer service intervals. They also run cooler than traditional bearings.

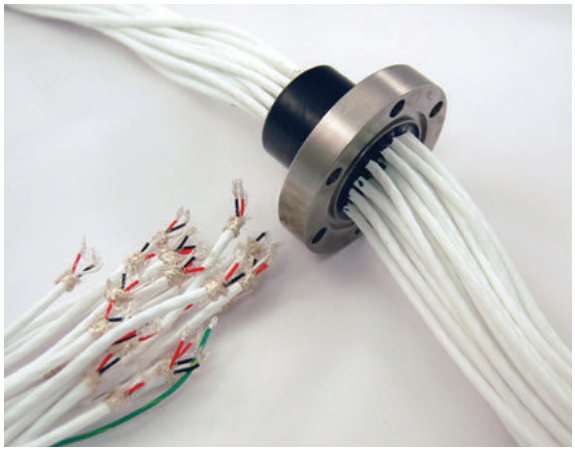
For all the good they do, magnetic bearings raise the bar on the compressor's electrical requirements. Like traditional compressors, they require provisions for power penetrations through a pressurized compressor housing. Magnetic bearings, however, require additional signal connections that traditional compressors lack. That is where epoxy-based hermetic feedthroughs enter the picture.

Feedthroughs Required

A typical magnetic bearing for a chiller compressor can have up to 40 sensors to feed position, speed, voltage, current and temperature data back to the digital controller ensuring that the high speed bearing is operating within specified parameters and provides a constant monitor for the health of the machine which helps to prevent unexpected maintenance downtime. The bearing will also need

Maintaining signal integrity for all the various sensors required to operate a magnetic bearing chiller is an ideal application for epoxy technology. Allows for uninterrupted point to point wiring for both the sensor wires and the shields required for EMI protection.





a 50 to 750 Amp power connection for the electromagnets. A traditional compressor, by contrast, might have only one or two sensors.

Epoxy-based hermetic feedthroughs are essential in this application because the bearings must function inside a pressurized compressor housing. Compressors running 134A refrigerant are pressurized to 350 psi. Epoxy feedthroughs maintain hermetic performance at much higher pressures— with leak rates of just 1x10-9 cc-He/sec at pressures up to 15,000 psi in our case.

To pass power and signal through the compressor wall, most designs rely on two types of feedthroughs, which are kept separate to minimize the effects of EMI. For power, we have developed simple threaded StudSeal variants specifically for compressor applications. These StudSeals carry a UL 984 listing and have successfully served in the air conditioning and refrigeration market for nearly 40 years. Also, we have passed compatibility testing with newer R134a, R410A, R514A, R513A, R1234ZE refrigerants—in addition to legacy R12, R123 and R22 refrigerants.

For signal, we typically deliver a custom DuctorSeal feedthrough that accommodates all the signal conductors required by the magnetic bearing. To maximize the quality of the magnetic bearing's control signals, we often recommend a "direct sealing" approach—in which we run sensor wires straight through the epoxy feedthrough to the controller PCB. This approach eliminates the voltage drop and signal degradation associated with connectors at the pressure bulkhead wall. And directly sealing to shielded and twisted wires provides an extra measure of EMI protection. Most compressor designs, however, call for a connectorized wire harness, which we can also supply.

More Magnetic Bearing Uses

Thanks to their oil-free, non-contact design, magnetic bearings are used widely in applications that are sensitive to contamination from lubricants or that require very high-speed shaft rotations, including:

- Flywheel energy storage systems
- Centrifugal pumps
- Turbines
- Motors
- Generators

In addition to running in pressurized environments—as in the case of compressor chillers—magnetic bearings are a natural fit for many vacuum environments, such as kinetic energy batteries.

Whenever the magnetic bearing needs to run under pressure or in a vacuum, it needs a robust feedthrough to handle all the power and signal connections.

Epoxy-Based Solution

Magnetic bearing compressors in the past relied on glass-to-metal feedthoughs, but epoxy-based feedthroughs have some clear advantages in this application.

- Epoxy offers far more design freedom. We routinely supply custom feedthroughs that freely mix 30 or 40 conductors of all different types.
- Epoxy offers the ability to directly seal shielded and twisted wires, dramatically improving signal quality.
- Epoxy allows the use of fully connectorized harnesses, which eliminated connection points that create additional failure points and cost and reduces BOM/vendor count.
- Epoxy saves space. It's not unusual for an epoxy feedthrough to take up 40% less space than a glass-to-metal feedthrough with soldered pins.



Chris Rempel *is Director of Sales and New Product Development for Douglas Electrical Components. He has nearly 2 decades of experience designing hermetic solutions for demanding customer applications. For more information contact the engineering team at Douglas Electrical or visit* ***www.douglaselectrical.com***

What's New



Clariant announced that **Martin John** has been appointed global head of the Advanced Surface Solutions business line in its Additives business unit. Advanced Surface Solutions offers a wide range of wax technologies to the plastics, coatings, inks, and adhesives industries.

According to Clariant, with his knowledge and experience in managing international businesses, John and his team will continue to transform the business line into a leading solution provider as it extends its global footprint with a particular focus on innovation and sustainability. He most recently headed Clariant's Performance Additives business line. Prior to that appointment, John gained management experience by holding various global and regional business management roles in sales, marketing, procurement, and logistics in Europe and North America.



Infineon Technologies AG announced the closing of the acquisition of **Cypress Semiconductor Corporation**. The San José-based company has become part of Infineon.

"The acquisition of Cypress is a landmark step in Infineon's strategic development," said Infineon CEO Reinhard Ploss. "Together, we offer our customers the industry's most comprehensive portfolio for linking the real with the digital world and shaping digitalization, one of the most important global trends. We serve as a trusted partner for customers and distributors.



Carrier Global Corporation debuted as an independent, publicly traded company after successfully completing its separation from **United Technologies**. Shares of Carrier began "regular-way" trading on the New York Stock Exchange under the symbol "CARR."

Carrier is a leading provider of innovative heating, ventilating and air conditioning (HVAC), refrigeration, and fire & security technologies. The company has an extensive global footprint with approximately 53,000 employees, offering solutions in more than 160 countries. Carrier has leading positions in critical segments, including North American residential HVAC, commercial HVAC equipment in major markets, global fire detection and suppression, global access controls for security systems, and refrigerated equipment for the North American and European truck trailer and container businesses.

As an independent company, Carrier will have greater focus and enhanced agility based on its own distinct operating priorities and strategies for long-term growth and profitability, including strengthening and growing its core businesses, extending its product range and geographical coverage, and expanding service and digital offerings. The company is well-positioned with strong megatrends driving sustained industry growth, leading positions with significant installed base, a disciplined operating system, and an unwavering commitment to innovation.



Emerson supports U.S. Army Corps of Engineers. As the number of New Yorkers infected by COVID-19 skyrocketed, health department officials were bracing for local hospitals being unable to accommodate the thousands of people who needed medical attention in coming weeks.

In response to the crisis, the FEMA issued a $350 million Mission Assignment to the U.S. Army Corps of Engineers for construction of four alternate care facilities in New York, including the Westchester County Center arena in White Plains, NY.

In need of pipe protection, the project's general contractor Haugland Energy Group LLC reached out to AEF Sales, a local sales representative of Emerson brand Nelson™ heat tracing cables and accessories. AEF Sales had worked with Haugland on various power plant projects in the past and enjoys a strong partnership with the contractor.

Recognizing the importance of getting the Westchester County Center up and running, Emerson's sales representatives removed all barriers to meet the order quantity expeditiously.

As a result of the efforts of AEF and Emerson, the water lines were fully protected from the elements by the time service was turned on. The Westchester County Center project is a part of Emerson's efforts to combat COVID-19 by supporting critical infrastructure and by helping federal, state and local governments address urgent healthcare needs.



Mixing adhesives in his mother's basement was something Harry Arnon probably never imagined doing growing up. He likely never thought he'd co-own a U.S. company with his brother, Josef, either — and especially a world-renowned one that manufactures high-performance adhesives, sealants, and precision dispensing equipment.

However, the two brothers are at the helm of **Hernon Manufacturing**, which distributes to dozens of countries including major industries such as energy, defense, aerospace, automotive, medical, and many others.

"Hernon Manufacturing represents the great American story," shares Drew Richards, marketing manager with the company. "It was founded by immigrants looking for a better life in this country…and finding it."

Harry and Josef Arnon are Iranian-born Jews. But before dreaming of America, both brothers served in the Israeli military. When the time came, Harry Arnon enrolled in the Israeli Air Force and Josef joined the Army.

According to Richards, Arnon spent quite a bit of time in the Air Forces working on and repairing fighter jets. In 1974, however, he arranged for a big move away and landed in New York City. He only had a few dollars to his name then, but managed to find work in general contracting. Josef followed him to America a few months later and, eventually, worked as a graduate student in the Applied Science Department at New York University, where he holds a bachelor's degree in aeronautical engineering and a master's in polymer chemistry.

"Josef ended up working on a university project with his professor at NYU, developing an adhesive that proved quite effective. It actually gained the recognition and a contract from the government to continue production," says Richards. "This set off a light bulb of sorts for Josef and Harry about possibilities and where it could lead for them."



To complete the vision for **Sequel Wire and Cable**, a new and reimagined company wire and cable manufacturing company, Rich Carr, CEO brought together his dream team. Along with business partner Denise Feece, Rich recently announced that Mike Frigo will be joining them as Chief Commercial Officer.

Rich commented, "We are ecstatic to have Mike join as a founding member of the team. He has 36 years of experience in the OEM space and has an excellent understanding of the market, the customer base and exactly how Sequel can fit into that space. His process and product knowledge allow him to quickly identify and address how to help customers solve any problems as they arise."

Rich shared, "Mike and I worked together for many years at Copperfield and we developed a great reputation in the OEM space... We are excited to have the opportunity to assemble this leadership team that has the benefit of a strong history. We know what success looks and feels like. Our reputation, wisdom from years of experience, and passion for customer service will help us stand apart."

Mike agrees that the team is a perfect match, "The reason Rich, Denise, and I team up so well together is because our skill sets complement each other. We can all wear many hats, but when we focus on our individual strengths, we bring something to the industry that frankly doesn't exist."

Sequel is bringing a high level of technology to the new venture with systems they are creating on the plant floor for real-time manufacturing order status, and with the level of transparency to the customer on Sequel's service performance metrics, which will be incredibly advanced and unique to the industry. Mike reiterated that the delivery system for information is up to the customer. "Whatever their preference is, we will be able to accommodate it without a lot of effort on their part."

Mike concluded, "We recognize that the market has changed significantly in the last 10 years, but what has remained constant is the need to have an unrelenting focus on taking care of the customer, and that is one of the main components and backbone of Sequel."

For more information on Sequel Wire and Cable, visit www.sequelwire.com, email sales@sequelwire.com, or call 574-626-1515





EpoxySet introduces FLASHBOND™ UV-6502CL, a non-yellowing, optically clear epoxy that can be cured in under 10 seconds with 365 LED light. This low viscosity adhesive produces high bond strength to glass, metals, ceramics and many engineered plastics. With a glass transition temperature of 135°C, it can be used continuously to 200°C without discoloration.

The low cure shrinkage of UV-6502CL yields low stress on even the most delicate parts making it ideal for alignment applications. It can be cured up to 1 mil thick to create a scratch resistant finish that can easily be cut and polished. Designed for optical bonding, the UV-6502CL can be used for sealing, coating and small encapsulations. It has excellent resistance to moisture and chemicals.

This tough polymer is RoHS and REACH compliant as well as halogen and BPA free.



Southco's AV Display Mount series is designed with their patented Positioning Technology, which precisely regulates operating efforts, ensuring displays move easily when needed, yet holds them securely under vibration and touchscreen user force.

- Integrated positioning technology allows for controlled operating efforts
- Reliable service eliminates the need for constant adjustment or maintenance
- Clean appearance with integrated wire management covers
- Withstands touch forces, vibration, and heavy loading



In **Britain, Prime Minister Boris Johnson**, who was on the mend after contracting COVID-19, had placed an order for 10,000 ventilator units from **Dyson**, the company best known for its vacuum cleaners.

Dyson's founder, James Dyson, confirmed the order in an email to his employees. ''Since I received a call from Boris Johnson ten days ago, we have refocused resources at Dyson, and worked with TTP, The Technology Partnership, to design and build an entirely new ventilator, The CoVent,'' Dyson wrote.

The design and manufacture of a new ventilator would typically take many years and require complex components, but the Dyson-TTP team have condensed design and manufacture to a matter of weeks.

The ventilator meets clinician-led specifications to address the explicit clinical needs of COVID-19 patients, according to Dyson's press office. The U.K. Government requested a design for a ventilator that was safe, effective, efficient in conserving oxygen, easy to use, bed-mounted, portable and not needing a fixed air supply.

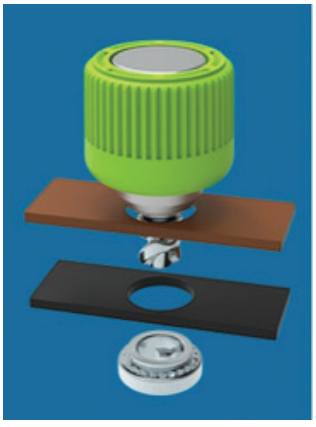
Dyson and TTP answered the call with a bed-mounted, portable ventilator that operates on batteries so it can be used in different care settings, including field hospitals or when patients are transported. The unit is powered by Dyson's digital motor, which has been specially re-engineered to meet the requirements of the ventilator. The fan units are available in very high volume and the unit conserves oxygen using a rebreathe circuit to deliver high-quality filtration.

According to James Dyson's email, the company will further donate 5,000 units to the international effort, 1,000 of which will go to the United Kingdom.



Southco's new compact quarter-turn fastener for tight spaces.

- Smaller head diameter for use in limited-space applications
- Color differentiation enables identification of application zones
- Tool- and hand-operated options available
- Available in press-in and flare-in installation styles



Southco's DZUS® Quarter-Turn Fastener series satisfies a broad range of requirements for quick access, high strength and economical performance. Each DZUS® fastener is available in a variety of stud lengths and mating receptacle options for accurate, secure engagement and convenient mounting.

- Quickly secures and releases with a 90-degree turn
- Stays captive to the panel, preventing lost hardware
- Provides a strong, consistent clamping force with repeated operation
- Remains securely fastened under vibration



Dow announced its new **DOWSIL™ EA-3838 Fast Adhesive**, an advanced primerless silicone adhesive that cures rapidly without oven heat for improved productivity and reduced energy usage in the manufacture of appliances, automotive electronics, lighting and avionics. This innovative new adhesive cures at room temperature and provides fast adhesion for shorter cycle times. Additionally, DOWSIL™ EA-3838 Fast Adhesive creates strong, reliable bonds between a variety of dissimilar materials, including glass to metal, glass to painted metal and glass to plastic.

"Appliance manufacturers and those in other key industries are increasingly calling for higher performing industrial adhesives that are reliable, strong, easy-to-use and promote cost-saving efficiencies," said Beato. "New DOWSIL™ EA-3838 Fast Adhesive is addressing this demand and illustrates Dow's commitment to providing our valued customers with the cutting-edge materials they need to achieve the right balance of properties, better bonding and more efficient overall business operations."

With its fast cure speed, DOWSIL™ EA-3838 Fast Adhesive achieves bond strength in just five minutes. Homogenous curing throughout the adhesive cross-section promotes greater reliability. Manufacturers can also apply heat to accelerate further curing. Regardless of production volume, DOWSIL™ EA-3838 Fast Adhesive's standard 2:1 mixing ratio eases processing and is simpler to use than current 5:1 offerings. For bonding applications that require expanded open times to support repositioning, 3:1 or 4:1 mixing ratios may be used.

"With its flexible mixing ratios, DOWSIL™ EA-3838 Fast Adhesive provides the processing flexibility that appliance manufacturers and other industries need," said Beato. "This certified high-throughput material is suitable for a wide range of end uses, which can enable job site managers to reduce the number of products they typically need to order, store and handle."

LumenRadio's new release of **MiraOS** – their operating system for reliable wireless connectivity – they take a new step towards providing more options and a quicker time to market for customers, resulting in a smoother development process for products based on MiraOS. LumenRadio´s focus is to develop the most resilient and Future-Proof connectivity solution on the market, but their vision is also to make it easier for development teams to implement wireless technology into their products, something that is clearly shown in the new 2.4 version of MiraOS.

Unique Features in MiraOS 2.4

- Stand-alone MiraMesh – Use the ultra-reliable mesh technology with MiraOS or with any other operating system of preference
- Universal Radio Protocol Time-Sharing – Run any radio protocol concurrent with MiraMesh, leveraging the same physical layer
- Link Local Multicast – Multicast that can be optimized for data thirsty or ultra-low energy products

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CIT Relay & Switch announces the acquisition of **Picker Components**. Both companies are designers and manufacturers of high quality electro-mechanical relays and switches. ''The combination of CIT and Picker will generate value for our customers through a large choice of tailored solutions, a global network of services and expanded engineering expertise. It will magnify our value with a wider breath of product while at the same time extracting synergies. We look forward to continued growth and strength this will give to our operation,'' noted Jeff Hampton, President of CIT Relay & Switch.

Wherever opportunities arise, CIT will work to provide customers the best product for the application and most compelling support experience. Two quality manufactures rolled into one for continued growth of CIT/Picker through paramount service, selection, quality, and value – we strive to be the best.

CIT Relay & Switch places the customer first working directly with customers from simple to complicated projects, tailoring custom solutions and designs. When you contact CIT, you are immediately connected to a professional.



THE BEAUTY'S IN THE DETAILS

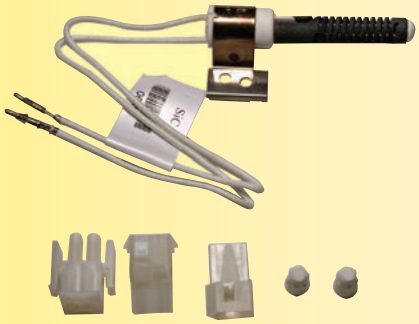
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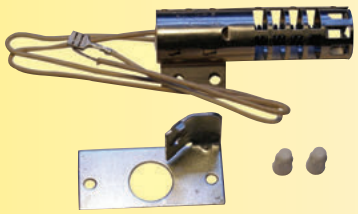
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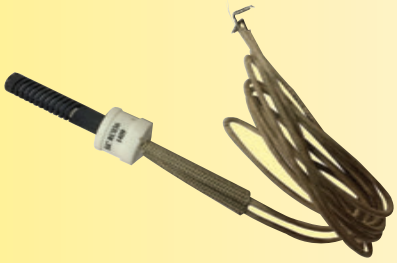


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The resulting ACR products are smaller and lighter yet can be produced using familiar manufacturing methods.

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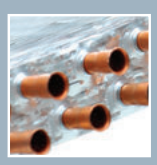
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