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Tractor Makes
Its Debut **28**

May 2022

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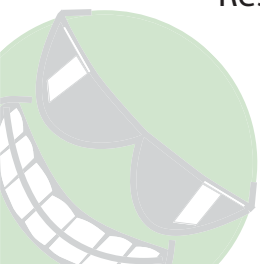
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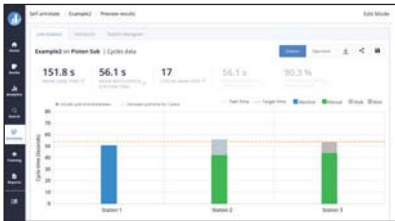
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The Future Looks Positive for Fluid Power

Demand for hydraulic and pneumatic components is forecast to be strong in the coming years, which is good news for our readers. As our cover story starting on pg. 14 indicates, market conditions are expected to be positive for the next several years for the fluid power industry.

Recent figures from the National Fluid Power Association (NFPA) show shipments for fluid power components continue to trend in an upwards direction. Mobile hydraulics in particular are experiencing good growth conditions due in large part to strong demand for heavy-duty equipment such as construction and agricultural machinery. The construction equipment segment especially is expected to remain positive for several years due to ongoing investments in infrastructure projects around the world. This will greatly benefit hydraulic component manufacturers.

The pneumatic components market is expected to benefit from positive growth in manufacturing as well as the oil & gas

markets. Automotive will account for a large portion of the market according to a report from Allied Market Research as OEMs increase their use of robotic automation to improve the cost and efficiency of their manufacturing operations.



SR166/DREAMTIME

Pneumatics are aiding automation in many industries. Our article on pg. 18 demonstrates the many benefits pneumatics offer in automating the food packaging process. As the piece states, pneumatics can offer precise movement and increased throughput while helping to ensure the cleanliness, safety and efficiency necessary in this application.

And as global demand for goods—and getting them quickly—continues to increase, there will be a continued need for more automation in many manufacturing applications.

What are you seeing in the industry? How are market conditions trending for your business? Reach out to us on social media or via email and let us know!



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Danfoss Editron Powers Doosan Electric Excavators

by Sara Jensen

Danfoss Power Solutions' Editron division—the company's hybrid and electric powertrain systems division—recently worked together with construction equipment manufacturer Doosan to electrify two excavator models. The 16-ton wheeled excavator and 30-ton crawler excavator are powered by electric drivetrains provided by Danfoss Editron instead of diesel engines.

In addition to the electric powertrain, Danfoss also provided a control system and display utilizing its PLUS+1 software to help ensure an optimized solution.

For the project, Electric Construction Equipment (ECE)—which has a license agreement with Doosan to modify its machines for European dealers—worked with Electrauvision, a division of Danfoss' partner Hydrauvision, which provides system integration for various applications. Electrauvision supplied ECE with the electric drivetrains and worked together with the company to ensure optimized installation of the Danfoss components.

Integration Key to Successful Engine Swap

To convert the Doosan excavators to electric power, their engines were swapped out for the Danfoss electric powertrain consisting of an electric motor and inverter. The machines' hydraulics were left untouched, says Antti Väyrynen, director of Off-Highway for Danfoss' Editron division.

He says the general requirements of the excavators were easy to meet with the Danfoss Editron technology. The biggest challenge when replacing a combustion engine is the need for the electric powertrain to interface with auxiliary systems. "The most challenging part was the HMI (human machine interface) and the DC controller connection because we have to keep the functional safety and the vehicle homologation as it was before," he explains. Doing so ensures the machine will operate as it was originally intended.

According to Väyrynen, the Danfoss Editron system is one of the most efficient in the market. This is important for ensuring the battery holds its charge which leads to maximum operation time before recharging. The components are designed for use in heavy-duty operations and harsh environments which further aids performance optimization for customers as there is less chance of wear-and-tear due to the operating conditions. "[The components] have been designed for off-highway machines; this maximizes uptime, lifetime and most importantly the total cost of ownership," says Väyrynen.

Included in both excavators is an exchange battery swapping system comprised of an electric powerbox which provides power

to the electric drivetrain. Väyrynen explains the system works by having the battery provide energy to the electricity consumer and the motor inverter uses that energy to drive the electric motor. The motor is connected to the main hydraulic pumps; hydraulic oil flow and power demand set the working speed of the electric motor. Danfoss' customized PLUS+1 control system enables communication between these components.

Use of the PLUS+1 hardware and tool chain aided integration of the electric systems. Ensuring optimized integration was important says Väyrynen because the companies were converting an existing excavator platform to electric power. "This PLUS+1 system is handling the power management in the electric system," he says. "It



The Danfoss Editron electric powertrain features a high-efficiency electric motor which helps to ensure machine performance and productivity.

controls the main Editron inverters as well as the auxiliary systems [such as] cooling, the 24V power supply and the HMI."

The collaboration with Doosan is one of several electrification projects in which Danfoss has participated over the past several years. "We have electrified almost [every type of] mobile work machines you can think of," says Väyrynen.

Read about Danfoss Editron's most recent work in the marine sector at powermotiontech.com/21236247.

Because of its experience electrifying various types of equipment, Danfoss Editron has gained a wealth of knowledge in how to develop the necessary technology as well as meet the requirements of OEMs and their end-use customers. The company's technology has also amassed several operating hours in the field, proving its capabilities and reliability. This expertise will be beneficial as electrification advances in many industries and Danfoss Editron continues to work with various OEMs and machine types. **P&M**

One Year Out, IFPE & CONEXPO-CON/AGG Looks to be Bigger and Better

by Sara Jensen

The countdown to the 2023 edition of the co-located CONEXPO-CON/AGG and International Fluid Power Exposition (IFPE) shows has begun. These triennial events—considered to be among the world’s largest for the construction, mining and fluid power industries—are set to take place March 14-18 at the Las Vegas Convention Center (LVCC).

IFPE brings together the latest technologies related to the fluid power industry as well as power transmission and motion control. Along with traditional hydraulics and pneumatics components are sensors, robotics, data analytics technology and more which can all be used in tandem to create more efficient systems and machines.



IFPE provides a look at the latest technologies for fluid power, power transmission and motion control.

In addition to the over 300 exhibits, IFPE also offers 150 educational sessions. This provides attendees the opportunity

to learn about the latest industry trends and design methods to help improve upon their product developments.

The 2023 IFPE show will be co-chaired by Marcia Klein, treasurer at Casappa Corp.—also the first woman to chair the event—and Bob Pettit, certified Fluid Power Specialist and North American CEO of HAWE Hydraulik. Both say they look forward to helping guide direction of the exhibition and its educational sessions.

“IFPE provides a dynamic global resource for industry professionals to keep up with the latest advances and interact with the fluid power community,” said Eric Lanke, president and CEO of the National Fluid Power Association (NFPA), which co-owns the show, in a press release announcing the 2023 co-chairs. “Both Marcia and Bob bring such a depth of knowledge about the fluid power world to the IFPE committee, I can’t wait to get to Vegas for the next show.”


Education Sessions to Focus on Key Industry Trends

According to IFPE’s organizers, its educational events are intended to provide crucial information on new technologies benefitting those designing components and systems for fluid power, power transmission and motion control.

Automation, digitization and electrification will be among the trends highlighted at the 2023 event. John Rozum, IFPE show director, said in a press release about the educational sessions that these trends are more than buzzwords; they are in use and helping shape the industry. “From smart systems and energy efficiency to machine safety and motion control, the technology of tomorrow is out there today. We’re looking for the experts who can bring these technologies to life, share their insights and help show attendees gain valuable knowledge that they can

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take back to their businesses.”

A call for educational content was sent out in 2021; submissions are currently under consideration by the show’s education committee and it is currently seeking presenters.

Topics of interest for the 2023 IFPE educational sessions will focus on the following areas:

- IoT- Smart Systems/Connected Systems
- Electrification of Vehicle Powertrains (hybrid to fully electric)
- Electrification of Motion Control
- Equipment Up-Time Optimization and Availability
- Energy Efficiency
- Machine Safety
- Autonomous Equipment/Machines
- Professional Development (career development, workforce issues, economics)

Convention Center Improvements Increase Show Size and Accessibility

CONEXPO-CON/AGG and IFPE are huge, taking over the majority of the Las Vegas Convention Center. Per show organizers, CONEXPO-CON/AGG alone accounts for 2.7 million sq. ft. of space. The newly built and completed West Hall will reportedly add an extra 1.4 million sq. ft. of indoor space.

“AEM and our show committees of industry leaders are working to take advantage of everything that has changed in Las Vegas to deliver a top-notch event delivering the latest innovations and best practices to help construction pros take their businesses and careers to the next level,” said Dana Wuesthoff, show director of CONEXPO-CON/AGG 2023, in a recent press release from AEM discussing the event. “Between the West Hall and Diamond Lot bringing a lot of displays closer to the rest of the show as well as serving as a connector to the Festival Lot, and the LVCC Loop making it effortless to get across the entire Las Vegas Convention Center, it’s never been easier for attendees to see everything they want to learn about when they get there.” **P&M**



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New Software Tools Reduce Design Time

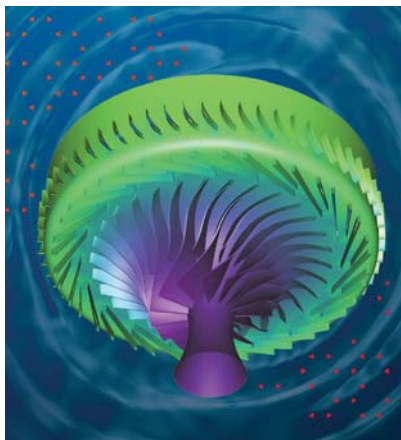
by Sara Jensen

Design software comes in many varieties and can greatly benefit development teams. Advancements over the years have helped to improve the productivity of design teams by reducing the amount of time spent developing a product as well as the amount of physical work needed to do so.

New design tools are continually entering the market to help improve the efficiency and accuracy of designs.

Manufacturer of power transmission and fluid power solutions Gates has launched Design Power. This new software platform includes several digital design tools to aid with engineering and specification of belt-drive systems.

Cadence Design Systems Inc. has also



Cadence Fidelity CFD Software features a next-generation, high-order flow solver which helps to improve the accuracy of simulations while also reducing the amount of time necessary to complete them.

recently introduced a new software tool, Cadence Fidelity CFD. It is a suite of computational fluid dynamics (CFD) solutions designed to increase turnaround time while ensuring accuracy.

Gates Design Power

According to Gates, the new Design Power platform features some of the most sophisticated belt-performance models available in the industry. These were developed based on data Gates has gathered over the years from its test laboratories. The company says this helps to ensure customers are able to design robust, application-specific drive systems when utilizing the software.

The Gates Design Power software platform contains six modules, four of which are new applications. Upgraded versions of Gates' Design IQ and Design Flex Pro digital tools are included, as well.

A Mobility Drive Analysis tool—which Gates says is an industry first—is one of the new programs available in the platform. It is designed to help OEMs in various applications such as motorcycle and power sports more easily integrate clean, quiet, durable and low-maintenance Carbon Drive belt systems from Gates into their products.

Gates says there are features included in the software platform which are aimed at improving the design process as well as making it easy to use and design belt drives for engineers of all skill levels, including inexperienced ones. A collaboration functionality allows users to work with a Gates application engineering experts to optimize their designs.

Industry knowledge built into Gates Design Power offers design guidance for those with more advanced engineering skills.

The platform also automatically synchronizes with Gates' product catalog to make it easier for users to find and learn about the products they want to use in their designs. Multiple designs can be stored in a single project file, the company says, allowing

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design teams to easily track design derivations and iterations while also enabling them to make notes as changes are made.

Gates Design Power is available globally as a free download with 15 languages included. The company plans to continually develop the platform to provide more features and enhancements to further benefit users.

"At Gates we are committed to relentless innovation and finding ways to make our customers' lives easier. Digital innovation is as important as product innovation in making this happen," said Tom Pitstick, chief marketing officer and senior vice president of strategic planning for Gates, in the company's press release announcing the launch of Design Power. "The new Gates Design Power software platform builds upon our existing design tools to support our Global 'Chain to Belt' initiative, making it even easier for engineers across all applications, from two-wheelers to manufacturing equipment, to design-in our products and get the most out of their belt drives."

Cadence Fidelity CFD Software

Cadence's new CFD software aims to improve the performance and accuracy of multiphysics simulation for various applications including automotive, turbomachinery, marine and aerospace. The company says its Fidelity CFD software offers a next-generation flow solver with high-order numerics, scale-resolving simulations and massive hardware acceleration. All of these work together to help increase performance and speed up turnaround time of CFD simulations while maintaining accuracy.

Fidelity CFD brings together various technologies an engineer would need to simulate the performance of multiphysics system in a streamlined workflow states Cadence in its press release announcing the launch of the software tool.

The software features several specialized flow solvers for marine and turbomachinery applications along with

general-purpose ones for an array of flow types. Fidelity CFD can help engineers to evaluate and address noise around a vehicle, optimize the power generated by wind turbines as well as reduce fuel consumption of engine-driven vehicles or equipment. All of this can be done in a fast and accurate manner, helping to reduce development time for design teams.

Next-generation, high-order flow solvers with advanced simulations of fluid turbulence are included in the software which can predict aerodynamic drag on a road vehicle up to 10 times more accurately than a traditional CFD solver the company says. And turnaround time to run this type of simulation is reduced to a day or less compared to weeks.

According to Cadence, a unique feature of the software is the combined meshing expertise from the NUMECA and

Pointwise companies which it acquired in 2021. Geometry and meshing can take up to 75% of an engineer's time but integration of these companies' capabilities into the software, which is ongoing, helps to reduce the amount of time needed for this work.

"We chose NUMECA Autoseat and Hexpress to be our standard workflow for CFD preprocessing," said Antoine Delacroix, Manager Vehicle Performance Engineering R&D at Toyota Motor Europe, in Cadence's press release. "They allowed us to reduce our total lead time and work hours respectively by 91% and 97% while consistently providing high-quality meshes with excellent layer coverage."

"Since becoming part of Cadence, the team has continued to deliver valuable new solutions. We like the integration of all these tools in Fidelity CFD and look forward to continued innovations." **P&M**



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Terzo Introduces New Hydrapulse Unit to Aid Electrification in Larger Applications

by Sara Jensen

Terzo Power Systems has introduced a new version of its electrohydraulic system to enable electrification of larger vehicles and equipment. The Hydrapulse Frame Size 3 (Hydrapulse F3) provides increased power density to meet the needs of commercial trucks as well mining and other large off-highway equipment.

The new Hydrapulse F3 is the company's largest model to date. It features power levels up to 100 kW and 800V of direct current. Multiple units can be used in tandem, as well, to provide even more power for larger vehicle and equipment applications.



The new Hydrapulse F3 provides power levels up to 100 kW and 800V of direct current.

"The F3, like every Hydrapulse, has some unique features worth highlighting," says Mike Terzo, CEO, Terzo Power Systems, in the company's press release

announcing the launch of the Hydrapulse F3. "The inverter and liquid cooling are integrated, which makes plug and play much simpler for OEMs. These factors, combined with the power-on-demand capabilities of the F3, solve many of the problems encountered in off-highway electrification."

Versatile drive and mounting options will be available with the Hydrapulse F3, as well as other features including:

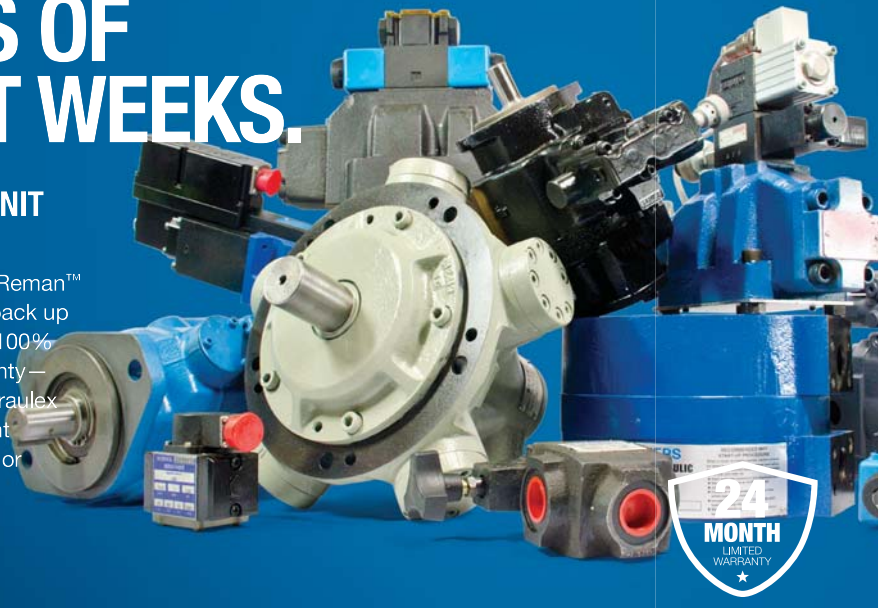
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Hydrapulse Blends Electric and Hydraulic

Hydrapulse was developed to help improve the efficiency of hydraulic systems and enable the electrification of off-highway equipment. It is comprised of an electronically controlled motor and pump assembly which enables it to efficiently perform several types of fluid power functions. Integration of the Hydrapulse's various components helps to ensure optimized performance while also creating a compact system.

The Hydrapulse is a plug-and-play system for easy installation for OEMs. It is customizable but also comes in three standard sizes. Additional features include:

- rugged IP6K9K rating
- wide voltage input range
- liquid cooling
- custom mounting options
- quiet pump options
- production ready design.

Since introducing the Hydrapulse technology, Terzo Power Systems has demonstrated its capabilities in construction equipment and expanded the applications in which it can be utilized such as heavy-duty trucks.

The company has also expanded partnerships with other component suppliers to provide OEM customers with a full system solution. In June 2021, it announced a partnership with Briggs & Stratton whose Vanguard commercial lithium-ion battery pack will provide electricity to the Hydrapulse unit.

Terzo Power Systems most recently (February 2022) entered into a partnership with Continental/Hydreco to build steering and electrohydraulic systems for OEMs. Continental/Hydreco components are used in various off-highway equipment applications. As such, they are able to meet the demands of these machines while ensuring durability all of which will benefit use of the Hydrapulse in heavy equipment.

Continental/Hydreco also offers silent pump products which will be particularly

beneficial in electric vehicle applications. The pumps reduce the amount of fluid borne noise generated and transmitted, helping to minimize noise from the overall hydraulic system.

Electric vehicles are known for their

quieter operation because of the lack of an engine and other supporting parts which means other components and systems will need to begin operating at quieter levels as electrification increases to ensure comfort of operators. **P&M**

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POSITIVE MARKET CONDITIONS

Will Continue for Hydraulics and Pneumatics

Growth in manufacturing, heavy equipment and oil & gas will benefit the fluid power industry in the coming years.

by Sara Jensen

Steady growth is expected to define the hydraulics, pneumatics and overall fluid power industry for the next few years. Several factors will help keep demand for components high, including continued growth in heavy equipment markets such as construction and mining, as well as strength in the manufacturing sector.

Despite supply chain challenges, demand remains strong for products in a variety of industries requiring the use of fluid power components which will benefit the market.

The National Fluid Power Association's (NFPA) latest *Fluid Power Industry Growth Trend* report shows there has been steady growth for hydraulics, pneumatics and total fluid power components since February 2021. Year-to-date percent change for total fluid power shipments in February 2022 was 18.8%, states NFPA in its report.

The association also notes mobile hydraulic component orders received from March 2021 to February 2022 were 142.5% of those received during the previous period (March 2020 to February 2021). NFPA says pneumatic shipments stayed the same as the previous month while both industrial

and mobile hydraulic shipments were up.

A forthcoming report from Interact Analysis indicates mobile hydraulics—which account for close to 60% of the total hydraulics market—will be the key driver for the hydraulics market going forward. Electrification is a key driver for this, states Brianna Jackson, research analyst at Interact Analysis, and contributor to the upcoming report.

As OEMs move to electric powered machines, they will need to improve the efficiency of other components and systems such as hydraulics, which could provide many opportunities for manufacturers.

Jackson predicts in 2022, supply chains will pose some challenges to the industry though not necessarily to the extent other industries are facing. She also foresees a strong outlook over the next five years for mobile hydraulics. Though some predict a displacement of this technology, that is not likely to be the case, as hydraulics still offer the power density needed in many applications as well as cost efficiency.

Hydraulic Cylinder Market to Grow Through 2027

Research firm MarketsandMarkets' latest report on the hydraulic cylinder market projects it will reach a value of \$18.3 billion by 2027, achieving a compound annual growth rate (CAGR) of 4.4% from

2022-2027. MarketsandMarkets says the growth will mostly be attributed to increased demand in construction and mining equipment used in the construction, mining and oil & gas industries.

The research firm notes increased adoption of material handling equipment—much of which utilizes hydraulic cylinders—in various global industries will help boost growth for the market.

Double-acting hydraulic cylinders are expected to account for a larger share of the market during the forecast period, says MarketsandMarkets. These cylinders' retraction properties benefit a variety of industries including aerospace, automotive and agriculture, and tend to be in high demand for mobile applications such as earth moving equipment, forklifts and heavy trucks. All of these segments are anticipated to see growth in the coming years, aiding market conditions for double-acting hydraulic cylinders.

Welded hydraulic cylinders are also forecast to make up a large part of the market and its growth. According to MarketsandMarkets, these cylinders accounted for the largest share of the hydraulic cylinder market in 2021. They are commonly used in mobile applications such as construction, mining and material handling equipment which have all seen a high level of growth over the past year, leading to growth for the hydraulic cylinders as well.

Per MarketsandMarkets, the agriculture industry is expected to grow at the highest CAGR during the forecast period due in large part to increasing mechanization around the world. And because hydraulic cylinders are utilized in almost all types of agriculture equipment,



the market will benefit from the growth anticipated in this machinery segment.

Of the various hydraulic cylinder types, MarketandMarkets' research shows those with a bore size ranging from 50-150 mm (2-6 in.) comprised the majority of the market in 2021. This size range is forecast to continue dominating much of the market because of the wide range of applications in which it can be used, including construction and agriculture equipment.

Asia-Pacific (APAC) accounted for the largest share of hydraulic cylinder demand in 2021, and is expected to have the highest CAGR for this market through 2027. Increased demand for hydraulic cylinders is due to growing demand in the region for agricultural, construction and mining equipment. There is a growing population and desire for more industrialization, necessitating use of these machines.

MarketsandMarkets says Japan and Australia are the major markets for hydraulic cylinders in APAC. Japan has several automotive manufacturers and suppliers who require the use of hydraulic cylinders, even as they begin to automate more of their manufacturing operations. Meanwhile, Australia is home to several mine sites which use hydraulic cylinders in their equipment. The growing need for minerals and other materials for various products around the world such as batteries will continue to drive the mining market and thus the need for hydraulic cylinders.

Manufacturing, Oil & Gas will Provide Gains for Pneumatic Cylinder Market

A report from Allied Market Research released in late 2021 on trends in the global pneumatic cylinder market indicate this segment will see a CAGR of 5.8% through 2030. The market is expected to generate \$23.85 billion in revenue.

Growth will be driven by increased

demand from the manufacturing sector, rising use in the automobile and aerospace industries, as well as increasing construction activities states Allied Market Research. The research firm says increased automation and advancements in space technology will pro-



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This size range is forecast to continue dominating much of the market because of the wide range of applications in which it can be used, including construction and agriculture equipment.

vide new opportunities for the pneumatic cylinder market in the coming years.

According to the report, linear products are projected to achieve the highest CAGR at 6.0% through 2030, while the rotary segment will achieve 5.5% CAGR. Linear components accounted for over half of the global pneumatic cylinder market in 2020; this market strength will continue through the forecast period due to availability of products which meet new industry demands.

The largest end use segment for pneumatic cylinders in 2020 was the oil & gas industry, says Allied Market Research. It projects this segment will continue to be the largest market driver for these components due to a rise in population and industrialization—and therefore

increased need for oil and gas products.

Automotive is also expected to account for a large share of the market, with a CAGR of 9.2% projected through 2030. Allied Market Research says this is because of the growing demand for economical and efficient manufacturing which has increased use of robotic automation.

North America is projected to continue being the dominant market for pneumatic cylinders as the oil & gas industries in the U.S. and Canada are fueling demand for these products. Asia-Pacific will achieve

the fastest CAGR of 7.0% due to its large population and low-cost manufacturing sector says the research firm.

Heavy Equipment Sectors to Help Drive Growth

Among the key drivers for continued positivity in the fluid power industry is strong demand for heavy-duty off-road equipment such as construction machinery. President Biden's infrastructure bill has aided this market as well as infrastructure investments taking place around the world.

According to a new study from Grand View Research Inc., the global construction equipment market will achieve a CAGR of 3.9% through 2030. It is



STUART MADE / DREAMSTIME

Hydraulics are a key component in several types of construction equipment. As such, growth in this machinery market will greatly benefit hydraulic component manufacturers.

projected to reach a value of \$161.99 billion. Modernization efforts and global infrastructure investments are key drivers for this market growth.

Hydraulics are a key component in several types of construction equipment. As such, growth in this machinery market will greatly benefit hydraulic component manufacturers.

Grand View Research reports material handling machinery will exceed a

4% CAGR during the forecast period due to increased demand for crawler cranes, which offer more convenience and accessibility on smaller job sites. Concrete and road construction machinery is expected to reach a 5% CAGR as investments in highway projects increase.

The Association of Equipment Manufacturers (AEM) reports in its *Ag and Construction Equipment Market Outlook* released Feb. 21 that the value

of the construction industry is projected to grow 4.5% in 2022. It will be driven in large part by the residential construction segment, which benefited during the COVID-19 pandemic when more people were buying homes and making improvements on their existing domiciles.

AEM says insights provided by its members indicate strong demand in the construction equipment sector will continue, with 83% saying year-over-year growth is likely going forward. Over the next 12 months there is the potential for 6-10% growth, which will be 6-10% higher than what was anticipated in 2021.

Likewise, the agricultural equipment market—also a strong user of hydraulic components—is expected to remain positive. AEM says farmer income has increased, enabling money to be spent on new equipment. Members of AEM expect equipment demand will stay strong in this sector as well; 81% of members surveyed



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...the **agricultural** equipment market—also a strong user of hydraulic components—is expected to remain positive. AEM says farmer income has increased, enabling money to be spent on new equipment.

by the association foresee year-over-year growth in the near-term, while 91% are expecting continued growth. However, inventories are low after being depleted in 2021, says AEM, which could pose challenging for OEMs needing to keep up with the high level of demand.

In AEM's March 10 U.S. and Canada agriculture report, Curt Blades, senior vice president, Industry Sectors & Product Leadership at AEM, says continued strength in the commodities

market will aid farm equipment sales, particularly larger row crop units. The rise in fuel prices will also likely drive farmers to purchase more efficient models to help curb fuel costs.

In its *Ag and Construction Equipment Market Outlook*, AEM notes the global economy is forecast to remain on track for expansion in 2022, with growth of 3.9% projected for the year. This will be a slight decline from 2021 which saw 5.1% growth; overall 2022 is expected

to be a year of slow growth.

Despite the projected positivity in the market, AEM notes surveys of its members show there are some market factors which could pose challenges for equipment and component manufacturers. Supply chains, the ongoing COVID-19 pandemic and labor shortages are some of the short-term factors, while deglobalization and inflation are long-term aspects which could all impact manufacturers and the global economy. **P&M**



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Pneumatics Help Automate FOOD PACKAGING

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Durable pneumatic components help keep packaging processes clean, efficient and safe.

by Christine Hoffman, Tom Voth

The market for packaged food and beverages in the U.S. is predicted to grow at an annual rate of just over 4% from now until 2028. Fueling that growth are consumer demands for safety and convenience. One way companies are trying to keep up with those demands and the anticipated growth in packaged foods is by focusing on automating the packaging process.

A key tool companies have been relying on for the handling and motion control aspects of automating food packaging is pneumatics. That's because pneumatics such as valves and air actuators are clean, reliable, precise, easy to maintain and increase throughput.

Here are several recent advances in the cleanliness, safety and efficiency of pneumatics that are helping food companies automate and improve their packaging systems.

Keeping it Clean

A critical requirement for components used for food and beverage packaging is that they can meet stringent regulations

for food contact. For example, they must be designed to withstand repeated wash-down procedures.

Traditionally, valves have been housed in cabinets or other enclosures to protect sensitive components from wet or harsh environments. Although stainless steel cabinets provide the necessary protection, they can be expensive.

The latest valves—like those used in vacuum packaging—have IP69K ratings, the highest protection class. This rating indicates the valves and other similarly rated components provide protection from dust, high temperatures and pressure wash-down liquids. This makes these valves ideal for packaging and food processing where machinery must be thoroughly sanitized. To keep the process even cleaner, companies use NSFH1 (food-grade) lubricants in their valves for added safety.

Along with the highest cleanliness level, these valves also feature improved cylinder performance which uses air per cycle for better response times and

increased energy savings. Having shorter compressed air lines from the valve to the cylinder equates to less volume to fill and exhaust, improving cylinder performance.

Valves are designed for easy cleaning and built from durable, clean materials. One leading pneumatic valve supplier, for example, offers an IP69K-rated valve with no joints or gaps that uses stainless steel components and polymers appropriate for high-pressure washdowns with aggressive detergents.

In addition to hygienic designs, the latest valves can be configured to meet the needs of a host of applications and will work with a wide range of communication protocols. Many also work with pneumatic actuators. Some valve companies provide online configuration tools that make it easy for design engineers to quickly access CAD drawings, schematics, part numbers and ancillary related components.

Keeping it Safe

No matter how well designed and built, all automation equipment needs routine and scheduled maintenance, as well as servicing to remedy problems due to electrical, mechanical or process issues.

To keep machine shutdowns few and safe, companies making consumer



Pneumatic valves designed for food packaging, such as Emerson's Aventics Series CL03, are resistant to cleaning agents and chemicals.



To lower energy costs and prevent downtime of pneumatic equipment, food packaging lines monitor the uses of compressed air using flow sensors such as Emerson's Aventics AF2.

packaged goods use various forms of functional safety that most commonly adhere to ISO 13849. The standard stipulates that when technicians need to enter a machine enclosure, all moving systems are in a "safe" condition.

Whether it is a complete lockout/tag-out or implementation of the "minor servicing exception," the most common method used to render pneumatic components "safe" is to release the pneumatic energy. The preferred component with which to do that is a redundant safety exhaust valve (RSEV). It can be part of an air-preparation subsystem that feeds compressed air to a machine or section of the machine.

Risk assessments indicate that lots of equipment requires a Category 3 PLd safety device (ISO 13849-1) to keep it safe during repairs and servicing tasks. The device must have redundant circuits. RSEVs meet this need by using redundant valves and diagnostics from sensors, such as spool-position monitoring, to ensure stored energy (i.e., compressed air) is released and removed.

When a device such as a safety gate on a machine enclosure is triggered, two safety outputs are sent to the RSEV. If one valve fails, the redundant valve will still complete the safety function. Diagnostics coverage will raise an alarm so that action can be taken to address

the failure before operations resume.

Some redundant safety valves feature built-in soft starts. Upon start-up, this feature ensures pressure remains at 60% to 70% of final system pressure before opening fully. The slow buildup of pressure/force, as actuators move to their home/start position, prevents damage to components and equipment.

Keeping it Efficient

Smaller carbon footprints are goals in nearly every industry, including the food and beverage sectors. This means lowering energy consumption and devising better ways to control energy use in food-packaging facilities.

One focus in these efforts looks at compressed air consumption, a significant source of energy use in packaging. If left undetected and unaddressed, air leaks can waste substantial amounts of energy and money.

To stem these losses, many companies are outfitting new and existing machines with air flow sensors. They continuously monitor compressed air flow and can help operators detect and address leaks earlier, minimizing energy losses and costs.

By continually measuring process parameters, including pressure, temperature, mass and volumetric flow rates, flow velocity, total mass, total volume and energy, sensors let operators

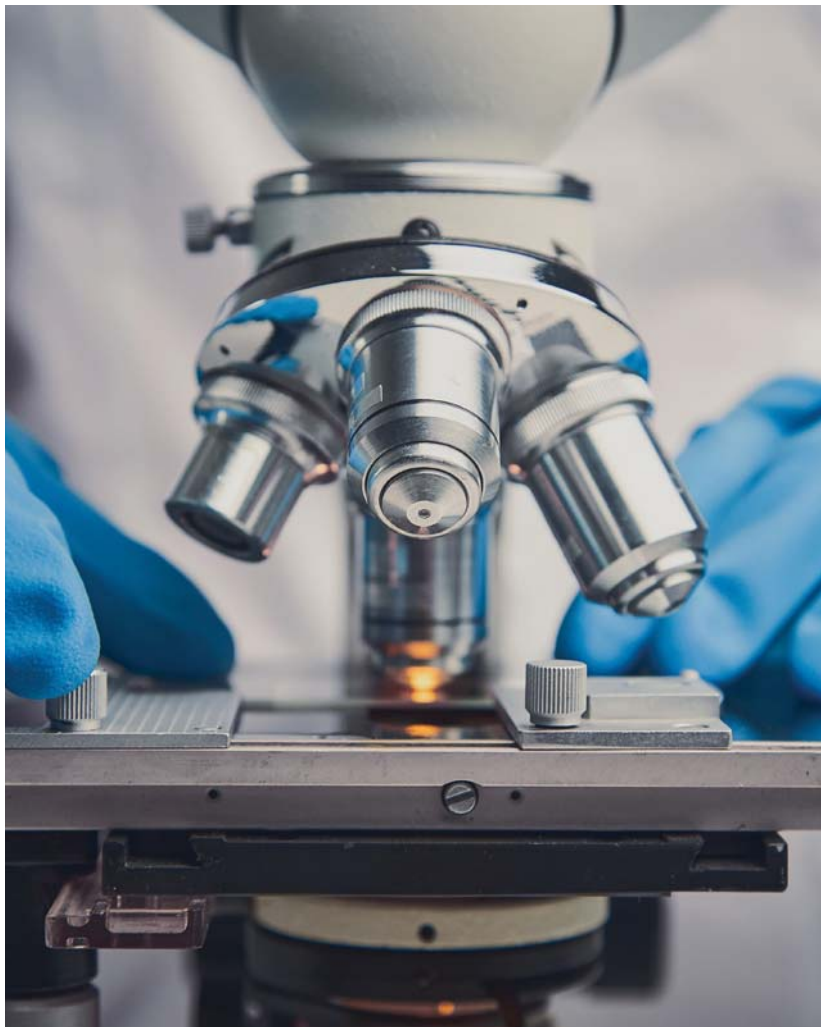
track air consumption and energy use. Operators can then use that data to locate and address potential problems, such as leaks, before they occur. By preventing leaks, facilities improve energy efficiency while reducing downtime and costs.

Air flow sensors are suitable for facilities of any size. Some air flow sensors let operators see data at the machine level. They also let facilities keep collected data within their own IT network without connecting to the cloud. Facilities can also connect sensors to a gateway to access other data for additional insights. Air flow control valve manufacturers experienced in digital transformation can help facilities decide what is most suitable for their individual needs and goals.

The latest trends in food packaging automation let packaging companies ensure that machines in their lines meet the highest machine safety, energy efficiency and hygiene standards. Leading pneumatic suppliers continually enhance the reliability, data measurement and collection capabilities, and connectivity, to make food packaging efficient, productive and safe. **P&M**

Christine Hoffman is a product marketing manager for Air Preparation, Sensors and Accessories, and Tom Voth is a product marketing manager for Pneumatic Proportional Products and Safety Systems, both at Emerson.

The Future of Oil Analysis: Converting to Electric Power and Sensors



With new technologies on the horizon, watching the oil analysis industry and planning for the future are key.

by Berly McCoy

In the 1940s, the railroad industry in the U.S. began inspecting the oil that lubricated locomotive engines. The inspectors were looking for contaminants—metals that could cause wear and lead to catastrophic engine failure. Nearly 80 years later, the industries that rely on oil analysis have expanded beyond the railroad, and so have the kinds of tests that the oil condition monitoring industry has to offer.

The goal of oil condition monitoring (OCM) has always been to avoid machine failure. “The OCM strategy is to use predictive maintenance to understand when a machine is going to fail so that we can do what we need to do to avoid any downtime,” says STLE member Lisa Williams, training manager at Ametek Spectro Scientific. From power generation and trucking to pulp and paper, a plethora of industries rely on maintaining healthy

At a Glance:

- Commercial oil analysis laboratories play a key role in the oil condition monitoring industry, but sensor technology and electrification have the potential to disrupt the status quo.
- While oil sensor technology is expanding, high costs and low buy-in have prevented it from significantly displacing the role oil analysis laboratories play in the oil condition monitoring industry.
- Electrification, especially in the trucking industry, has a high potential to disrupt the oil condition monitoring industry because many commercial oil analysis laboratories focus on diesel engine testing.

oil to continue their operations.

The OCM, or oil analysis, industry is the key to helping other industries monitor and prevent wear and sustain healthy oil in their equipment. Commercial oil analysis laboratories play a big role in this sustainment by running tests on oil samples, interpreting the results and suggesting maintenance actions. But two new technologies have the potential to displace these laboratories' lead role in the OCM industry: sensors and engine electrification.

How exactly and when these two technologies will impact OCM is still unknown, but they have the potential to drastically change how OCM companies do business—from pushing them to develop new technologies or testing new kinds of fluids, to catalyzing merges and rendering services obsolete. Matthew Spurlock, global technical manager at SGS, says, "I don't think that there's going to be a significant impact on the standard oil analysis industry as it sits today for at least 10 years, but we're going to get to that inflection point, and then it's going to happen very quickly."

Today's Oil Condition Monitoring Landscape

Today, there are approximately 200 oil analysis laboratories in North America. The global OCM market is a billion-dollar industry and is expected to grow to \$1.4 billion by 2026.¹ Some companies provide in-house oil analysis, but many operate as a third-party vendor, providing services to a range of operations. The list of industries that the OCM market serves is long, as is the machines they service (see page 22).

"OCM really starts with setting up a program within an organization," says Williams. That organization could be a manufacturing facility or a truck depot. The oil analysis laboratory will work with its client to determine an oil sampling frequency of its equipment, which could range from a transmission or an engine on a vehicle to a steam turbine in a nuclear power plant.

After determining the oil sampling frequency, a technician will start taking oil samples to gather data on the condition of that oil. Data collection can range from very minimal—for instance, testing the water concentration present in a steam turbine oil—to very complex, such as understanding the factors that are causing a particular wear pattern in an engine.

Williams says the average cost of an oil sample for routine maintenance is between \$30 and \$45, which is relatively inexpensive considering the benefit of avoiding machine failure. She says perhaps



Oil condition monitoring sensor that uses the dielectric constant to determine oil condition.

20% of routine samples need additional testing to further diagnose a problem or troubleshoot an existing issue.

Though the advent of sensor technology over the past 20-25 years has mimicked the types of tests oil analysis companies can run, the latter list is still longer, although sensor capabilities are growing. Some oil analysis companies have dedicated time and money to developing sensor technology, or at least considered it, but a decline in demand for lab-run oil analyses due to increased use of sensors has yet to take place. Still, according to Bill Quesnel, president at WearCheck Canada, "Sensors have the opportunity to make a radical shift in our industry."

Perhaps the more pressing technology for OCM companies is the move toward electric motors, especially as a replacement for internal combustion engines in diesel trucks. Because the over-the-road truck industry makes up a large subset of the oil analysis customer base, and because electric motors require different lubrication strategies, OCM companies have to consider how the industry will shift when electrification occurs.

With both of these technologies on the horizon, Spurlock says now is the time for companies to consider how their business models may shift in the coming years.

Sensor Technology

Oil sensors first came on the analysis scene around 20 years ago as a way to automatically collect operation data in machines running on used oil. They initially measured simple characteristics to detect wear, like ferrous density. But the capabilities of sensors continue to grow. On top of ferrous testing, sensors can now measure characteristics like oil base number, soot, changes in viscosity, additive depletion, particle count and relative humidity, which can be correlated to moisture content.

But lab testing capabilities still outnumber sensor capabilities. Williams says an oil analysis company could offer a client 20 or more tests, which could include in-depth microscope work and an elemental analysis—something sensors can't fully provide yet. And labs can offer exception or add-on testing based on initial testing results, such as measuring oxidation, nitration and corrosion.

But sensors have other advantages. For example, sensors can be particularly helpful when they are installed in difficult-to-reach areas, such as in a gearbox in a wind turbine. "Sending somebody up-tower quarterly may not be a reality, but if we have sensor technology installed, we can get that data," says Williams.

Industries that utilize oil condition monitoring

- Food and beverage
- Pulp and paper
- Car manufacturers
- Nuclear power
- Pharmaceutical
- Fleet
- Off-road vehicles
- Fixed plant
- Aviation
- Marine
- Construction



List of oil condition monitoring industries.

Sensors also are used in other capacities. “What you do see is a lot of sensors on inboard engines, but in terms of OCM, those sensors are usually just using algorithms to determine oil condition life. They’re not directly measuring properties of the oil,” says Quesnel.

Another advantage of sensors: They can serve as red flags. “The big bang around sensors is their early identification of root causes of failure. They’re very good at that,” says Spurlock. Early detection of wear generation is important, but ideally a sensor would detect factors that are capable of causing wear before the wear occurs. Spurlock says the two most common things that cause internal machine wear are particles—usually dirt and debris—and moisture contamination. “So if we can capture those two key root causes of failure by identifying their

Machines that benefit from oil analysis

- Robotics
- Gearboxes
- Cranes
- Compressors
- Bearings
- Circulatory systems
- Emergency diesel generators in hospitals and nuclear power facilities
- Construction
 - Excavators
 - Dozers
 - Loaders
- Off-road vehicles
 - Waste trucks
 - Boom trucks
- Powertrain components
 - Transmission
 - Final drives
 - Differentials
 - Wheel hubs
 - Axles
- Hydraulics
- Turbines
 - Jet
 - Steam
 - Hydroelectric

presence and then do something about it, that’s where the big wins come into play.”

Oil health monitoring sensors also exist, but because the majority of the root causes of failure are due to these kinds of oil contaminants, Spurlock says sensors that measure particle and water contamination are the most useful for the end-user.

Still, oil sensor use isn’t widespread and hasn’t drastically disrupted the oil analysis industry. “The big problem is that the cost for these sensors is still prohibitive for the original equipment manufacturers (OEMs)—the people who make the engines,” says Quesnel. “We were told at one point when we were trying to commercialize our own sensor that it would have to be \$10 or less to make it into widespread production in a diesel engine. Some sensors out there today that would be useful for diesel engines are on the order of \$1,000

or several hundred dollars.”

The sensor industry has yet to produce a low-cost, high-production versatile monitor that can directly measure oil condition, which has prevented widespread sensor use. The situation is somewhat of a Catch-22: To drive down sensor costs, their production needs to increase, but production won’t increase until demand does, which is currently stymied because of high costs. “The key roadblock in adoption is 100% on the price,” says Spurlock.

Until that roadblock is surpassed, either from government subsidies, increased consumer demand or a commitment to large-scale production in order to decrease cost, sensors won’t likely make a significant impact on the OCM market. Even if costs do come down, Williams doesn’t think sensors will make the industry obsolete. “We’re still going to need people with expertise so that [end-users] know what to do with sensor technology,” she says.

For example, she says a sensor may report that additive levels are low without diagnosing why or suggesting follow-up actions. Deciding whether to change the oil versus filtering it requires some understanding of what the data means, and “that doesn’t come with sensor technology,” says Williams.

Automated data interpretation software does have the potential to replace oil analysis technicians. “But the reality is that a software becoming widespread that can analyze complex data without an expert is a ways off, and what is currently available is expensive,” says Williams. If or when software use becomes widespread, the industry may see a large shift in the kinds of jobs available—from oil technician to software developer.

But the expertise of understanding complex changes in oil will still be required in some capacity. “The type of job in the industry has the potential to shift, but with cost being a big barrier, I don’t see it happening anytime soon,” says Williams. She thinks the industry would take a hybrid approach, coupling the technology with lab work.

When and if sensor technology causes a

shift in the OCM market is a large unknown. When sensors were first developed two decades ago, there was a lot of interest and a global market for the technology, especially in the diesel engine industry. "The problem is, 20 years later, no manufacturer has decided they're going to make a million sensors to get the cost down, and no company has decided they want to buy a million in order for somebody to make a million, to get the cost down. So it is a Catch-22," says Quesnel.

Electrification

Another factor that has the potential to disrupt the OCM market is engine electrification, particularly in large commercial trucks that travel long distances. Companies that monitor diesel engine oil comprise the bulk activity in the OCM market in North America. A switch to electric in over-the-road fleets would significantly impact large sections of the oil analysis industry. But it's not there yet.

In contrast, passenger vehicle electrification is well underway. Last year, Boston Consulting Group estimated that sales of electrified cars will surpass 50% of the market by 2026,² replacing internal combustion engines. Although electrification of heavy trucks is still in its infancy, it has started to occur. OEMs have produced commercial electric semi-trucks and are currently testing their capabilities.

A factor that has the potential to disrupt the OCM market is engine electrification, particularly in large commercial trucks that travel long distances. "What's driving electrification of vehicles, especially in the commercial space for fleet trucking, is reduced cost of ownership. It's number one," says Quesnel. That cost of ownership depends on the market's ability to overcome certain hurdles.

Producing an efficient electric motor for a large truck traveling long distances has different obstacles than producing an electric motor for a passenger vehicle or a mid-size commercial truck. The former requires more power, which necessitates larger, heavier batteries.

Even if the cost of the actual motors comes down, other factors will affect total cost, such as the efficiency of the charging stations and the infrastructure to support charging across long distances.

But many experts agree electrification is not a question of if but when. "The replacement of the internal combustion engine globally is certainly well on its way. Over-the-road trucks now have electric motors. Vehicles now have electric motors. Everything else that runs on an internal combustion engine is eventually going to be transitioned over to an electric motor. When that's going to happen, I don't know, but it will happen," says Spurlock.

Some passenger car OEMs have already committed to phasing out internal combustion engines in their vehicles as early as mid-decade, says Quesnel. "Passenger cars are going to be the first wave, but electrification of large trucks is going to come soon after. I would say by 2040, we may see a rapid reduction in the amount of internal combustion engines on the roads in

North America. It's going to happen faster in Europe."

But how much will engine electrification impact OCM companies? "That's the million-dollar question. Is there going to be a need for OCM? That's the one on everybody's mind," says Quesnel. That's because electric motors don't require oil. They do need grease and fluid for cooling.

And an electric vehicle will still require a transmission, although its lubrication may change as well. Williams says it's these components that oil analysis companies will need to focus on in order to adapt, and Spurlock agrees that monitoring grease is just as important in preventing failure as monitoring oil.

But whether companies will want or need to monitor non-oil components is unknown. "There's no market for it yet," says Quesnel. "If these electric vehicles are extremely reliable and have low failure rates, or if the failures are not lubricant related, there will be no market." He says OCM companies will need to figure out how the motors will fail and if those failures are lubricant related.

Currently, there's no standardization in the OCM market for electrified trucks. Before that can happen, a list of questions will need answering: Will vehicles be outfitted with reduction gearbox differentials or single or multi-speed transmissions? Will electric motors be wet or dry?

continued on p. 32



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The Basics of Small-Bore **FITTINGS**

A variety of small-bore tube fittings are available for hydraulic and industrial fluid systems. Making the right choice based on system requirements is critical.

by **Natalie Hagan**

Small-bore tube fittings represent one of the most important components for fluid-handling systems. They are installed at critical connection points where they must deliver leak-tight performance to contribute to operational safety and efficiency. They are used to connect a wide range of fluid system components, including tubing, hoses, valves,

regulators, filters and sample cylinders, as well as various measurement devices such as flow sensors, pressure gauges, pressure transducers and thermometers.

Small-bore systems can carry chemicals and hydrocarbons in refinery applications, active ingredients for pharmaceutical manufacturing, exotic gases for semiconductor wafer fabrication, steam

for process heating and industrial air for manufacturing operations. Such systems may move air, various gases or any of a wide range of fluids.

There are many different fitting options to choose from, with each type suited for different needs. So, how do design teams determine the right choice for their applications? Here's a look at the options available and where each design can be advantageous.

Threaded Fittings

Threaded fittings are one of the most common options for securing connections with two threaded pieces. The first is male with threads on the outside of the fitting; the second is female with threads on the fitting's interior. The connection is formed when the male threads are twisted into the female threads and secured by tightening the connection.

Many available threaded fittings adhere to either the British Standard Pipe (BSP) or the National Pipe Thread (NPT) design standard. (Per specifications, small-bore tubing and fitting applications range in size up to 2 in. (50 mm) for the tubing outer diameter).

There are two types of threaded fittings: **Tapered threads** seal as the male and female threads are drawn together. These fittings are built at an angle in relation to the centerline (straight threads, by comparison, are parallel to the centerline). A thread sealant or thread tape fills in gaps between the crests (peaks) and the roots (valleys) of the threads to prevent leaks. Tapered threads are typically effective for system pressures up to 15,000 psi.

Parallel threads, also known as straight threads, seal as the flanks of the threads are drawn together; there is no interference between the flanks, crests and roots of parallel threads. Installing them calls for supplemental items, including gaskets, O-rings or metal-to-metal contact to create leak-tight seals. Parallel threads are typically used in applications with system pressures of 5,000 psi or less.

When not dictated by pressure requirements, the choice between parallel and tapered threaded connections typically comes down to simple user preference. When considering which to choose, it can help to standardize the use of one type versus the other throughout a facility to reduce the potential for confusion or misapplication.

Compression Tube Fittings

Compression tube fittings are another common option. They use ferrules to create leak-tight seals, not threads. Compression fittings are also simple to assemble and disassemble.

There are two primary types of compression fittings: single ferrule and double ferrule.

- *Single-ferrule compression fittings* incorporate one ferrule to create a seal. The ferrule gets compressed between the nut and receiving fitting when the nut is tightened. The ferrule then bites into the tube, creating tube grip and body sealing action.
- *Double-ferrule compression fittings* include a front ferrule and back ferrule. Each has its own function but

works together with the other. The front ferrule creates a seal between the body and tube, while the back ferrule grips the tube.

It is important to understand how the back ferrule bites into the tube, as not all tube fitting designs are alike. The reliability of a compression fitting's tube grip is related to how well the back ferrule bites into the tube.



Medium-pressure mechanical grip fittings feature a preassembled cartridge that holds the two ferrules and nut, helping to ensure proper ferrule orientation during installation.

There are a few design differences between compression tube fittings, and those differences may affect performance. For example, a bite-type ferrule, whether it is a single or double ferrule design, bows during assembly. Bowing drives the leading edge of the ferrule into the tube to indent the tube surface, creating its grip.

However, any vibration, pulsation, thermal shock or side load on the fitting may compromise the minimal contact of the single gripping ferrule. In a dynamic fluid system, the potential for either damage to the tube or pullout may exist. (Pullout refers to the tubing pulling out of the fitting connection due to other forces, such as vibration, causing the tubing to back out.)

An even stronger grip and seal are created by fittings featuring a two-ferrule, mechanical grip design that delivers hinging-colleting action. This radial hinging-colleting action of the back ferrule grips the tube next to and outboard from the swaging point to improve

vibration endurance. The hinging colleting action forces the mid-portion of the back ferrule to press onto the tube while keeping the back end of the back ferrule away from the tube surface. This creates direct and axial support to the tube-gripping function. This design also reduces the likelihood of fittings backing off in dynamic applications.

By creating long lines of sealing contact between the ferrules and tube, mechanical grip designs result in reliable gas seals. They are a good choice for applications where leaks cannot be tolerated.

Finally, medium-pressure mechanical grip fittings are an evolution of two-ferrule compression fittings. They consist of a female fitting body, a male nut and pre-oriented ferrules. These fittings deliver outstanding performance and enhanced installation efficiency. They use a hinging-colleting action similar to two-ferrule tube fittings. This design creates a unique dynamic wedge for a stronger bite into the tubing. The design

also lets fitting connections be disconnected for maintenance and then reconnected rather than replaced.

When remaking such connections for medium- and high-pressure applications, operators may tighten them by a standard wrench or a torque wrench to recreate the original leak-tight gas seal. (Medium-pressure applications range from 6,000 to 20,000 psig. High-pressure applications go up to 60,000 psig.)

Medium-pressure mechanical grip fittings also have a preassembled cartridge that holds the two ferrules and nut, helping ensure proper ferrule orientation during installation. These fittings can reduce installation time and lower assembly and maintenance costs while providing more reliable connections.

Cone and Thread Fittings

Cone and thread fittings are another widely used type of fitting. They are available in a variety of alloys and have several

[Fittings & Couplings]

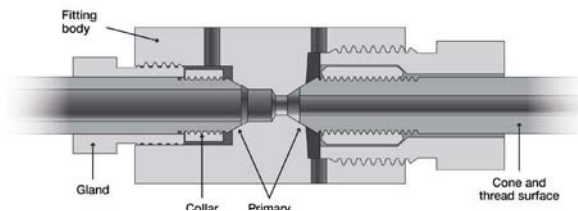
design features that suit medium- and high-pressure applications. Cone and thread fittings have been a standard choice for demanding, high-pressure applications for many years.

A cone and thread fitting will feature a gland, a collar, a female port and a weep hole that lets technicians detect leaks and verify proper installation. In high-pressure applications, thicker-walled tubing is typically required.

Installing cone and thread fittings is complicated and requires coning and threading tools, along with cutting lubricants, but can result in long-term reliability when performed correctly. Installers must properly cone and thread the tube before joining it with the fitting. Here, it is critical to remove any burrs, gouges or scratches in the tubing.

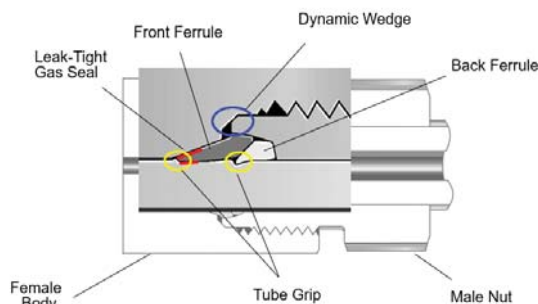
After preparing the tubing, a collar is threaded onto the tubing and a gland nut is inserted into the fitting body for final tightening. To extend the life of tubing connections in systems that experience regular shock or vibration, it is recommended to use antivibration components.

Small-bore fittings may be made in a range of materials, including stainless steels such as 316 SS, 6-Moly alloys and 2507 Super Duplex, as well as other alloys, with 316 SS being the most common choice. When specifying 316 SS, design teams should consider using metals with higher concentrations of chromium and nickel than the minimum American Society for Testing



Cone and thread fittings commonly feature a gland, a collar, a female port and a weep hole that enables you to detect leaks and verify proper installation.

Leak-Tight Seal



Medium-pressure mechanical grip fittings use a female fitting body, a male nut and pre-oriented ferrules. This design creates a unique dynamic wedge, allowing for remakeable pullups by torque and a more robust bite into the tubing.

and Materials (ASTM) guidelines. ASTM calls for a minimum of 10% nickel and 16% chromium.

However, components featuring a more highly alloyed material with at least 12% nickel and 17% chromium resist corrosion far better. Nickel stabilizes the austenitic structure of stainless steel and helps provide a more ductile or non-brittle material for a wider range of temperatures and system media.

The greater nickel content provides the austenite with added stability. Chromium, which forms the passive oxide surface layer that makes stainless steel, provides corrosion resistance, and higher levels of chromium offer added resistance to localized corrosion.


There are many other complexities involved with fitting selection and installation. This article has only covered the basics. If a design team is interested in learning more about small-bore tube fittings, some suppliers offer training. These programs give engineers valuable tools for meeting practical challenges relating to fluid system design, operation and regular maintenance, and they can be invaluable for new and veteran technicians.

Armed with greater knowledge about the variety of and distinctions between different fitting technologies available today, the team will be more likely to make the right choice for its system requirements. **P&M**

Natalie Hagan is product manager for Swagelok Co. This article is based on material that appears on the Swagelok Reference Point blog at <https://www.swagelok.com/en/blog/small-bore-tube-fittings-key-differences>.



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This Week in Power & Motion: HAWE Rebrands Electrification Subsidiary

HAWE's brand which develops electric components will now be included under the HAWE Hydraulik brand name, and more news you may have missed.



Danfoss Editron Powers Doosan Electric Excavators

Danfoss Editron has provided the electric powertrain as well as control system to aid electrification of two excavators.



Perception Systems Guide the Path to a Fully Autonomous

Creation of robust and reliable perception systems enables fully autonomous operation of the John Deere 8R tractor.

by Sara Jensen

Automation is making its way into many applications, from the smallest of components and systems to large pieces of heavy-duty mobile equipment. It can take many forms such as controlling a single movement of a part or enabling an entire vehicle to drive without interaction of a human being.

The technologies which make automation possible are varied; sensors and software are key among them as well as perception systems.

For John Deere's autonomous 8R tractor unveiled at the Consumer Electronics Show (CES) 2022, Noah Schwartz, lead perception engineer at Bear Flag Robotics—an autonomous agriculture technology company acquired by John Deere in 2021—said the company leveraged many of its existing automation technologies. These include StarFire GPS, which provides reliable localization to enable the tractor to know where it is at when traversing the field. Such technology is vital to ensuring safe operation of the fully autonomous tractor.

Robust, Reliable Technology Development

In addition to its StarFire GPS technology, John Deere utilizes a robust control stack for path planning. "It handles all of the navigation and obstacle intelligence [necessary] to get through the field in a safe and effective way," says Schwartz.

The autonomous 8R's perception system feeds into this control stack to ensure safe movement through a field. It is comprised of six pairs of stereo cameras which provide a 360-deg. view around the tractor. The cameras are able to capture the environment surrounding the tractor and send data about it to the control stack, ensuring the safest path is chosen.

Not only does the perception system need to monitor the tractor's surroundings, but also the implement being pulled by the tractor, the health of the implement health as well as the field state. All of this information needs to be fed to the tractor so it can appropriately determine how best to do its job. As such, Schwartz says there are a lot of robust AI (artificial intelligence), models and algorithms built into the system to ensure the tractor has a constant feed of high-quality information about what is going on in its environment.

Schwartz goes on to say the company relied on the use of deep learning and computer vision for its perception system because of their ability to accurately take in the amount of information necessary for this application. "It's really rich technology, and we built models specifically to work with the cameras," which are collecting full color imagery as well as near infrared and depth information.

He notes there is a suite of sensors currently undergoing research and development which John Deere plans to bring to market as necessary and as it brings automation to more agricultural equipment.

Tractor



ALL IMAGES COURTESY OF JOHN DEERE

The perception system on John Deere's autonomous 8R tractor is comprised of six stereo cameras as well as AI and software to provide accurate information on the tractor's surroundings.

Perception and autonomy in agriculture is less like autonomous driving through a city and more like perception on Mars or the moon, says Schwartz. "We have sparse environments where there is not a lot of information, or it is the same thing over and over again. How do we develop models that are sensitive to things, because once they do detect [an object] it is a big deal. There should not be anything [in a farm field] but if there is we need to deal with it correctly," he said.

Agricultural environments are harsh, which can also present challenges when developing perception systems for autonomous equipment. Farmers spend about a third of the day driving into the horizon and into the sun; they may also be operating at night or in fog or dust and in a variety of temperatures. "We have to make sure the system is robust and reliable throughout all of it," says Schwartz.

He says it has been a fun challenge for the design team to determine the best sensors, models and techniques to utilize to ensure a robust and accurate system is developed. "It has been an amazing journey, and I'm really proud of what's coming out in the fall."

The autonomous 8R tractor is scheduled to be available to customers starting in fall 2022.

Autonomy's Benefits in Agriculture

Like many industries, agriculture is facing a shortage of skilled workers entering the market. This is causing many challenges for farmers, many of whom are already working long days. And as many start to reach retirement age, there will need to be younger generations entering the field to ensure the growing global population can continue to be fed.

It is estimated the global population will reach close to 10 billion people by 2050, increasing the demand for food 50%. This will put a lot of strain on the farming industry.

Autonomy is seen as a way to help overcome these challenges. A fully autonomous machine could be completing a task in the field, freeing up a farmer's time to focus on other necessary tasks. Use of autonomous equipment enables them to do more with less. "There are always competing priorities [on a farm]," said Deanna Kovar, VP of Production and Precision Ag Production Systems at John Deere, during the company's press conference unveiling the autonomous 8R at CES 2022. "And if you don't manage them, they're likely to not get done well or not get done at all."

The autonomous tractor can help with this as it can run 24 hours a day if necessary, greatly benefiting a farmer's productivity. In addition, autonomy can help ensure work is done correctly and efficiently as the precision needed to do so is built into the machine and there is no chance of human error. And like an assembly line, the autonomous tractor is able to perform the same operation repeatedly and precisely; no matter the conditions, the operation is done the same every time says Schwartz.

To start, John Deere's autonomous 8R will focus on tillage. This application helps prepare fields for planting which is integral to the growing season. "It is a core operation and the market suggested that was a great place for us to start," says Schwartz.

He notes the company is working with its other divisions—specifically construction and forestry—to evaluate and develop autonomous systems for those industries as well, as they are also facing similar labor challenges and need for increased productivity.

In the near term, Schwartz says John Deere is focusing on getting the autonomous 8R into customers' hands and scaling out the technology as much as possible. There is a roadmap for expanding the autonomous system out to other tillage implements and eventually other types of agricultural equipment. **P&M**

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2.



1. Vision System Provides Easy Set-Up, Deployment

The In-Sight 2800 series vision system puts the power of a full-featured vision system into an easy-to-use package that gets applications running in minutes. In-Sight's EasyBuilder interface guides users through the application development process step-by-step, making it simple for even new vision users to set up any job. Experienced users will appreciate how In-Sight's intuitive, point-and-click interface simplifies more complex application development and keeps operations moving fast. The combination of deep learning and traditional vision

tools gives users the flexibility to solve a broad range of inspection applications; operators simply select the tool designed to deliver the highest possible accuracy for their task. Tools can be used individually for simple jobs or chained together for more complex logic sequences.

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2. Cabinet Cooler Calculator Finds The Right Solution

The Cabinet Cooler Calculator simplifies the process of choosing the correct Cabinet Cooler System by asking the customer to answer a few simple questions. By providing certain information

like size of the enclosure, NEMA rating needed and environmental conditions, the new calculator will sort through the large selection of ready-to-ship Cabinet Cooler Systems and provide instant feedback on the best cooling solution for any applicable electrical enclosure. Taking the guesswork out of the equation, the Calculator library ensures the customer that they can be confident in selecting the correct product for their unique specifications. It is another in a line of customer tools such as the Calculator Library, Application Database, CAD Library and Efficiency Lab.

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3. Contactless Switching System Also Features Colors

The TTS RGB adds technical finesse to the original TTS switch series introduced in 2021. The TTS series provides contactless switching, highly precise operation and now customizable colors. With the new RGB ring illumination, the TTS switch series adds a multicolor palate to its existing bi-color options. The TTS series uses the highly precise Time-of-Flight (ToF) sensor technology, whereby light is emitted by a transmitter and reflected by one or more objects. The reflected light beams are then detected, and the distance is determined from the Time of Flight. The standard detection distance for the TTS series is programmed for 20-60 mm. The minimum setting allows for wiping

or cleaning of the switch surface without triggering a false signal. With no moving parts, the TTS has a service life of more than 20 million switching cycles. Shock Protection is IK06. It has an ingress protection rating of IP67, and it is insensitive to splashes, drips, rain or sunlight.

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4. Robotic Alignment Software Increases Speed, Accuracy

The High Speed Alignment software offers manufacturers the ability to increase the speed of 6-axis robots by 70% and accuracy by 50%, which will reduce time-to-market while increasing accuracy levels. The PC-based software includes Visual

Serving technology using one or more cameras, combined with a computer vision system, to control the position of the robot relative to the workpiece. As the robot is moving, the cameras continuously capture image information that the computer vision system processes to cross-check and adjust the robotic movements to deliver 0.01 to 0.02 mm precision. Along with effortless commissioning and tuning, system integrators and manufacturers can benefit from a reduction in deployment time—down from an entire shift of eight to just one hour. Minimal programming experience is required, as the software is easy to use and has an intuitive user interface.

ABB Robotics

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4.



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“We still don’t know what the look of the standard electric truck is going to be,” says Quesnel, and that will affect both the lubricants that will be required and how often they need to be tested. “The question is, are fleet owners going to view lubricant testing of an electric powertrain as important as lubricant testing of an internal combustion engine powertrain? That’s what remains to be seen.”

Quesnel says the oil analysis industry will need to wait and see what fluids and lubricants OEMs decide to use for their electrified vehicles and then design tests to detect and prevent failure. “I think we’re still sitting on the sidelines [knowing] electrification is going to happen. Now we’re going to wait to see how dependable electric vehicles are.”

Quesnel says the industry can guess where areas of interest might lie. For example, transmission fluid, which currently comprises a small fraction of the OCM industry, could take on a larger share of oil analyses. For that to occur, “There has to be a shift from the consumer deciding that sampling transmission fluid is important. The only reason that will start to happen is if they experience costly failures,” says Quesnel.

Even if oil analysis labs shift to monitoring the types of fluids present in electric vehicles, other industries may be better poised to step into the role. For example, “Labs that specialize in insulating fluid condition monitoring are more akin to the fluid an electric motor will need,” says Quesnel. “I really don’t see that there is going to be a lot of OCM occurring for electric vehicles because I think they are going to have much higher reliability.”

Spurlock thinks electrification of the trucking industry will push many oil analysis companies to other markets that aren’t as immediately affected by the change, like the turbine, marine, aviation and fixed plant markets, which will increase competition in those industries. “I also think we’re going to see more merging of oil analysis companies,” says Spurlock. “I’ve said for a long time that any laboratory that is only focused on running oil samples in their lab and nothing else, their time is limited. They’ll be closing their doors I suspect within 10-15 years.”

One consequence of engine electrification in the OCM industry may be that electric motors can be fitted with more sensors because the kinds of sensors that electric vehicles may need, such as conductivity and heat sensors, already exist. But Quesnel says because existing OCM sensors are very specialized, they are unlikely to translate to electric vehicles, and the ones that electric vehicles will need are already available and cheap.

“Onboard sensors tend to be very specific,” he notes. “An onboard sensor on an engine will measure things like rapid

viscosity drop, fuel elution, increased soot load or ingression by water and coolant. But with an electric motor and a transmission, the concern will be copper corrosion or excessive heat. They are worried about viscosity, but not as much. They are worried about low conductivity, high resistivity—things that current OCM sensors aren’t designed for.” But because low-cost sensors with these

properties already exist, “This could herald a dominance of sensors in the OCM industry for electrified vehicles,” says Quesnel.

Sensors for grease may be an even more difficult sell. “It’s easy to put an oil sensor in the flow of oil because the oil is moving. Grease isn’t moving through a system the way oil is,” says Spurlock.

Still, Williams thinks that a move to sensor technology and electrification will require a skilled workforce. “We have to know how to manage those components. We have to know how to interpret our sensor data. And we have to know when to take action. If we don’t have those things, these more expensive technologies are going to be ineffective,” she says.

Where to go From Here

So, what should oil analysis companies be doing today? “Some planning is good. It’s a matter of keeping an eye on the industry,” says Quesnel. “But until there’s some significant penetration in the market, [we won’t know] how our customers

are going to react or what their requirements are going to be.” He says he’s seen companies make drastic changes to their operations to adapt to small industry changes. “But now we’re talking about a radical change in the industry.”

Spurlock agrees that a change is inevitable. “Many labs that aren’t forward thinking will continue doing business as usual, but if they don’t change what their approach is and what they’re willing to do after 10 years, it’s going to be too late.” **P&M**

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Many labs that aren't forward thinking will continue doing business as usual, but if they don't change what their approach is and what they're willing to do after 10 years, it's going to be too late."



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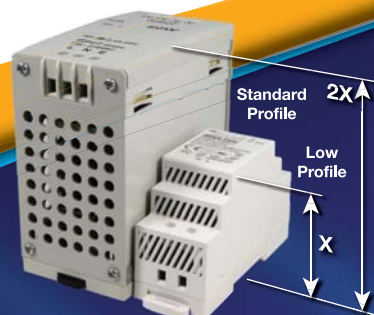
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