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Filtration Technology Brings Fluid Power Into the Future

p. 10

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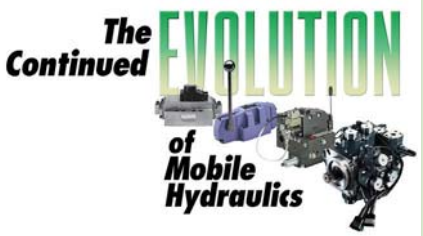

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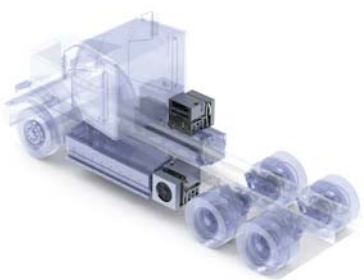

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POWER&MOTION

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[Editor's Note]

SARA JENSEN
Executive Editor

How is Sustainability Impacting the Fluid Power Industry?

A number of approaches are being used by the fluid power industry to aid sustainability efforts.

SUSTAINABILITY IS NOT a new concept, but one which continues to gain in importance as the environmental impacts of various activities become of greater concern to many industries and the global population at large.

The fluid power and electric motion control sectors can be counted among those placing a greater emphasis on sustainability. Efforts to improve efficiency and reduce material use are just two examples of how this is coming to fruition.

Although sustainability was not intended to be the focus for this particular issue, technologies discussed within it demonstrate just how influential this topic has become. In our cover story on pg. 10, it is stated by one member of the fluid power industry that the desire for more efficient and sustainable solutions is driving new filter technology developments.

On pg. 18, you can read how Liebherr-Aerospace used additive layer manufacturing to create a flex shaft — approved for series production — which allowed for a reduction in parts. Doing so will help to reduce weight, and thus fuel costs, for aerospace applications as well as maintenance as there are fewer components to wear and replace over time.

The topic of sustainability has become such an important one that *Power & Motion* will be dedicating an entire week of new content to it, starting October 14. Our Sustainability Takeover Week, as we've termed it, will include new articles and video interviews covering the potential impacts of PFAS legistlation in the U.S. and elsewhere, a review of new technologies aiding with sustainability efforts, and more. In addition, we will host a webinar on October 17 with industry experts providing their insights on how efficiency can benefit sustainability. There's still time to register at *powermotiontech.com/55136469*.

If you have thoughts on sustainability and its influence on hydraulics, pneumatics and other motion control technologies, let me know! You can reach me at *editor@pmtmag.com* to discuss this or any other topics of importance to the industry. P&M

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This digital-only white paper summarizes the key findings and challenges discussed at the 2023 STLE Tribology & Lubrication for E-Mobility Conference held in Cleveland, Ohio (USA), in November 2023, exploring the latest advancements and outlook for the electric vehicle market and technologies impacting the tribology and lubrication field.

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by Sara Jensen, Executive Editor

Manufacturing Industry Projected to Grow 15% by 2028, Despite Slower Growth in 2024

Economic uncertainty and shrinking backlogs will contribute to slower growth trends for the manufacturing sector before returning to an up cycle in 2025.

Shrinking backlogs will likely lead to slowing production volumes in 2024. 132075177 © Fotoeventstock | Dreamstime.com

MANUFACTURING HAS GROWN significantly over the last 15 years, doubling in value to $44.8 trillion from 2007-2023 according to market intelligence firm Interact Analysis. The firm is projecting the manufacturing industry to grow 15% through 2028.

Growth has slowed since the peaks reached in 2021 after the COVID-19 crisis, said Blake Griffin, Research Manager, USA of Interact Analysis, during a presentation on the U.S. manufacturing economy at Automate 2024. Both 2022 and 2023 were slower growth periods, and 2024 is anticipated to be a down cycle. But higher growth trends are anticipated starting in 2025.

"It is not super optimistic right now, based on conversations that we have had, but it's also not the bottom is falling out of manufacturing," said Griffin. "We're expecting a flat year globally and growth to return in 2025."

Industry Sentiments Reflect Lower New Order and Production Figures

The global economic uncertainty which began in the last half of 2023, paired with shrinking backlogs after high levels of demand in 2021-22, was represented in manufacturing production which slowed in the second half of the year. Griffin noted annual figures are not yet available, but production likely remained in positive territory at the end of 2023 despite the declines in growth.

Into 2024, growth is expected to taper off further for the manufacturing sector which he said is demonstrated by the sentiment survey Interact Analysis issued to members of the Association for Advancing Automation (A3) — the trade association which produces the Automate event and represents organizations involved in robotics, artificial intelligence, machine vision, motion control and other automation-related technologies.

Members indicated a slight decline in new orders during the last half of 2023, but sentiment is starting to trend into more positive territory with some members indicating slight increases in new orders as 2023 came to an end and 2024 began. Griffin said 20% of respondents are still citing new orders as the greatest issue they're facing right now, so there is still a lack of demand as many said their customers are not spending due to continued economic uncertainty.

While new orders slowed in the later part of 2023, production was still positive during this time which Griffin said was likely due to backlogs still being quite strong. Production began to slow toward the end of 2023, indicating backlogs are starting to dry up. This will be a factor which plays into the flat growth trends anticipated in 2024.

Inflation and Interest Rates Determining Factors for Manufacturing in 2024 and 2025

Economic uncertainty is likely to continue as inflation remains above the U.S. Federal Reserve's goal of 2%. Griffin said communication from Federal Reserve meetings is that there is still a long way to go to get inflation sustainably down to 2% and so interest rates will remain at higher levels.

There was a period during the last part of 2023 during which it was thought rates would come down as inflation got closer to that 2% target, but the Federal Reserve has since said there is not enough confidence in the data that inflation is yet under control. "They don't want to lower rates too quickly because inflation will surge again, and they don't want to raise rates anymore because they're afraid it's going to put stress on the economy," explained Griffin. He noted a more recent Federal Reserve meeting indicated more favorable data that inflation may be under control more than previously thought.

"And the important thing is that wage growth has actually slowed down a little bit…it is an indication that the inflationary pressures are starting to ease," he said. The sentiment survey of A3 members has indicated prices started declining from the highs of 2022 as well over the last few quarters with Q4 2023 being the first during which no respondents indicated a significant increase in prices.

Despite this, Griffin said prices are still somewhat increasing which indicates inflation remains an issue but there are signs it could be easing. "Hopefully, it will start to ease over the next 6 months or so," he said because he believes how the manufacturing sector performs in the coming months will greatly depend upon what happens with inflation and interest rates.

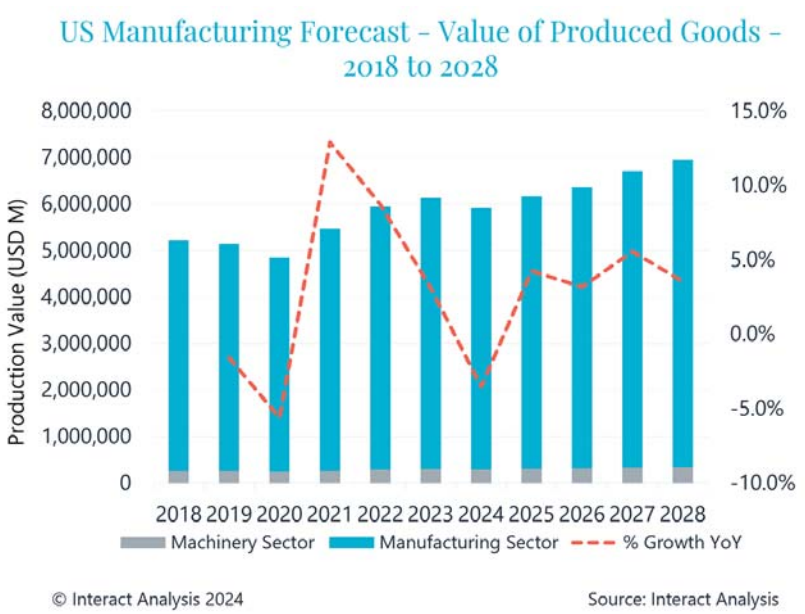
He shared thoughts from the April 2024 Federal Reserve meeting which showed there was still uncertainty among participants about the persistence of high inflation. However, the majority of participants at that meeting felt moving to a less restrictive policy at some point in 2024 would be feasible assuming the economy evolves broadly as expected.

"They're saying, essentially, that they're not confident to lower rates but if they got better data, they would be comfortable lowering rates," explained Griffin. "I think the general consensus now is that they're expecting the Fed to lower rates at the end of 2024, potentially into 2025 but hopefully it's not that long."

When the Federal Reserve does decide to lower interest rates, he said it is not likely to be the essentially 0% rate economy many have been used to in recent years which was a stimulatory rate introduced after 2007. "I think the Fed is going to hold rates between 3 and 4%."

Once interest rate cuts are enacted, Griffin said Interact Analysis expects they will stimulate growth for the manufacturing economy in 2025 and beyond. The firm is projecting the U.S. manufacturing industry to decline around 3% in 2024. But starting in 2025 the sector will enter an up-cycle trend through 2028 with an average growth rate between 3 and 5% anticipated. P&M

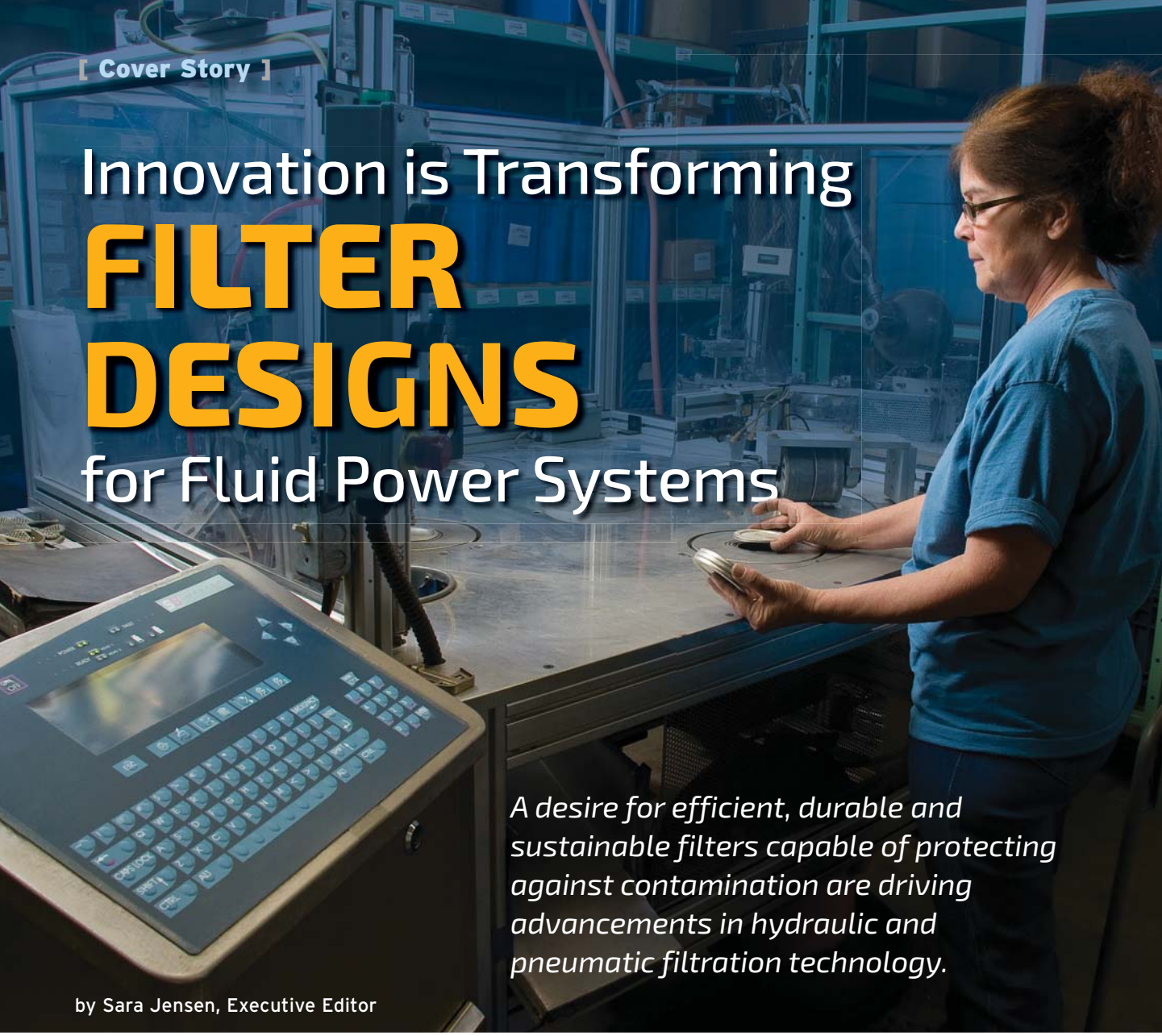
The Manufacturing Industry Output (MIO) measures manufacturing performance, and currently shows a slight down cycle for 2024 before entering a period of growth through 2028. Interact Analysis



Anticipated interest rate reductions in late 2024 or early 2025 are expected to help spur growth for the manufacturing sector through 2028. Interact Analysis

FOR EVEN MORE economic and market trends information for the fluid power and electric motion control industries, visit our State of the Industry page at ***powermotiontech.com/magazine/51708***. There you'll find video interviews, articles and more overviewing current and future market information as well as insights on how these trends could impact hydraulic, pneumatic and electric component designs.

Innovation is Transforming FILTER DESIGNS for Fluid Power Systems



A desire for efficient, durable and sustainable filters capable of protecting against contamination are driving advancements in hydraulic and pneumatic filtration technology.

by Sara Jensen, Executive Editor

FILTERS ARE AN IMPORTANT part of hydraulic and pneumatic systems as they help eliminate the presence of various contaminants which could cause performance issues. And like many other fluid power system components, advancements continue to be made in filter designs to meet evolving customer and industry requirements.

"Over the past 5 years, filtration technology for fluid power systems has seen significant advancements," said Michael Shaw, CEO of Ohio Fabricators Company. "Customers are now looking for features and capabilities that enhance efficiency, product quality, and environmental sustainability."

He said some of the key trends and innovations taking place within the filtration industry include:

- **Advanced Filter Media:** The development of synthetic filter media, including various polymers and fibers, has improved filtration capabilities and durability compared to natural materials.
- **Nanotechnology:** Emerging technologies like nanotechnology promise more efficient, effective, and environmentally friendly filtration systems.
- **Degradation-Based Maintenance:** Incorporating elements of degradation-based maintenance in filtration systems helps power plant operators meet their desired performance goals by improving operating costs and power output.
- **Environmental Sustainability**: Customers are increasingly looking for filtration products that minimize waste, meet environmental regulations, and monitor air and water quality.

"These advancements have transformed filtration technology from its early beginnings to the cutting-edge innovations of today, making it more efficient and versatile than ever before," said Shaw.

◀ *Significant advancements over the past 5 years have helped to make fluid power filtration technology more efficient and versatile. Ohio Fabricators Company*

Gregg Shanley, Technical Marketing Manager, Automotive and Industrial at The Lee Company, agrees that filtration technology has evolved to meet the needs of hydraulic and pneumatic systems across multiple technological applications and industries.

"While there have been advancements — especially in aerospace — the goal is still largely the same," he said. "Customers are looking for filtration products that can provide the contamination protection they need, with the lowest pressure drop possible. By doing so, they are able to use that energy in other places in their systems (instead of at the filter level)."

Material Advancements Improving Filtration Performance

An area in which many technological advancements are taking place is in the design of filter materials. The materials used in filters are key to trapping debris to prevent it from entering hydraulic and pneumatic systems, as well as other systems further downstream in machines and vehicles.

According to Shaw, nanofiltration and membrane technologies have emerged as game-changers in industrial fluid handling. "They utilize semipermeable membranes with extremely fine pores to separate particles, contaminants, and unwanted substances on a molecular level," he explained. "Nanofiltration systems offer superior filtration efficiency while allowing desired molecules to pass through, making them ideal for applications requiring precise separation of ions, organic matter, and pathogens."

Shaw went on to say that advancements in membrane materials and structures have increased durability, fouling resistance, and higher permeability, helping to ensure sustained performance in various industrial settings.

He said the nanotechnologies that have been deployed in nonwovens — whether spunbond, meltblown, wetlaid, or apertured films — have led to a step function in products available to the market.

Material advancements, such as the development of nanofiltration and membrane technologies, are enhancing the capabilities of fluid power filters. Ohio Fabricators Company

A consistent need for more precise filtration methods in industries such as pharmaceuticals, food and beverage, as well as water treatment have been a key driver he said for these filter material developments.

"These solutions have been driven into industrial filtration applications across many markets [and] hydraulic, lube, and fuel filtration markets have all improved from these new technologies as well," said Shaw. "These markets continue to demand complex filtration solutions that are high efficiency and durable as engines are more precisely built with fuel efficiency and emissions standards in mind."

Shanley said hydrogen systems are also impacting the material design and pres-

Continued development of advanced filter media using polymers and various fibers is expected to provide further improvements in filtration capabilities and durability. Ohio Fabricators Company

Development of compact systems, particularly in the hydraulics sector, is requiring filter manufacturers to design products which not only maintain fluid cleanliness but also offer a lower clean pressure drop and longer lifespan. Ohio Fabricators Company

Innovations in restrictive safety screen filters are helping to meet the high pressure needs of hydrogen systems which are becoming more common in many industries. The Lee Company

Safety screen filters are often used as a final line of defense to protect components from contamination. The Lee Company

sure needs of fluid power filtration technology. He explained that filter material can be compromised by hydrogen embrittlement, leading to issues with reduced tensile strength, cracking, or other catastrophic failures. Although some materials may be sufficiently resistant to hydrogen embrittlement, he said they can still fail under certain conditions.

"The material selection process is crucial to help ensure compatibility throughout the system, and filter materials need to be sufficient to handle the needs of hydrogen systems," said Shanley.

He also noted that hydrogen systems typically operate at very high pressures and designers may want to use a restrictive safety screen filter with an extremely low micron rating of about 10 microns or lower.

"Getting down to these lower micron ratings is a challenge in higher pressure systems, as it usually results in reduced material strength," Shanley explained. "The pressure needs of hydrogen systems are helping to drive innovation to create filters that can handle these increasing pressures without a significant rise in flow resistance."

Compact Systems are Driving Filter Designs

There is a growing trend toward the development of more compact systems, particularly in the mobile hydraulics sector, as the amount of available space on machines and vehicles continues to decrease.

Shaw noted the size of hydraulic reservoirs, for instance, are decreasing to reduce the weight of mobile equipment as well as improve their aerodynamics, both of which help to lower energy use and emissions — increasingly important factors for OEMs and their customers.

"This has led original equipment manufacturers (OEM) to [use] roto-molded tanks, thermoformed components and integrated filtration systems within tanks," he said. "All of these developments can stress fluids with less residence time for cooling and evacuation of air molecules."

With the move to more compact systems, Shaw said hydraulic and lubrication filter manufacturers are now being pressured to offer solutions designed to yield a lower clean pressure drop and longer life while maintaining fluid cleanliness.

The space constraints with which design teams must now work makes it even more critical to consider all necessary filtration technologies as early in the development process as possible.

Shanley said most hydraulic and pneumatic systems are designed with a system filter to maintain fluid cleanliness during operation and reduce wear on parts. However, sensitive components are sometimes located far from the filter. Therefore smaller safety screen filters are often used as a final line of defense to protect components from contamination that may otherwise affect performance.

The need for a safety screen filter, though, is often discovered late in the design process, he said.

He explained that designers sometimes assume their system-level filter will provide enough protection and so do not incorporate additional filters into their initial designs. But testing then reveals potential sources of contamination not previously anticipated, such as rogue contamination and debris generated during manufacturing or produced during operation, can occur.

"As systems become increasingly complex, however, the space available to place filters post-design may be incredibly limited," said Shanley.

To help overcome this challenge, he said The Lee Company develops safety screen filters in various sizes to meet customer needs. "Adapting to unique system geometries provides us with the flexibility to produce filters optimized to the customer's performance and pressure requirements — even if their system was originally designed without this filter in mind."

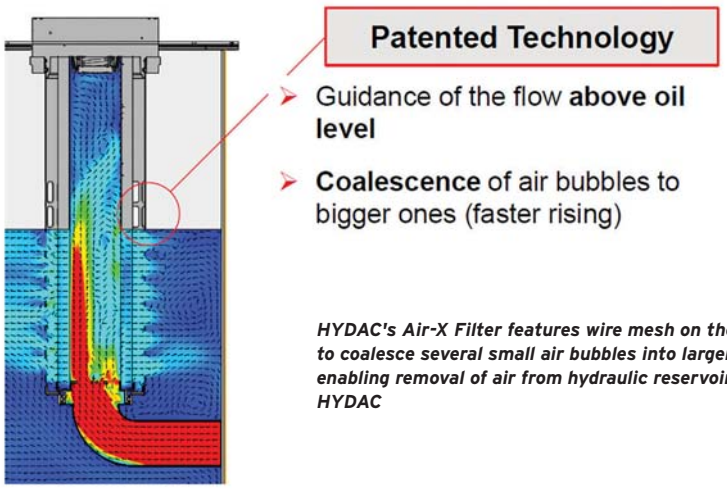
New Filter Technology Aids Hydraulic Reservoir Optimization

To help its customers see the potential benefits of better optimizing the size of their hydraulic reservoirs, HYDAC offers a Tank Optimization Platform as part of

its engineering services. Through simulation and field testing, the company can demonstrate how different geometries and smaller reservoir (also called a tank) sizes can improve performance and operating costs.

A key enabler of this platform is the Air-X Filter developed by HYDAC to extend oil and filter life. On the outside of the filter is wire mesh which coalesces several small air bubbles into larger ones. The larger the air bubble, the more buoyancy it has and thus the faster it can rise and get out of the hydraulic reservoir explained Marcus Herrera, Application Engineer, Advanced Systems Team, HYDAC International during a presentation he gave as part of the National Fluid Power Association's (NFPA) June 2024 quarterly technology conference.

Removing air from the oil within a reservoir is critical to ensuring the performance of hydraulic systems; the faster a filter can get air out of a hydraulic reservoir, the better.



HYDAC's Air-X Filter features wire mesh on the outside to coalesce several small air bubbles into larger ones, enabling removal of air from hydraulic reservoirs. HYDAC

The wire mesh also guides oil to release above the oil surface. "As the oil comes in, the mesh encourages that oil when it exits the filter to exit at or above the oil level in the tank," he explained.

Additionally, the filter design slows the velocity of the oil as much as possible. "The faster the velocity, the more likely it is going to create bubbles," said Herrera. "So, we're trying to slow it down to allow the bubbles to escape."

He noted that commonly an out-to-in filter design is used for hydraulic reservoirs, but the Air-X technology is an in-to-out solution. Out-to-in filtration has a slow entrance velocity into the filter and oil is dejected out the bottom of the filter. This creates velocity into the tank though,

causing sloshing and vortexes as well as bubbles that might be in the oil to make their way to the bottom of the tank. The bubbles will have to make their way all the way to the top of the oil to escape, he said.

With in-to-out filtration, on the other hand, the inlets coming into the hydraulic reservoir come through the center of the filter and the filter slows down the oil. This allows any bubbles created to escape at the surface of the oil.

As the reservoir filter's job is to collect contaminants, it will eventually need to be replaced. Spin-on filters are commonly used in the market, Herrera said and are usually thrown out once past their useful life and replaced with a new filter.

To help reduce the amount of waste associated with filter replacement, HYDAC designed the Air-X to have a cartridge inside the filter housing. The cartridge is made with plastics or aluminum so they can be recycled. The goal was to create a filter in which as many of the core components can be reused as possible.

Where is Fluid Power Filtration Technology Headed?

Both Shaw and Shanley see more technological advancements for filters coming in the future to meet the ever-evolving needs of hydraulic and pneumatic systems.

According to Shaw, continued development of advanced filter media using polymers and various fibers will lead to further improvements in filtration capabilities and durability. "These developments, driven by nanotechnologies, will lead to more efficient, effective and environmentally friendly filtration offerings industry wide," he said.

In addition, implementation of condition-based monitoring on systems will continue to grow, leading to degradation-based maintenance in systems as performance goals dictate less downtime, and the push for reduced operating costs becomes a greater focus.

Shanley said The Lee Company predicts there will be an increasing focus on the development of filtration technology that can accommodate a wider range of fluids — including the incorporation of different materials and processes to filter fluids.

"Additionally, as filtration technology continues to develop and more components become electrified, consideration should be paid to the unique filtration needs of these products in future fluid power systems," he concluded. P&M

> "These developments, driven by nanotechnologies, will lead to more efficient, effective and environmentally friendly filtration offerings industry wide."
>
> *— Michael Shaw, CEO, Ohio Fabricators Company*

Mechatronics Bring Performance Improvements to Range of Applications

Craig Hooker of Schaeffler discusses how the fusion of mechanics, electronics and software is benefitting machine and vehicle performance.

by Sara Jensen, Executive Editor

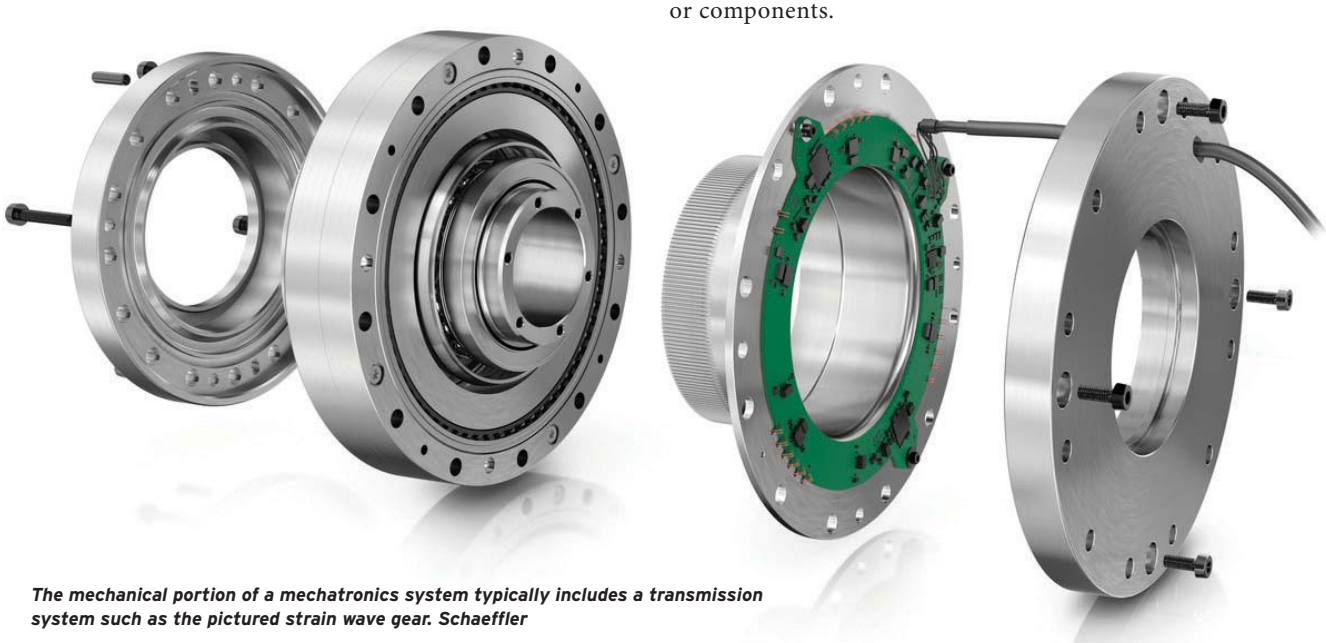
TODAY, IT IS HARD TO FIND applications which do not utilize mechatronics — the combination of mechanical, electric and software technologies — in some manner. Doing so can help to improve throughput, efficiency and operator comfort by enabling more precise control and intelligence to be built into a vehicle or machine.

In this interview with *Power & Motion*, Craig Hooker, Director of R&D and Mechatronics at Schaeffler in the Americas, provides an overview of what mechatronics systems entail, how they are being utilized, and what is driving widespread use of these systems.

Editor's Note: Questions and responses have been edited for clarity.

Power & Motion: **Mechatronics is not always a clearcut term that everybody is familiar with or knows much about, so to start our conversation, could you define what mechatronics is or what it means to a company like Schaeffler?**

Craig Hooker: To make it simple, mechatronics is a combination of mechanics, electronics and software, usually embedded software. For Schaeffler Group, that means developing products that consist of those different disciplines or components.



The mechanical portion of a mechatronics system typically includes a transmission system such as the pictured strain wave gear. Schaeffler

***P&M:* What technologies are associated with a mechatronics system?**

CH: The easy way to do it is break it down into those different elements that I just mentioned. If we think of mechanics, then usually the component technology would be things like some type of transmission system — it could be planetary gears, strain wave gears, parallel gears, etc. It could be a screw-driven system like lead screws, roller screws, ball screws; it could be belt drives, rack and pinion, cam drives, etc. Usually there is something that is creating motion of some type, so you have a mechanical transmission system, then bearings that support the rotation of the system, you would have structural housing [including] end plates, shafts, those type of things.

And in addition to that you have electronics like microcontrollers that do the intelligence or control of the device. If it's a motor related production, typically you would have a power driver as well. Usually, you have some type of sensing, feedback sensing like position and speed, or torque and force, or vibration.

And then also there's usually software included that's doing the control or adding the intelligence to those devices.

***P&M:* How are mechatronics being used within various types of applications? Are there certain applications where you see these systems used most, or which they are most benefitting?**

CH: I'd probably generalize and say when I think of mechatronics, it's usually to do some type of sensing on a machine or a vehicle, or to create motion. And so, within those two spaces, there's usually an intent to use that to improve throughput or the efficiency of the machine; I have this machine, and I want to add mechatronics in order to get more throughput or a lower production cost out of my machine.

The other area would be to add comfort or user features. If I want to buy a vehicle and I want to push a button, and I want something to happen, I could pull a lever mechanically, but I'd really like to push the button because it's more convenient for me. Those are typically areas that drive the use [of mechatronics].

And then application areas are everywhere. I mean, it's almost hard not to find mechatronics products, once you've defined it, like I'd mentioned earlier, because there's so many things today that integrate electronics and software into a machine or device. A couple of examples would be the off-road market where you have tractors or scissor lifts; you'll see traditional mechanical components like hydraulics, for example, but you also see a lot of trends to convert that into electromechanical [components] or add intelligence to the hydraulics themselves. Electrification is a big push within that market to add this intelligence and efficiency to machines.

Robotics is an area…you can't have robotics without mechatronics because it's a very precise motion control application. And so typically, [you need] to have some type of embedded control and electronics in order to be able to accomplish that. You see lots of examples in robot arms or the humanoid [robot] push that [is happening] in the market today. All of those have lots of mechatronic examples inside of them.

Inclusion of sensors and other electronics with mechanical components and software enable the creation of mechatronics systems which can offer improved control for various applications. Schaeffler

***P&M:* What role do you see hydraulics and pneumatics playing within the mechatronics space?**

CH: When somebody says mechatronics, my first thought is usually towards electromechanical devices. Usually, I have hydraulics or pneumatics and I'm going electromechanical. And that's certainly an example of mechatronics. But also, I think you can say hydraulics and pneumatics can have mechatronics embedded inside of it. There's servo control valves, for example, in hydraulics where you're trying to improve the efficiency of the system, and there you have electronics doing some type of solenoid control and getting feedback in order to control the hydraulic loop. Similar on the pneumatic side, there's valve control to get better performance out of those systems.

So, I don't think that they're mutually exclusive. You can have mechatronics within those spaces, but of course there's also the trend to evaluate those as technologies where you may be improving upon that by going to electromechanical mechatronic type systems.

***P&M:* How have you seen the use of mechatronics evolve in recent years, and how do you foresee them continuing to evolve in the coming years?**

CH: There's definitely been an evolution, or an advancement, of the technology, more so on the electronics and the software side than the mechanics. A lot of mechanical technology has existed for many years; certainly, there have been improvements on that but where you really see a rapid improvement is more in the electronics and software.

If you look at electronic components that would go into circuit boards, like microcontrollers and integrated circuits, those have become much more available, much less expensive, smaller, more powerful [and] easier to use. So, it really is an enabler then that you can create a lot more products at a lower barrier to entry than you could create previously, and that opens up a lot more business cases and opportunities to put products into the market. I think that curve is continuing to accelerate, and the expectation is that it will accelerate into the future.

Market trends drive that as well. You have robotics, AI (artificial intelligence), automation, electrification, all of these things that we hear about a lot in the news today, those are all areas that need products that require mechatronics. So, there's the pull from the market side as well.

The last point would be also from the customer side. People are much more familiar with electronics today than they were decades ago. You almost have an expectation among the modern consumer that they want these conveniences they see in their car or have on their iPhone; they want that in their machines and vehicles that they use for other purposes as well. That also creates this pull to have the technology in the market.

***P&M:* Are there potentially markets or applications where mechatronics is not widely used at the moment but could benefit from utilizing those systems?**

CH: I don't know that there's an untapped market. Back to my comment earlier, it's really hard to think of a market that doesn't use [mechatronics] in some form. If you go back in time, everything was mechanical. And you look at industries like textiles for example, it was all driven by gears and cams and timing of machines. Those types of products were more difficult to make, you had less flexibility.

And so, I think the [mechatronic] technology has already been pretty broadly adapted. The areas where people would typically stick to more of a mechanical system [are those in which] there may be a reason for that based on power density or something else where it forces you into that space. But in general, I don't see a market where [mechatronics] hasn't been discovered yet. P&M

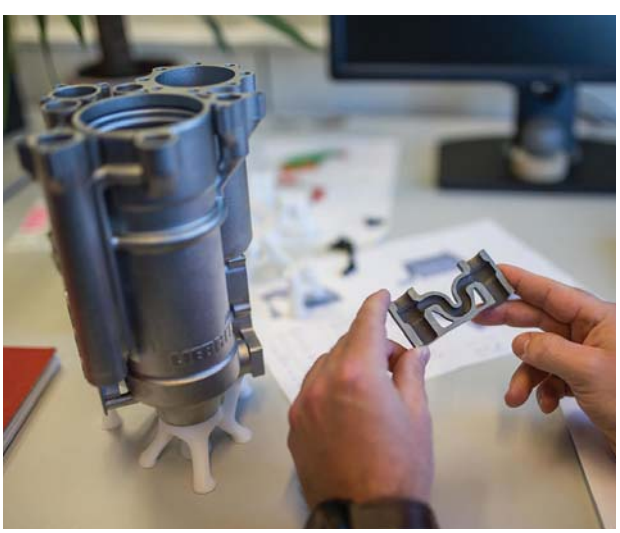
3D Printed Flex Shaft Brings New Design Opportunities to Aviation

By 3D printing a flex shaft used in aviation applications, Liebherr-Aerospace is able to reduce component complexity, weight and maintenance.

by Sharon Spielman, Technical Editor

LIEBHERR-AEROSPACE HAS taken the next step in its 3D printing journey by producing a flex shaft for aviation applications using additive layer manufacturing (ALM). This allows for the creation of a less complex component, helping to reduce wear parts and weight.

Airbus and the European Union Aviation Safety Agency (EASA) have approved the flex shaft, made of titanium powder, to enter series production. It will be integrated into the differential gearbox of the flap system that is part of Airbus' A350 high lift system where it will be used to transmit rotary movement to a position sensor to help compensate for potential angle and axis misalignment between the gearbox and sensor.



Use of additive manufacturing allows Liebherr-Aerospace to create components which are more reliable and lighter in weight, leading to reduced operational costs for customers. Liebherr-Aerospace

"Liebherr-Aerospace Lindenberg GmbH has been certified by the German authorities (LBA) for additive manufacturing since 2017 and has produced parts in series production since 2019," said Svenja Pestotnik, head of additive manufacturing at Liebherr-Aerospace Lindenberg GmbH. "The approval of the flex shaft shows that AM (additive manufacturing) is a reliable technology that enables designs which improve the sustainability of current and future aircraft."

3D Printing Provides a Flex (Shaft) for the Aviation Sector

Traditionally, the flex shaft is a component requiring seven separate parts to be assembled through welding, gluing and other labor-intensive processes. Using ALM instead allows Liebherr-Aerospace to produce a single piece with an integrated mechanism, reducing complexity and labor.

"The flex shaft is a perfect example [of] how additive manufacturing can integrate a complex assembly into one unified component," Pestotnik said. "The additively manufactured part is manufactured as a single component with an integrated mechanism. This saves on manual labor, stock keeping of individual parts and reduces lead-times significantly."

With fewer parts contained in the final component assembly, the number of potential wear points is reduced, which helps to improve reliability while also reducing the need for maintenance. Creation of a single, more integrated flex shaft allows for a lighter weight component as well, leading to weight reductions for the application into which the flex shaft will be installed.

Both aspects can greatly benefit a cost-sensitive industry like aviation. Less time and money will be spent on unplanned downtime and weight reductions are directly correlated to reduced fuel consumption which not only lowers operating costs but emissions as well.

The 3D printed flex shaft is more complex than those previously manufactured by Liebherr-Aerospace using additive manufacturing. Through the success of this project the company is able to show what is possible when using this technology for highly integrated systems.

"The flex shaft demonstrates how different functions can be efficiently integrated into one component. Extensive tests showed the reliability of this novel design approach, which opens the door for more complex and critical applications of AM in the future," Pestotnik said.

Using additive manufacturing in the aviation industry requires setting up a reliable and repeatable process, according to Pestotnik. "This includes all steps of the process chain starting from the procurement of the powder to manufacturing, heat treatment and quality control," she said.

Because AM is a rather new technology, she noted that many of these processes had to be developed from the ground up,

"yet always in collaboration with our customers, partners and the authorities. During the development of the flex shaft, a collaborative effort with Liebherr's partner for computer tomography inspection enabled the successful certification by LBA," Pestotnik said.

On the Horizon: A Sustainable AM Future

Looking ahead, Pestotnik said that the company "will use its constantly growing and evolving knowledge and experience in additive manufacturing to develop the actuation systems and aircraft components of the future, gaining a significant advantage over competitors in that field." She added that Liebherr will continue to invest in AM to provide more economic and ecologic components in the future ranging over their whole product portfolio.

And when asked how additively manufacturing these components aligns with the sustainability goals of the aviation industry, particularly in terms of material efficiency and waste reduction, Pestotnik said, "AM is an enabler for future aircraft with compact and efficient part designs that would be impossible to produce with conventional manufacturing techniques. Since AM parts usually require minimal rework, the buy-to-fly ratio is tremendously improved over other manufacturing techniques, saving valuable resources and energy." P&M

Liebherr-Aerospace's 3D Printing Journey

IN MARCH 2017, the company, along with aircraft maker Airbus, was the first to successfully fly a 3D-printed spoiler actuator valve block on a flight test A380 aircraft.

Since then, the company has supplied numerous on-board 3D printed parts for a range of applications – some are prototypes and others are serial production parts like cabin air distribution ducting parts.

This latest venture into additive manufacturing comes just 5 years after the serial production of 3D-printed parts with the introduction of a printed proximity sensor bracket for the A350 nose landing gear.

Pestotnik said that Liebherr's approach has always been to tackle one challenge at a time. "Starting with simple parts and then progressing to more complex and critical parts allowed us to establish an industrialization process early on and gain trust and experience at an early stage," she said.

Converting from Hydraulic to Electric Actuators: Key Steps to Follow

Learn the key steps to successfully convert from hydraulic to electric actuators, including how to accurately determine loads and forces to ensure an optimally sized and priced system.

by Sara Jensen, Executive Editor

USE OF ELECTROMECHANICAL systems is increasing in several industrial machinery applications because of the precision and reliability provided. In many cases, they are replacing the hydraulics traditionally used in these machines.

While hydraulics will continue to be the technology of choice in many applications, for those where an electromechanical (i.e., electric actuator) option can be used it is important to understand how to convert from one technology to the other to ensure optimal machine performance.

Ryan Klemetson, Business Development Manager at Tolomatic, explained during a webinar hosted by the company on converting from hydraulic to electric actuators, that key steps to a successful conversion include determining the loads and forces of the application, and then defining its required motion profile and cycle rate.

Following these steps will ensure the performance of an industrial machine is maintained and the benefits of converting from hydraulic to electric are achieved.

Factors to Consider Before Converting to Electric

When looking to replace a hydraulic system with an electromechanical one, it is important to take some factors into consideration to ensure the conversion is feasible.

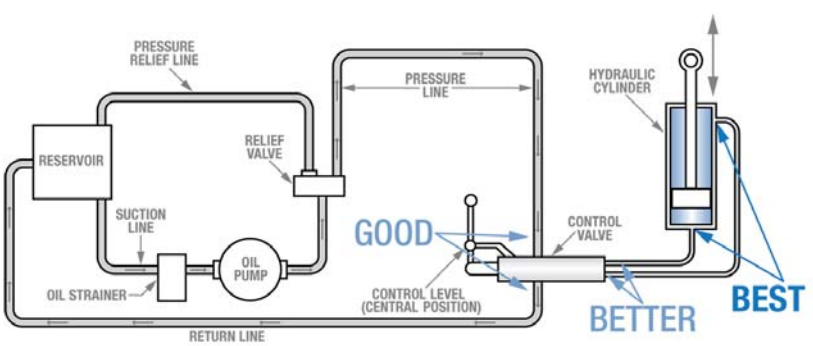


Figure 1: To determine application forces for replacement electric actuators, the best option is at the point of work. But given this is not always possible, there are other points at which measurements can be taken as illustrated in this figure. Images courtesy of Tolomatic

One of the first factors to assess is the space envelope available for the system. As Klemetson explained in the webinar, hydraulics are very power-dense and so machines have always been designed to optimize footprint. Because of this there may not be room for an electric actuator and its accessory components.

Electric actuators tend to require more space than a hydraulic cylinder because they are longer and wider. There is also mounting design work which needs to be taken into account.

Force levels and stroke length should also be considered, again in relation to how much space is available. While today's electric actuators can achieve high forces they are not as power dense as hydraulics which means they need more space to provide forces similar to that of the hydraulic cylinder they are replacing.

"It is all about finding the right tool for the job," said Klemetson. Therefore, having a good understanding of the machine design and its intended use will aid in determining if an electromechanical system will fit the application.

Accurate Force Measurements Ensure Proper Electric Actuator Sizing

Appropriately sizing the electric actuator that will be used in place of a hydraulic cylinder is one of the first steps in shifting from a hydraulic to electromechanical system. To do so, it is necessary to determine the force and load of the system.

Klemetson said Tolomatic always recommends measuring the force of a system as opposed to basing it on system pressure which is often done using the following formula:

Hydraulics Remain a Vital Method of Motion Control

ALTHOUGH ELECTROMECHANICAL OPTIONS are being used in place of hydraulics in many applications, there will always be a need for hydraulic systems. "Hydraulics can still do work that conventional electromechanical technology simply can't," said Ryan Klemetson, Business Development Manager at Tolomatic, during the company's webinar on converting from hydraulic to electric actuators.

He said the shift to electromechanical is no different from the one which started about 15-20 years ago when people began re-evaluating their pneumatic systems to see if different technologies could be used to improve processes and efficiency.

"We're starting to see more applications...following that same process of 'How do I evaluate where the best use of the tools is in different applications or equipment?'" said Klemetson.

Because hydraulics can provide higher power density than other motion control technologies, they will remain an important part of many applications for years to come, particularly those requiring a high level of force or movement of heavy objects. Understanding the pros and cons of hydraulic- and electric-based systems can ensure the right option is selected for a given application.

Force = Area of the Cylinder × Rated System Pressure

This can result in an electric actuator solution which is oversized and overpriced. Instead, a more accurate measurement of force can be achieved by measuring hydraulic pressures in a cylinder while a machine is in operation.

"Where to measure is kind of a good, better, best," said Klemetson. "The best place to always measure would be right at the point of work." This is not always feasible though, but there are ways to still get accurate force measurements.

Using the good, better, best analogy, there are three areas within a hydraulic system where pressure measurements can be taken *(see Figure 1)*:

- Good – Measure pressure at the valve, which is the commonly used option when converting to electric actuators. It is the furthest distance from the work point, though, increasing the potential for errors in actual versus measured pressure.
- Better – Measure pressure between the hydraulic system's valve and cylinder. However, pressure-compensated flow controls and needle valves or other inline accessories could influence pressure.
- Best – Measure pressure at the hydraulic cylinder. This is the most accurate location for reading pressure at the point closest to where work is happening but may also be the least accessible location.

"The more accurate you are in measuring, the more optimized you're going to be as far as the cost of your system," said Klemetson.

Because every hydraulic system is different, Tolomatic recommends measuring both working pressure of the system and the return pressure as there is the possibility of high return pressure between the system's cylinder and valve. This can reduce the total force of the system.

Therefore, it is recommended to place measuring gauges on both the extend and retract ports of the hydraulic cylinder *(see Figure 2 below)* and calculate effective surface pressure:

Force = (Area1(πr^2) × P1) – (Area2 (πr^2) × P2)

He gave the example of a small hydraulic system featuring a 1.5 in. bore cylinder with 0.75 in. rod and pressure relief valve set at 1,500 psi (103 bar). If doing a simple Area x Pressure calculation, the resulting force would be 2,60 lbf.

But if 250 psi (17 bar) of backpressure is factored in, that leads to a 40%

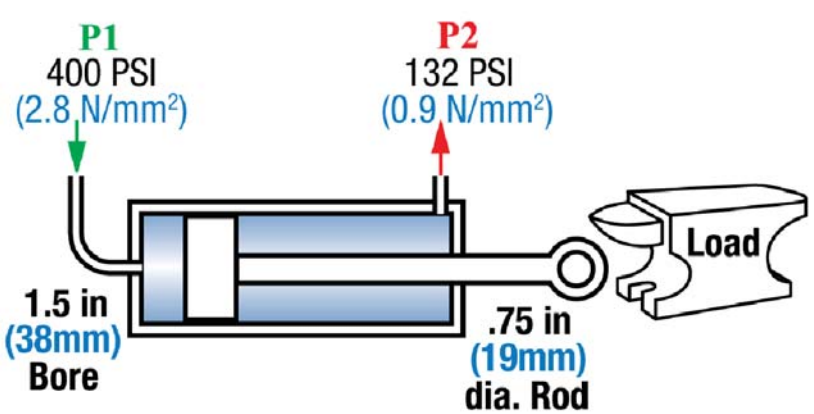


Figure 2: The most accurate method for sizing an electric actuator is to calculate the force on each side of the hydraulic cylinder it will replace to determine the force and load requirements of the system.

reduction in required force (1,788 lbf) and thus a smaller sized system than might have originally been designed. Taking backpressure into account "could literally in some instances save you thousands of dollars," said Klemetson. "So, we always recommend this as the most accurate" method of determining force requirements.

Know Your Application for Component Selection

Understanding the desired motion profile of an application is another critical step when replacing a hydraulic cylinder with an electric actuator. It can be captured simply with a stopwatch or a camera to help determine the requirements of the application.

"It's important to understand what is necessary — either I need to move at a given rate or I need to move a distance in a given time," said Klemetson. "The reason this is important is typically when you get into larger force applications, servo motors don't spin as fast when they are very large. You may only have 2,000 [or] 2,500 rpm versus 6,000 rpm."

By understanding whether it's time or speed that is important to your process and application, it is possible to reduce your motor speed by about 50% in some instances.

It can also help to inform component selection for the electromechanical system. Choosing the appropriate electric actuator screw technology (Acme, roller or ball), for instance, will correlate not only to system performance but also potential heat generation and maintenance requirements.

Klemetson noted during the webinar that roller screws tend to perform better than ball screws from a longevity standpoint in pressing and high-shock applications. Roller screws are known for their high force capabilities, low maintenance and high efficiency, all of which benefits these types of applications.

When you have a good understanding of your application and maintenance needs, it plays "into picking optimized components from a size and ultimately a cost perspective," he said.

When choosing to use electric actuators in place of hydraulic cylinders, it is important to first determine space available and then appropriately size the actuator for the applications.

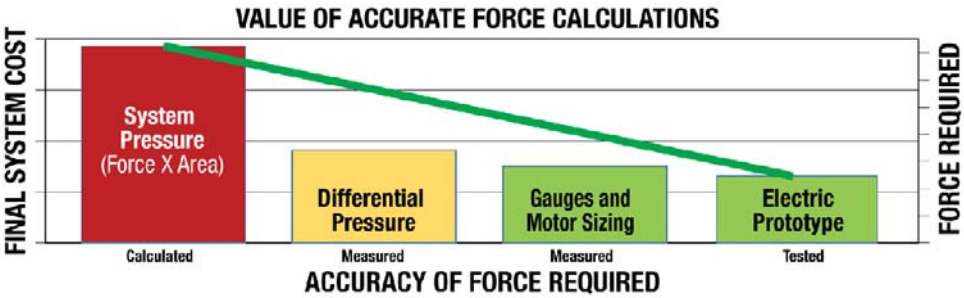


Figure 3: Accurately determining force requirements ensures the replacement electromechanical system is not only optimized for size but also cost.

Take Full System Needs Into Account

Klemetson said it is also important to remember you are engineering a system and therefore all necessary components need to be factored into the design process. Besides the electric actuator there is the motor and the drive which need to be taken into consideration as well as the power level that will be used.

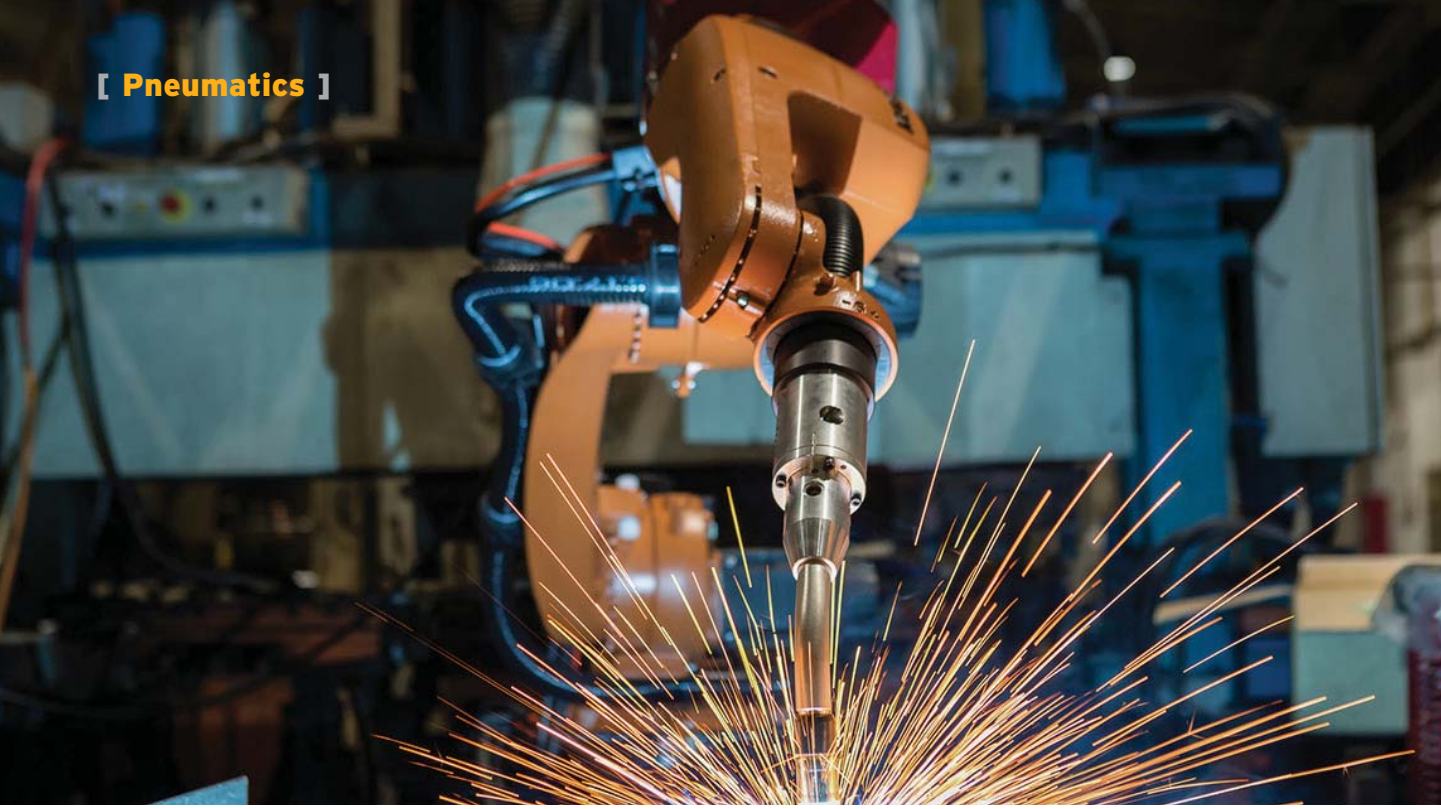
"All of these play into the electrical side of it," he said. Here again, understanding your application needs will aid with selecting the right types and sizes of electrical components that will be required.

One of the aspects which he said is often forgotten about is the cabling. "Hoses [and] fittings don't care too much about laminar flow or turbulent flow but with electricity it's pretty important," said Klemetson. "Anybody that is going to be designing a system, make sure that proper cabling is selected, [and] proper wiring and installation cable dressing is followed."

He said Tolomatic will often receive calls from customers that their actuator is not moving, and it turns out to be an issue with grounding, shielding or cabling. "From that standpoint, it can be a very challenging thing…and a chronic problem if it is not addressed at the beginning."

Therefore, it is important to remember all components that will be used in an electromechanical system and that everything will work together as desired.

By following these steps, it is possible to achieve a successful conversion from hydraulic to electric actuation in your industrial machinery. P&M



Pneumatics Provide a Tried-and-True Technology for Robotics

For robotics applications where speed, force, and weight are important considerations, pneumatics remains a viable technology of choice.

by Sara Jensen, Executive Editor

Brian Rockwell, North American Key Account Manager at Festo (left) and Cory Knight, Automation Technical Engineer – Food and Packaging at Festo (right)

THERE ARE SEVERAL factors to consider when implementing a robotics solution, including the type of motion control technology to utilize. Pneumatics are often used to move a robot arm or for end-of-arm tooling on a robot.

Using pneumatics for robotics provides many benefits, including lower maintenance and installation costs. It can provide the speed and force required of many applications as well, with pick and place being a common one.

As with any technology, it is important to have a thorough understanding of the application requirements to determine whether pneumatics is the right option for a robot versus hydraulics or electronics.

Power & Motion spoke with Cory Knight, Automation Technical Engineer – Food and Packaging, and Brian Rockwell, North American Key Account Manager, at Festo about the pros and cons of using pneumatics for robotics applications as well as key factors to consider when implementing the technology.

**Editor's Note: Questions and responses have been edited for clarity.*

Power & Motion: What robotics applications typically use pneumatics?

Brian Rockwell: First, I think it's important for us just to be on the same page about robots. The way I would define a robot is something that replicates human movements and functions automatically.

With that in mind, there are many different applications that are suitable to use pneumatics; probably the most popular would be a pick and place system where you're picking up an object and you're moving it and placing it in a different location. There are also material handling systems like conveyor systems, different tables that push and pull loads from one point to another. There are active gripping mechanisms that use pneumatics. For part manipulation and movement, there are a lot of different use types.

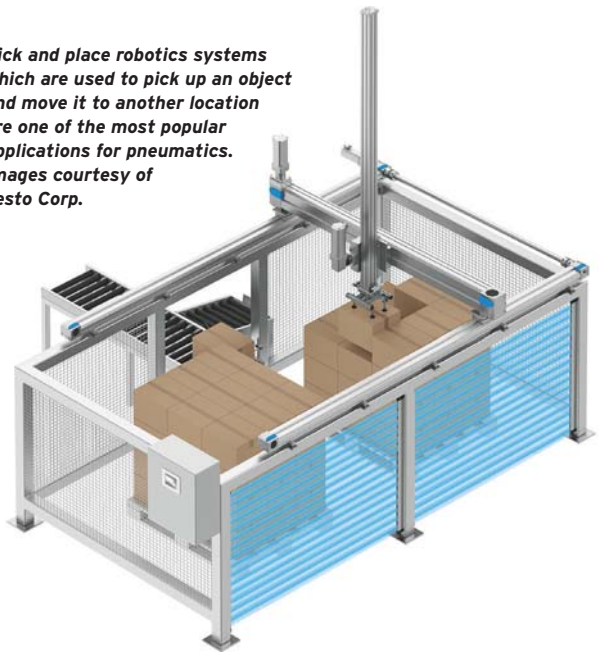
We develop technologies like grippers, and different end-of-arm tools that go on the end of a robot that are very suitable for picking up and manipulating loads. Those are the common material handling technologies that are used with pneumatics. But you also have secondary use cases, like tightening systems, torquing systems, pressing components together, joining components together through welding as an example. And then there's painting technologies that use pneumatics. Those are a handful of different use case opportunities that I see.

Cory Knight: If we drill a little bit further [into the] food and packaging industry segment, a version of pick and place is case packing. That would be a very widely used area for pneumatics for picking and placing objects into a case. And then also palletizing and depalletizing — picking a case and building a pallet with it. And then primary packaging for picking and placing an object into its primary pack. So primary packaging, secondary packaging, and tertiary packaging, all within the food and packaging industry segment, use pneumatics [for] robotics.

P&M: What are the pros and cons of using pneumatics in robotic applications?

CK: There's definitely pros and cons to pneumatics in robotics. Some of the pros first are high speed. When you talk about pneumatics versus an electric solution, such as an electric actuator, typically you're going to achieve a higher speed on the linear motion or rotary motion with a pneumatic actuator when you compare that to an electric solution. That's a huge benefit. They're simple and reliable, that would be another pro for pneumatics; [pneumatics is] very simple to work on, they're kind of a tried-and-true technology [which provide] millions and millions of cycles without any type of maintenance.

Very cost effective would be another pro to pneumatics. You compare just a pneumatic cylinder or pneumatic rotary compared to an electric solution, it's really difficult to beat a pneumatic solution. It's just lower cost overall. And then the power-to-weight ratio — with a pneumatic cylinder or pneumatic actuator, you have this ability to exert a really high force with a very small and lightweight package, that's hard to beat when you look at any other technology. I think the last pro would be hazardous locations, whenever you're dealing with explosive or flammable gases or liquids, if you're just using compressed air, you don't have any high voltage so that's a really nice pro for pneumatics.



Pick and place robotics systems which are used to pick up an object and move it to another location are one of the most popular applications for pneumatics. Images courtesy of Festo Corp.

Some of the cons, though, [include] limited precision, meaning if you're trying to do a really fine move or to do some type of controlled process, pneumatics is lacking in that area. Limited force control would be another one; you have that force available to you but if you wanted to have an exact, light-touch force on a component that's when you're starting to get into the servo pneumatics or high-end control for pneumatics [because] pneumatics typically just want to run at a constant air pressure and do the same thing over and over again.

Noise and vibration could be a con for pneumatics, dealing with all of the exhaust air, higher forces and the banging of a cylinder. A lot of times if you don't use the proper energy damping with pneumatics, you'll have a bang and a vibration as a result of a pneumatic actuation. So, those can be limiting factors. And then sometimes energy efficiency could be [a con]; pneumatics can oftentimes be viewed as less energy efficient than electrical systems. When an electrical system is sitting there, it's not using any power unless it's doing work. Whereas a pneumatic solution, sometimes there's leaks, sometimes there's more air consumption as a result of some external factor. Those would be my pros and cons to pneumatics in robotics.

BR: There are occasions where you're in an area of a facility that has limited power availability. In that case, you may not be able to access [an electronic power supply], so pneumatics may be an easier option to consider. If it is a complex move

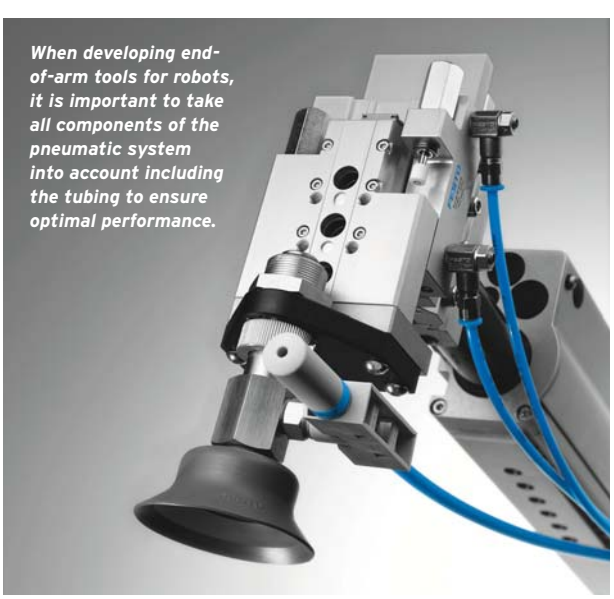
that requires multiple positions, then pneumatics might not be a good solution. [Pneumatics] is going to be for more basic movements. Reinforcing what Cory said, simple [applications] are pneumatics and complex would be other technologies.

P&M: What are some key factors to consider when determining whether pneumatics or another technology should be used in a robotics application?

BR: It's evaluating the application, really doing a lot of homework on what's required. What we would typically [do is look at] how fast a process is, how accurate it needs to be, and is there a force and torque requirement for whatever operation you're trying to do. As you get into environmental considerations, these are all helping you determine whether it's going to be hydraulic, electrical, or pneumatic.

Then the cost is always a big one. And one that slips through the cracks a lot of times is the knowledge of your maintenance staff. A lot of customers may have a maintenance staff that has never worked with robotics, as an example, so they feel more comfortable with pneumatics. Or they may be very skilled with robots and not have a lot of experience with pneumatics. It really just depends on the knowledge base that you're working with. Those are some of the main considerations that we walk our customers through. [Also], whether or not they have an energy efficiency mandate at the facility, if there's any noise and vibration requirements for the environment because that will also dictate that maybe pneumatics isn't going to be a good choice because it does cause a lot of noise and vibration. I would say on a high level [those are some] key considerations.

CK: One other thing, [which] Brian touched on already, is the familiarity of the customer with the technology. And then weight, that's a huge point that always comes into play is how much does the thing weigh if it's going to be used as an end-of-arm tool. Every ounce that the end-of-arm tool itself weighs takes away from the payload capability of the robot and the operator to do what they want to do in carrying the load or conducting the process. Oftentimes weight is a huge conversation when deciding which technology to go with when you're talking about doing simple linear motion with an electric actuator versus a pneumatic actuator.



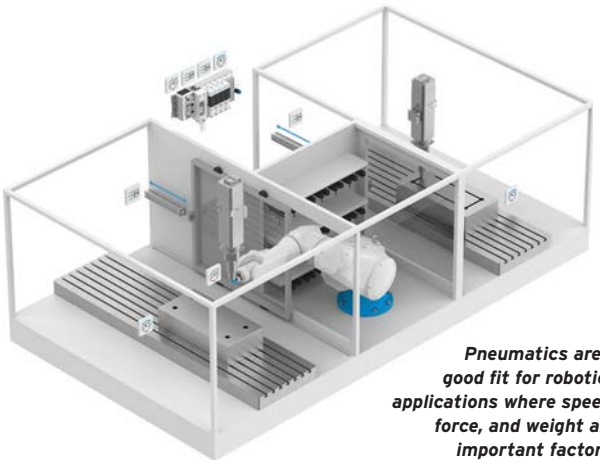
When developing end-of-arm tools for robots, it is important to take all components of the pneumatic system into account including the tubing to ensure optimal performance.

When you compare one to one, with electric you're going to have some type of motor involved, an axial kit, a motor coupling, maybe there's belts and pulleys, is it a pulley drive or a ball screw, there's linear bearings; there's all these types of mechanical components inside of an electric actuator just to get you 1 in. of stroke of linear motion. Whereas within a pneumatic cylinder you only have a tube, a piston, and a rod. So, it's obviously much lighter weight and that's probably one of the top considerations when [deciding to use] pneumatics or another technology.

P&M: When someone does choose to use pneumatics in a robotics application, what steps or best practices should be followed to ensure proper installation and performance?

CK: It really always comes down to machine design and having a mechanical design engineer that has a little bit of experience knowing what's the true scope of the tool. We want to start with system design — what's the requirement for weight, force, speed, precision, all these types of performance characteristics of the tool. And then that can help you kind of go along and determine what the size is, what the type of actuator is, and does it need to be guided. Are you going to do external linear guiding? Those are the types of questions [to answer] and then once the actuator and the thing that's moving and doing the work is established, you can start working your way backwards to how much flow do I need [and] what size valve needs to be used? What type of air quality do we need to have? And how much air preparation do we need to do to the incoming air from the facility.

Those are the types of questions and things we have to do at the start, proper components selection and looking at what utilities we have available. With an end-of-arm tool, its air supply and air pressure are always a topic. Oftentimes, someone will do a sizing on a system and assume that there's 90 psi or around 6 bar of air pressure available. And sometimes that's not always the case. Maybe the customer says we have 90 psi, but in high demand scenarios that pressure can drop down to 75 or 80 psi because we're running full production [for] certain amounts of time, and we have a huge air demand. If the entire system is designed right on the ragged edge of being able to have 90 psi and we drop, the supply air is lower, now [suddenly there may be] issues with the tool. So, really sizing the components with contingency of air supply, knowing that maybe the air supply might be lower than what the customer states that they can provide, that's a huge thing to start to look at.



Pneumatics are a good fit for robotics applications where speed, force, and weight are important factors.

One of the things I get tasked with all the time when it comes to fixing end-of-arm tools or fixing applications is where tubing was overlooked, especially for vacuum applications. Tube size does matter. The tube size dictates how much flow can be supplied to an actuator which directly correlates to how fast that actuator can operate. Whenever you're talking about vacuum, when you're picking up porous objects, tube size matters in a different way; that's a matter of how fast we can supply air to a venturi which then turns into vacuum flow and goes through a vacuum cup. If we have a porous object that we're trying to grip, like a slip sheet or a corrugated case, and we undersized the vacuum tubes, we're not able to achieve the correct vacuum level because oftentimes the tubes are too small. And all it [would take is] just going up a size in the diameter of the vacuum tubes, that allows the tool to operate like it should.

If we're talking about a pneumatic actuator, it's the same thing. If it's supposed to operate in 100 milliseconds and it's taking 175 milliseconds, look at the tubing. Most of the time the valves are properly sized and the tubing is overlooked. That's something [which is] a really big thing to look at.

Mounting and alignment [are also important] whenever you're talking about using pneumatic actuators. Sometimes I'll see people use multiple pneumatic cylinders if there is a large plate they want to lift up and down. They think they need to just mount four cylinders on the corners, and use smaller cylinders, and they can all lift it up and down at the same time. For that to work, those four cylinders all have to move at exactly the same speed and at exactly the same time, and if one tube is a little bit longer than the other, they bind. Or if one actuator wears a little bit differently than the other, it creates a bind. So really using machine design to know when to use an external linear bearing in one cylinder, and how to mount and align pneumatics components so that they don't fight each other, that's a really key point in the design consideration of pneumatics in an end-of-arm tool.

BR: Having a preventative maintenance plan in place is extremely important. One time I went into a customer to evaluate a machine that was really sluggish, [it] had been around for some time. And as we walked around, the filtration didn't have any elements in it. He didn't remember when the last time was that they had put an element in the filter. That allows contaminants to run through the valves and get into the cylinders. They weren't even considering following a few simple steps to ensure their air quality was maintained, and that's something over time that will dramatically affect the performance of your system. Something that costs less than $25 could ruin $100,000 to $400,000 or $500,000 systems, so it's very important.

P&M: Do you see continued opportunities for the use of pneumatics in robotics applications? If so, what is helping drive ongoing use of pneumatics in these applications?

CK: The answer is an emphatic yes. Pneumatics are going to stay in robotics. We don't see that they're leaving anytime soon. When you have a need for speed, force, and a lightweight, compact actuator there's just nothing out there that can compare with pneumatics at the moment. So, we don't see pneumatics going away, it's still a tried-and-true technology that offers so many benefits to the customer.

To add on to that, Festo is continuing to innovate with the use of pneumatics and revolutionize and digitalize pneumatics so that they can be used even further in robotics. We saw a huge step with that with the release of our VTEM motion terminal a few years back [which provides] the ability to control pneumatics in a very precise way using piezo technology and turn a two-position pneumatic cylinder into a multi-position servo pneumatic actuator with the use of a smart valve terminal.

We've got new products that are also on the horizon where we can do controlled force of a pneumatic actuator on an inborn tool with a smart controller, and have the ability to control that force no matter which orientation the tool is, if it's horizontal, vertical, or some combination thereof we can compensate for the gravity effect and maintain that, we are always applying the same force. Those are some of the things that we have cooking behind the scenes to not only say yes, we see the need for pneumatics and robotics in the future, but we're also innovating in this area to make sure that our customers can continue to use this tried-and-true technology.

BR: As an organization, Festo believes deeply in the philosophy of using pneumatics in industrial automation. And we see it also being a relevant technology as we automate non-industrial processes that we see evolving, and Cory is at the forefront of that in the food space where you're starting to see more and more kitchens being automated and pneumatics plays a key role in that technology, in handling food and preparing dishes and pouring beer. There are limitless applications. I'm proud to work for an organization, and I know Cory is too, that spends so much of its revenue on developing new ways to use pneumatics so it can continue to stay relevant moving forward. P&M

Braided Hydraulic Hose Meets High Pressure Needs of Electric Backhoe

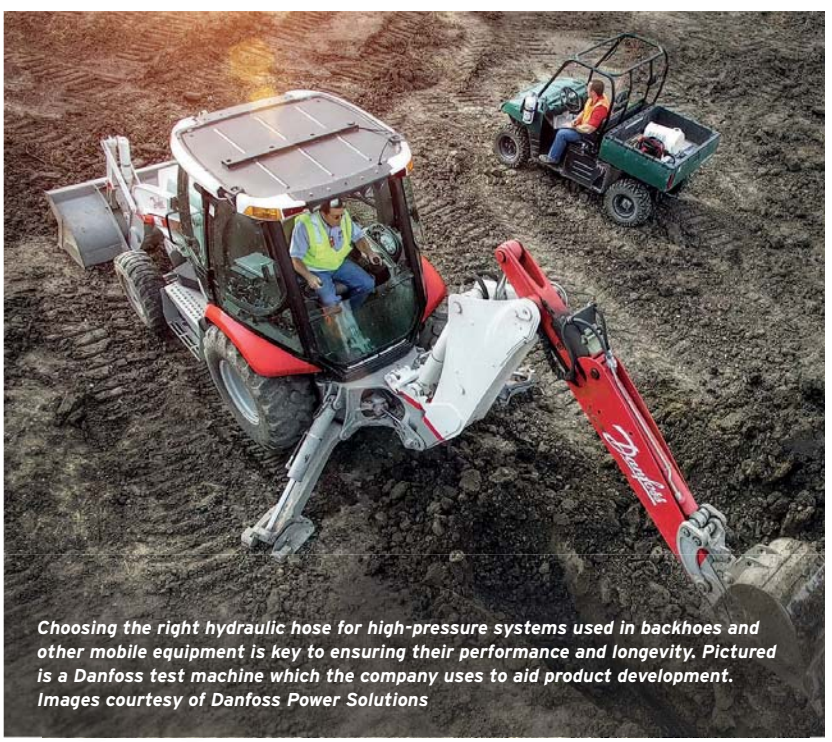
Replacing spiral hydraulic hoses with braided hoses offered cost and weight savings for a mobile equipment manufacturer without compromising on its high-pressure requirements.

by Sara Jensen, Executive Editor

SPIRAL HYDRAULIC HOSES are commonly used on mobile equipment as they can manage the high pressures required by these machines. But when a major OEM was developing the next generation of its electric backhoe loader, it discovered the high-pressure fluid conveyance components it previously used did not provide the same performance.

The equipment manufacturer reached out to multiple suppliers for a hydraulic hose that would meet the 3,800 psi working pressures of its electric backhoe. In its RFQ (request for quotation), the OEM specified SAE 100R12 four-wire spiral hoses.

However, engineers at Danfoss Power Solutions saw an opportunity for the manufacturer to utilize a two-wire braided hose instead which would still meet its high-pressure requirements while offering the potential to reduce costs.



Choosing the right hydraulic hose for high-pressure systems used in backhoes and other mobile equipment is key to ensuring their performance and longevity. Pictured is a Danfoss test machine which the company uses to aid product development. Images courtesy of Danfoss Power Solutions

Making the Switch From Spiral to Braided Hydraulic Hoses

Traditionally, high-pressure applications have required the use of spiral hoses because they commonly have four or six layers of wire reinforcement to withstand the hydraulic pressures moving through them.

As such, the backhoe OEM specified the need for a four-wire spiral hose which would be used for the high-pressure line between the machine's hydraulic pump and the main control valve. Although the backhoe is electric, hydraulics remain important to its functionality as many electric alternatives cannot yet match the power density needed in this type of application. Therefore, the OEM needed hydraulic hoses that could match the performance of those used in its diesel-powered machines.

During the RFQ process, Danfoss' engineers realized there could be an opportunity to utilize the Aeroquip by Danfoss EC881 Dynamax hose. This two-braided hose has a 35% higher pressure rating than other braided hoses, suiting its use in a high-pressure hydraulic application. It is also qualified to 1 million impulse cycles, a rating that commonly requires use of a spiral construction.

These and many other features make it possible to use the EC881 hose in place of four-wire spiral hydraulic hoses in certain applications.

The Benefits of Using a Braided Hose

Utilizing a braided hose like the EC881 instead of a spiral hose can provide various cost and design benefits to OEMs.

According to Danfoss, braided hose is more flexible than spiral hose which enables the hose to be rerouted if necessary to accommodate different machine layouts. It also helps to ease installation for the OEM and maintenance for machine owners.

Hose lengths can be reduced as well, which can offer both space and cost sav-

ings. This is beneficial as space within mobile equipment is becoming more limited due in part to the addition of more technologies. In some applications there is also a need for machines to have a smaller footprint — so they can fit within buildings or reduce soil compaction. As such, there is a need for hydraulic systems to become more compact which can potentially be achieved if using a braided hose.

Braided hydraulic hoses are also lighter in weight than spiral options, enabling overall machine weight to be reduced. This helps lower energy use and thus fuel costs for equipment owners. For electric machines, the use of batteries in place of an engine can add weight. Having the ability to reduce the weight of other systems, such as the hydraulics, can help compensate for this to ensure the machine remains the desired weight.

The electric backhoe OEM specified in its RFQ the desire for size 12 (0.75 in. inner diameter) 100R12 hoses. Danfoss was able to match this with its EC881-12 hose which also met the working pressure, burst pressure and other specifications desired by the OEM but at a lower cost.

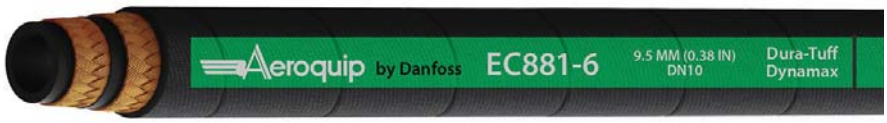
Per Danfoss, switching to a two-wire braided hose and fittings provided a 31% cost reduction for the OEM. The reduced cost of the hose will also benefit machine owners when it comes time to change hose assemblies.

Braided Hydraulic Hose Offers Future Design Opportunities

While Danfoss knew the benefits possible with its EC881 braided hose, switching to a different hydraulic hose construction for the electric backhoe application did require some convincing.

"The mentality has been, if I want spiral performance, I need a spiral hose. And now we're saying there's this braided hose that can do the same. They're skeptical," said Scott Larson, senior engineer, Danfoss Power Solutions, in the company's press release on the project.

Danfoss provided the OEM with an array of test data to demonstrate the hose's ability to meet the application's high-pressure requirements, such as how many impulse cycles the EC881 could withstand at specific pressures.



The Aeroquip by Danfoss EC881 Dynamax hose is a two-wire braided hose with a 35% higher pressure rating than other hoses of the same type.

Based on what it saw in the test data as well as the OEM's previous history with Danfoss, it decided to use the EC881 hose in its electric backhoe.

The equipment manufacturer was too far along in its design phase to change the hose performance specification and routing, but may consider doing so on future machines — especially those with space constraints — now that it knows about the flexibility possible when using the two-wire braided hose. This aspect can be taken into consideration earlier in the design process and therefore taken better advantage of if desired.

In addition, Danfoss said the OEM is looking at other applications in which it may be able to use the EC881 braided hose in place of four-wire spiral hoses.

"It's a breakthrough, in my opinion, because we've taken the industry norm of four-wire spiral hose — which is perceived as stronger and more durable — and come out with a product that still meets those requirements, but in a lower-cost hose construction," concluded Travis DeBoer, senior account manager, Danfoss Power Solutions. **P&M**

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4 Tips for Maintaining Hydraulic System Safety

Martyn Smart of Pirtek outlines four strategies to follow to ensure safety when working with hydraulic machines.

by Sara Jensen, Executive Editor

MACHINES POWERED BY hydraulic components and systems can be found in a range of applications and industries from construction to manufacturing and even amusement parks. However, care is required when working with these machines because of the high pressures at which hydraulic systems operate.

Martyn Smart, Group GHSE Manager at Pirtek, has outlined the four key tips and strategies that can be followed to ensure safe use and maintenance of hydraulic-powered machines.

1. Routine Inspections and Maintenance

Despite the durable design of hydraulic hoses and other components, the extreme pressures they endure on a repeated basis can cause damage and degradation over their lifetime. If not monitored on a routine basis, downtime and safety issues can occur.

Following a consistent maintenance schedule or employing preventative maintenance practices can help avoid these issues.

According to Smart, some may opt for easy fixes such as 're-ending' where the last few inches of a hose are cut off and replaced with new fittings to extend their lifespan. However, this does not truly fix the problem and could lead to further issues down the line.

Instead, working with someone — either in house or an outside supplier — who is trained in maintaining hydraulic components and systems will ensure potential failings are properly identified and fixed to mitigate larger problems from occurring.

2. Train Technicians to Industry Standards

Hydraulic systems are known to be complex, requiring a wealth of knowledge to understand how they work and can be maintained. As such, companies with hydraulic technician teams should do their best to have personnel properly trained and certified to work with hydraulic systems.

Helping technicians stay up to date on the latest technologies and standards will help to ensure they can safely and accurately address any potential maintenance issues.

Employing preventative maintenance programs on hydraulic systems helps to ensure a downtime failure or safety issue is detected before it occurs. 109278276 © Industryviews | Dreamstime.com

3. Provide Workers with Physical and Mental Wellbeing Programs

Smart states that working with hydraulic-powered machines and the hydraulic fluid which runs through them can be a challenging occupation due to the high temperatures and pressures of the fluids as well as often confined spaces in which it is necessary to work when replacing components.

He also notes that many hydraulic technicians work alone. This and the safety concerns associated with the job can impact personnel's physical and mental well-being.

Supporting these workers on a physical and emotional level not only benefits their overall health and safety but that of the workplace as well. When they are feeling well, they are able to perform their job accurately, which leads to a safe work environment for others as well.

4. Seek Out Support from Hydraulic Industry Specialists

For those who may not have on-site technicians for their hydraulic machines or need additional support, it is always a good idea to seek out specialists with knowledge and expertise of hydraulic components and systems.

Doing so helps to ensure proper monitoring and maintenance is performed on hydraulic systems, and thus safety is maintained in the workplace. And with the ongoing skills shortage challenging many industries, including those served by hydraulics, it will likely become even more important to know which industry specialists to reach out to for help with maintaining hydraulic systems. P&M

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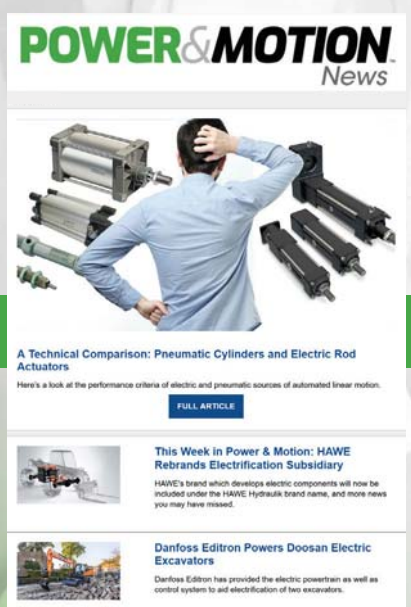

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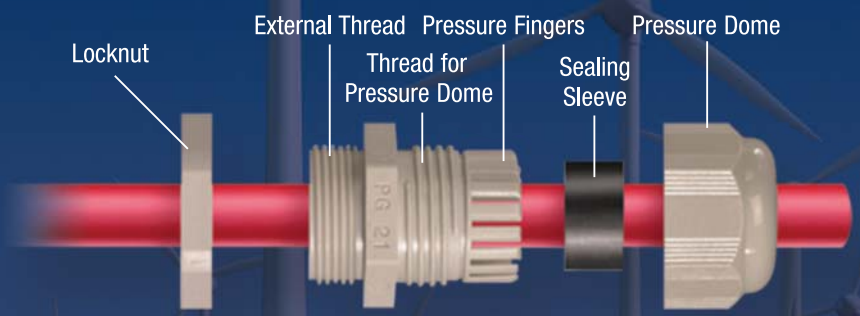

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