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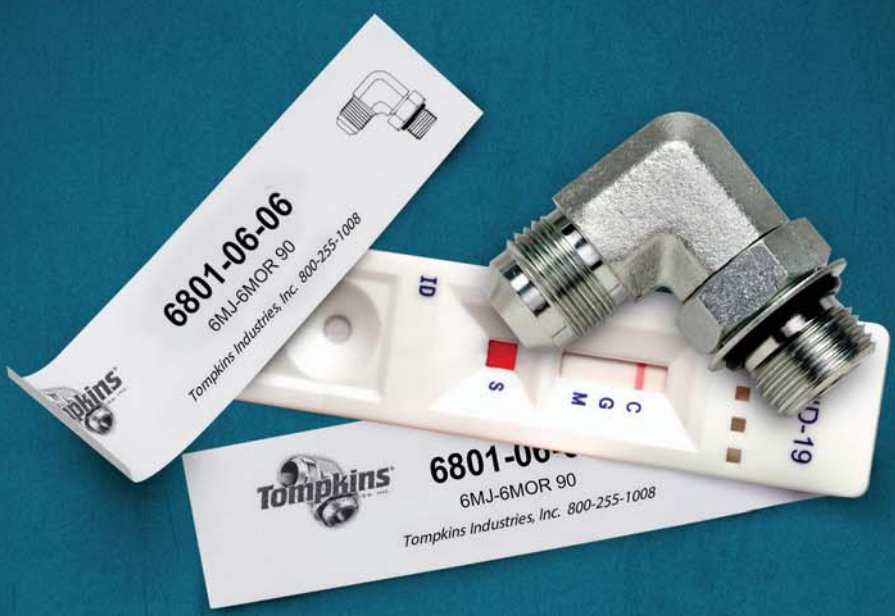

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Editor's Page

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What Did We Learn?

AS WE POKE our heads out into the partly sunny, vaccinated world of the post-pandemic era, there is an itch to get back to whatever normal now looks like. For many of us, that largely revolves around once again seeing people in three dimensions. We will be re-establishing, carefully, our face-to-face (and for a while yet, mask-to-mask) relationships, including our IDEA! Conference in Cleveland in November.

Once that is done, we should spend some time contemplating the answer to one fundamental question that will guide us in our path forward:

What did we learn?

I won't attempt to answer that in the larger geopolitical sense. Confining ourselves to our business at hand, what did we learn about our professional work and our professional colleagues? Despite the COVID surges and the economic challenges that ensued, we have emerged from all of this changed, and yet still remarkably the same in many ways.

One thing is for sure—we are more resilient that we might have expected. With an attitude that focused on solving our problems, we created new ways of doing our jobs, and developed new channels to get to the materials we needed to complete our jobs.

We relied on digital technology—not as a fad or a test, but as the way forward in our businesses. The Digital Transformation took hold in the last 14 months and showed us new things about our work, and our workforce—more than we might have suspected.

We innovated out of necessity, and with innovation we found the capacity to change as rapidly as needed to meet the immediate challenge. It's only now that we can step back and observe that rate of change that we can truly appreciate how much change has occurred, both in our systems and in ourselves.

Not everything worked, of course, and among those things that we learned is what to keep amid all of that change, and what ideas we can discard. Still, the timeline for trial and error was much shorter than if we had time to ponder such change.

It is too hopeful to say that we profited from this shared global experience. Too many walls and barriers remain. But we did our best to meet and exceed the individual challenges we faced each day, and that is something we can be immensely proud of.

But those are my answers to the question. Every organization should take the past year as a chance to see where we can find success and value for the future or our work. At every inflection point of change in our history we have seen our teams take a deep breath and get on with the business at hand. In change we find a fresh perspective, an incentive to grow and to get better at what we do.

What did we learn? Certainly more than we wanted to. But that lesson also begs one further question: What's next? hp

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News

Hydraulic Presses:
MATCHING ENERGY TO WORK

by Peter Nachtwey

Hydraulic presses are usually rated by the amount of force they can apply. Force is required to form the work pieces, but so is energy. One important part of press control is controlling the force that is required to form a part, and this means controlling the energy also.

There can be two extremes for forming parts. In one extreme, the press closes on the part and makes contact at near 0 speed, then builds pressure/force until the part is formed. This works, but time and energy are wasted; energy is wasted slowing down the press to near zero speed, and time is wasted because it takes time to build force in the cylinder(s).

The other extreme is to use kinetic energy to form the parts. Since it takes the integral of force times distance to form the part, this can be easily accomplished by matching the amount of kinetic energy to the amount of work required. Matching the kinetic energy to the work that needs to be done doesn't waste energy slowing down to near stop, and it doesn't waste time because there is no need to build up force to form the part.

Ideally matching the kinetic energy to the amount of work that needs to be done would be the best way to form parts. However, matching the kinetic energy to the work needed is difficult because the amount of kinetic energy an object has is a function of the velocity squared. This means there must be precise velocity control at impact. For optimum throughput, it is best if the press platen/slider comes down quickly, then decelerates to the precise speed that will result in the right amount of kinetic energy being delivered.

There are a few difficulties with this. First, presses expand due to thermal expansion so the exact position of contact will change during the day. This means that having the exact speed and the position of impact will vary. The press controls need to be adaptive by changing the deceleration position. This way, the impact velocity will be correct at impact even if the position changes a bit.

Another constraint is the deceleration rate. Since most presses have the cylinder rod pointing down, there is much more area on the top of the piston than on the bottom, so it is easy for the cylinder to cavitate while decelerating. Some presses have fill valves that allow oil to be "sucked out" of an oil tank at atmospheric pressure into the cap side to solve this problem.

A common question is, "Do I need to re-tune the controller when the parts change?" The answer is generally no. It isn't the press that is changing, it is the amount of energy required to form the workpiece or the position of impact. Generally, the amount of energy required to form a type of part is pretty much the same from part to part, so once the correct impact speed is determined for a given part, the impact speed should be recorded so the next time the part is being made the correct impact speed can be set up quickly. The hydraulic controller should not need to be tuned.

Another constraint is the response time of the servo valves controlling the press cylinders. Hydraulic servo valves are fast, but not faster than the potential force spike. A high-speed impact may be over in a few milliseconds which is faster than most hydraulic servo valves can respond to even if the sensors and controller are fast enough. If the workpiece is not very compliant then the rate of change in force can be too fast for the servo valve to respond and control. Therefore, the impact speed must be reduced to match the required work that must be done. Even so, the servo valve will still be open so it will add still more energy in the form of hydraulic pressure to the system. So in reality, kinetic energy can be used for most of the required energy for forming the workpiece, but hydraulic pressure is still required for the fine adjustment or control.

One addition to a press that would make it easier to control is to add a cushion. Mechanical presses often have hydraulic cushions, but a hydraulic press should be able to use a hard rubber mat for a cushion. The idea is that both the workpieces and the mat will absorb some of the energy of the press. While the press must move a little farther to compress both the workpiece and the mat, the valve has more time to respond. This permits better control and consistency at the expense of a bit of wasted energy that goes into the hard rubber mat.

In short, press control is not simple. There are a few things like pressure, impact speed and cushions that have their advantages and disadvantages, depending on the trade-offs one is willing to make.

PETER NACHTWEY is president of Delta Computer Systems, Inc.

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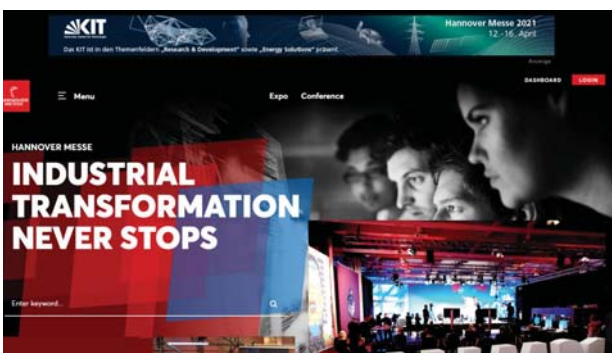
Hannover Messe Adapts and Changes

by Bob Vavra



As a session on artificial intelligence at Hannover Messe's 2021 virtual event, Prof. Dr. Sepp Hochreiter, the head of the institute for machine learning at JKU Linz, talked about the emergence of AI, and how it still is in the earliest stages of adoption in industry.

On Hannover's virtual event platform, Hochreiter told the global attendees, "You want to build a basic knowledge with your database, and from this basic foundation, you try to learn and adapt to a new situation."

That's exactly how Hannover Messe officials viewed this year's event. With global travel and gatherings still stifled by the COVID-19 pandemic, Hannover officials had to scrap the in-person event that annually draws about 200,000 individuals in favor of a digital presentation. If the smell of bratwurst cannot yet be recreated on a digital platform, the knowledge still offered attracted a crowd.

The discussion of digital manufacturing on a digital platform attracted a lot of attention. Hochreiter said the subject of AI deserves more attention from industry leaders. "The manufacturing industry, mechanical engineering, plant engineering, etc.—this is where AI is going to be injected," said Hochreiter. "AI systems need to get millions of input data, millions of images, thousands of words that it needs to learn first. But in industry, you can't wait that long."

Some companies are not waiting. At another discussion at the show, officials from Bosch and Estee Lauder discussed their journey to digital manufacturing. "You need to be hyperconnected," said Bernd Heinrichs, executive VP and chief digital officer of mobility solutions at Bosch. "You need to leverage what you get out of it and put it into data so you can make data-driven decisions."

Domenic Tota, executive director, global infrastructure engineering at Estee Lauder, explained how a clear governance model could help IT/OT convergence, which also started with its employees.

Thomas Fechner, senior vice president, new product area business for Bosch Rexroth accepts the 2021 Hermes Award on the opening day of Hannover Messe.

"We can draw from past experiences when other technologies converged," he said. "There were a lot of lessons learned from the early days where if people did not collaborate and teams did not work together, there were a lot of failures."

There were 90,000 registered attendees and more than 10,000 products presented at this year's digital event. Among the most prominent products was Bosch Rexroth's SVA R2 (Subsea Valve Actuator), the world's first electrical actuator for controlling process valves under water. It received the prestigious Hermes Award, presented each year for outstanding achievements in global product development.

"Bosch Rexroth is a longtime exhibitor at Hannover Messe and always impresses with its innovations. The winning product is another milestone and stands for high-tech in connection with environmental protection. The company is thus making a major contribution to sustainability, one of the key topics at the Hannover Messe Digital Edition," said Dr. Jochen Köckler, CEO of Deutsche Messe AG.

While everyone associated with Hannover Messe is hoping for a return to the fairground in 2022, some of the changes seen at this year's event are likely to remain part of the future of the show, Köckler said. "The Hannover Messe Digital Edition demonstrated the innovative power of mechanical engineering, electrical engineering and IT companies. At the same time, it showed that the trade show of the future is hybrid," he said.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BRINGING LEGACY MACHINES into the 21st Century

by Adam Justice

By the end of last year, there were an estimated 11.7 billion Industrial Internet of Things devices in the workplace, according to market research firm IIoT Analytics. This is a sure sign machine makers recognize the value of IIoT. But there are also lots of legacy devices still in the field, and companies could benefit by using data collected from these non-IIoT devices. Currently, much of the information available to industrial motors, centrifugal pumps, commercial kitchen equipment, motors, hospital equipment and furnaces just gets lost.

Turning these legacy, non-connected devices into IIoT-enabled machines could give factory managed safety and maintenance several benefits. First, it would let managers and supervisors turn off machines or set them to turn off based on the facility's operating hours. Another benefit would be determining what a machine's normal power consumption looks like and comparing that to actual use. If it's too high or too low, it might indicate the need for maintenance. Managers and supervisors who cannot predict outages or part failures can wind up losing several thousand dollars or more per day while technicians try to diagnose and fix the problem.

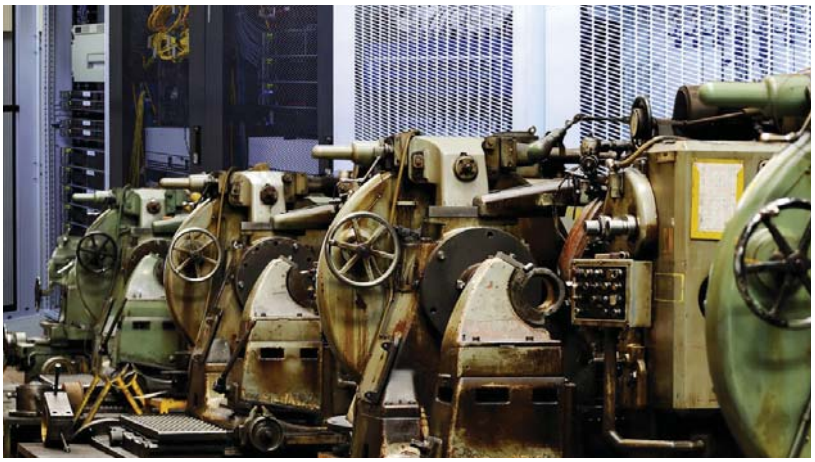
For machine makers, there's a potential revenue stream from legacy machine data: It lets them sell a service contract to monitor the equipment, not only telling the machine owner when to service the equipment, but also providing technicians who can handle the task outside times of peak use and prevent shutdowns during business hours.

Connecting legacy machines to the cloud moves a manufacturer closer to the customer because there's a stream of data about real-time use. That data, in turn, helps engineering departments design better products. As data streams in from the field, engineers and product development teams can see which features or add-ons are widely used or rarely tapped.

How can machine and equipment builders get actionable data from legacy machines? Among the tools required would be a data transfer protocol such as MQTT, CoAP or XMPP. Programmers designed these for machine-to-machine (M2M), applications.

With a protocol, an AC power connection to a machine and a local Wi-Fi access point, a machine designer could gather and record real-time voltage, current and power factors of the

load. That connection could provide high-resolution profiles of the voltage and current wave forms that would let a machine manufacturer track customer use and, in some cases, sign of approaching failure. Engineers could use the on-off cycle counts and powered-on time for the attached load for checking warranty information and exploring preventive maintenance.



A machine maker could also monitor events such as current, voltage, low power factor, temperature and excessive load time. By setting up parameters for these parameters, the company could also use data to trigger user- or manufacturer-defined alerts that sends off texts or emails to notify machine operators or owners in advance of a failure.

Data streamed from a legacy machine connected to the cloud might reduce the cost of supplies or lead to better maintenance. Real-time data could reduce downtime or eliminate trips to remote locations. Making legacy machines internet-ready could save machine owner energy (and money) by turning power on and off as needed, rather than having the machine run constantly. Perhaps most importantly, machine designers and owners could predict failures of parts and anticipate when to schedule maintenance.

ADAM JUSTICE is CEO of Grid Connect, Inc.

BY MICHAEL RUSSO | Emerson
JEREMIAH NEWTON | Motion

Pulse Valves: An Efficient Solution

Imagery courtesy of Emerson

Dust collection systems benefit from lower energy and maintenance costs.

In almost all industries, dust and particulates come with the job. But if they aren't effectively removed or collected, these contaminants can harm workers and damage equipment. And when contaminants are combustible, facilities may not meet related NFPA regulations or pass OSHA inspections. From automotive to concrete and mining to pharmaceuticals and beyond, facilities depend on dust collectors to improve air quality for employees and machinery.

By providing clean air that is essential to a safe working environment, a dust collector's performance and efficiency directly affect a facility's overall efficiency. Because of this importance, OEMs and end-users constantly seek new ways to improve these systems. Specifying components with beneficial qualities and features makes a difference.

But which components can make the biggest impact? Let's think about how dust collectors work.

As a dust collector operates, its filters catch dust. This accumulated dust forms a dense cake that can block filters and decrease system efficiency. In reverse pulse jet dust collectors, a reverse jet bag filter cleaning system delivers a burst of compressed air that sends a shockwave through the filters, breaking up dust cakes. The dust then falls out of the collector and into a hopper. By effectively clearing dust from filters, this system improves filter and overall system efficiency, and extends filter life.

In a practical example, most aggregate applications use a dust collection system to collect aggregate particulates produced from crushed limestone. The collected particulates are then sold in bulk for a significant return of investment, which is one of the many ways the aggregates industry maximizes efficiency and maintains quality. The crushed limestone dust particulates are then used to produce a byproduct called self-consolidating concrete. This resulting concrete mixture has a higher flow rate, and its coarse aggregates don't separate from the cement's adhesive properties. This helps to keep the concrete strong while making it easier to work with in many different construction applications.

So what makes the reverse jet bag filter cleaning system effective enough for even heavy-duty aggregate applications? The critical component that delivers the high burst of compressed air that ultimately cleans filters is a pulse valve.

DUST COLLECTOR EFFICIENCY

The number of pulse valves needed depends on dust collector size. Some dust collectors may have a few, while others can each have 50 or more. But no matter how many pulse valves a dust collector has, they operate in much the same way: A line of pulse valves activates in sequence to remove dust from filters. The pulse frequency depends on application needs.

The latest pulse valves are designed to extend component and system life, make installation and maintenance easy and reduce air consumption. To access these efficiency benefits, it's important to prioritize five features when specifying a pulse valve for a dust collector system.

1. High Peak Pressure

Ultimately, the most important feature when specifying a pulse valve is peak pressure. Peak pressure determines the speed and power of the compressed air burst, which is what cleans the filters.

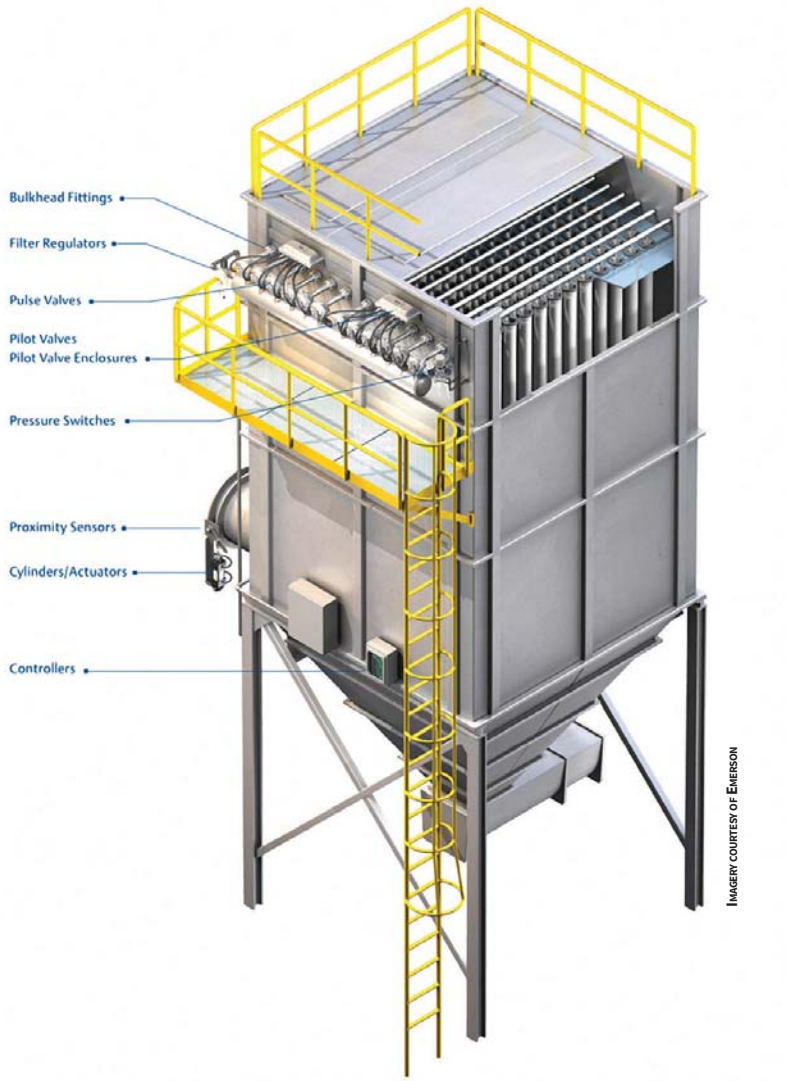
A pulse valve must provide optimal peak pressure to effectively break up and remove dust cakes from filters. A pulse valve with inadequate peak pressure won't be able to break up caked dust, leaving residue on filters. This residue makes the filters and the overall system less efficient and increases filter maintenance and costs. On the other hand, a pulse valve that provides too much pressure can prematurely wear or even tear filters.

Most aggregate dust collection systems use a baghouse containment system that consists of multiple filter bags that collect particulates for recycling. If the peak pressure is simply too strong or too weak, or if the pulse valves installed are undersized or poorly maintained, these filter bags can be damaged, resulting in expensive downtime and unnecessary filter replacement costs.

To maximize peak pressure, using a pulse valve with an extremely fast response time, which is the amount of time it takes the valve to open and close, is always preferred. Some valves on the market have a very short response time, opening between 8 to 14 milliseconds, and therefore save on expensive compressed air.

While conventional pulse valves use closing springs, these specialty pulse valves use a one-piece diaphragm that allows airflow to travel underneath the diaphragm rather than over a wall, resulting in less restriction to the flow and increased air speed. The single-piece design offers up to a 14% increase in peak pressure over legacy pulse valves.

Pulse valves that hit high peak pressure quickly deliver the burst of air that enables filters to do their job more effectively, increasing the efficiency of the dust collector's overall performance and the overall cleaning process. Filters can also be changed less often, reducing maintenance and related costs. Depending on how many filters it has, a plant can see significant savings.



The quality and performance of a dust collector's pulse valves make a remarkable difference in the overall system's performance and efficiency.

IMAGERY COURTESY OF EMERSON

The quality and performance of a dust collector's pulse valves make a remarkable difference in the overall system's performance and efficiency.

2. Fast Valve Response Time

Pulse valves that open and close quickly do even more than improve filter cleaning; they also use less compressed air. Compressed air, one of the more expensive processes used in manufacturing, is used in the jet of air during filter bag cleaning.

A pulse valve with a slow response time remains open longer and uses more compressed air. This unnecessary cost is magnified the more valves a dust collector has. In comparison, the extremely short valve response times and high flow of single-piece diaphragm design consume about 15% less compressed air than standard pulse valves in a dust collector with 40 valves. Considering that some facilities with many dust collectors can have up to a thousand pulse valves, this can be a significant opportunity for savings.

When selecting a pulse valve, it can be helpful to do a cost analysis on compressed air consumption costs. Some valve manufacturers have formulas, charts or tools available online or offer consulting services. Like filter savings, compressed air savings can be substantial when multiplied across an entire plant.

3. Quick and Easy Installation

For OEMs and end users alike, installation takes time. When specifying pulse valves, it's important to consider how complex their installation process will be. Do they require special tools or skills? Do they have a lot of parts that need to be assembled? The more complex valves are to install, the more time and labor costs they will consume.

To reduce installation time, it's important to consider a valve's connection and part count. Conventional valves have threaded or dresser connections and a spring-loaded diaphragm. There are some pulse valves, however, that have a quick-mount clamp connection with a single-piece diaphragm—this type of connection requires no special tools or additional sealing and connects to pipework more easily and quickly than threaded and dresser connections. Compared to other connection types, the quick-mount clamp reduces installation time by 60% and provides a more secure connection.

4. Quick and Easy Maintenance

Like it services any other piece of equipment, a plant with dust collec-

REDUCE MOISTURE TO ENSURE PULSE VALVE RELIABILITY

MOISTURE IS A dust collector system's worst enemy. OEMs and end-users can have the absolute best and most efficient pulse valves and sophisticated operating systems in place and *still* get taken down from the smallest amounts of water within their systems.

Before implementing a dust collector system, it's very important to be aware of moisture and how it affects the pulse valves' reliability. It's not enough to only check for leaks or signs of corrosion on steel structures. Atmospheric or frictional-related temperature changes can produce condensation and cause a long list of adverse effects on an entire dust collection system. Fractional amounts of moisture can cause particulates to cling together; having a properly designed pulse valve system is critical.

Consider implementing airstream monitoring devices. A temperature change of approximately 15°F or more could indicate condensation within a dust collector system. A desiccant or refrigerant dryer can also be installed into a pulse jet cleaning system to assist with removing moisture from the compressed air system.

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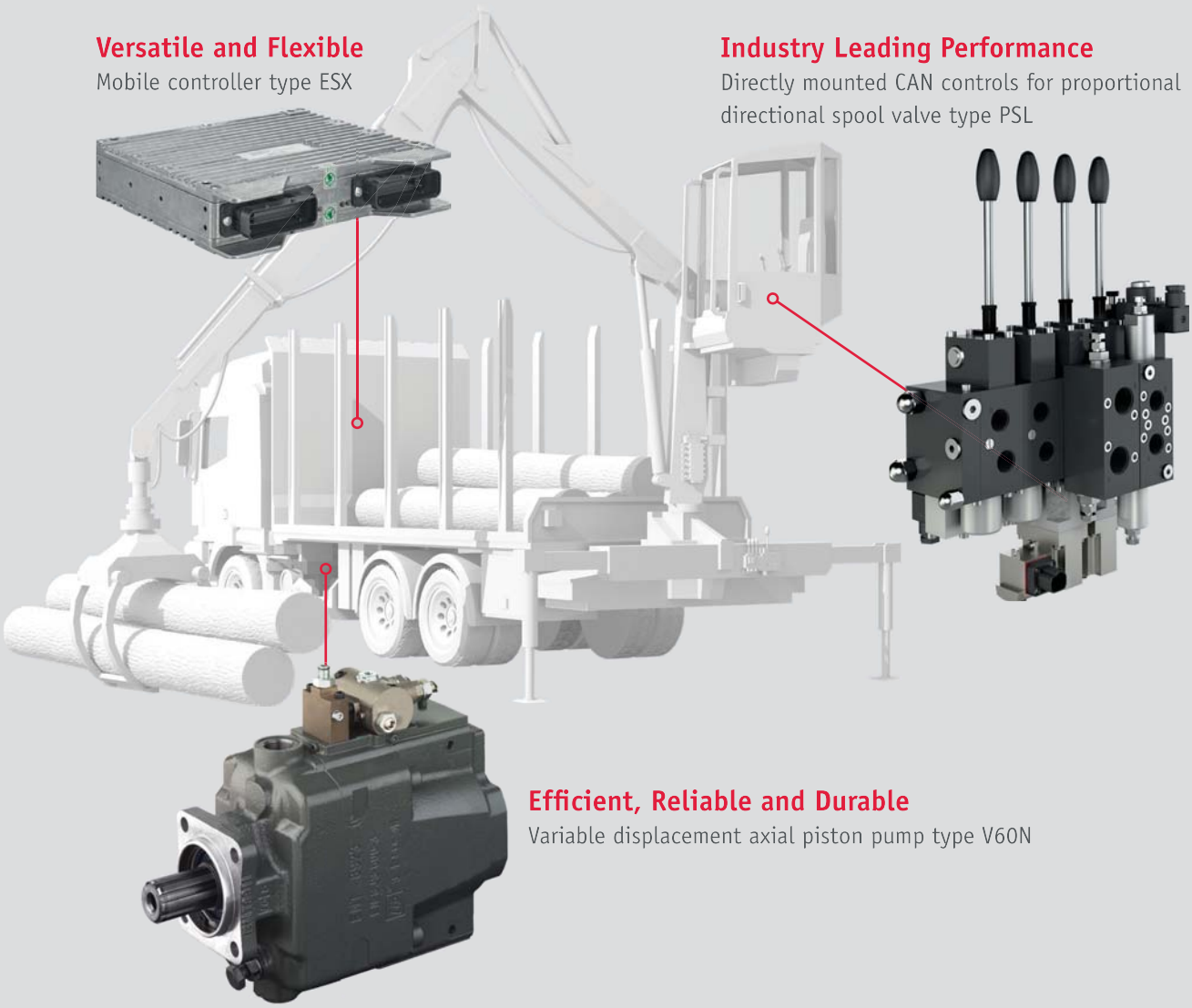

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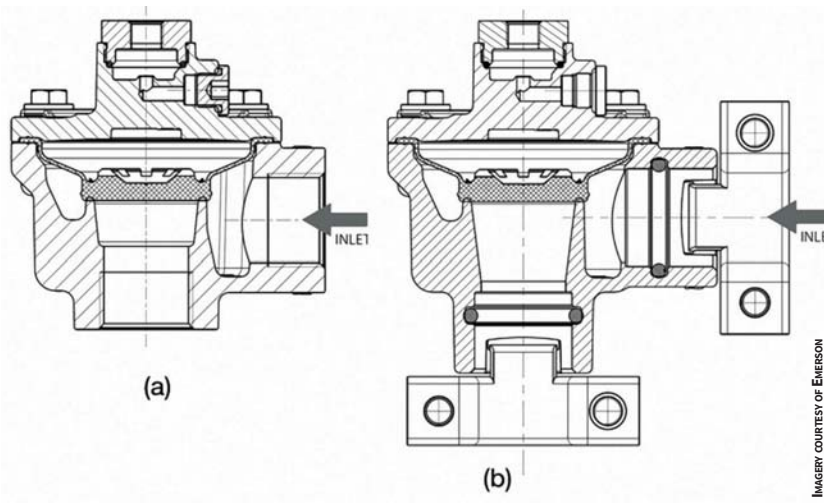

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A pulse valve's connection and part count determine how much time it takes to install. The patented quick mount clamp connection reduces installation time by up to 60% compared to dresser and threaded options. Pictured: (a) Standard threaded pipe connection; (b) Quick mount clamp connection.

tors must perform regular maintenance on these systems to avoid costly plant shutdowns. But even if a downtime is planned, it needs to be as short as possible. It's in a plant's best interest to select a dust collector with pulse valves that are fast and easy to maintain.

To keep annual maintenance time short, it's important to consider how many parts a valve has as well as how durable it is. Disassembling and replacing more parts requires more time, especially in facilities with a high pulse valve quantity. Conventional pulse valves often have washers, islets, rivets and diaphragms. The pulse valves with a springless, one-piece diaphragm design have only one part to service, greatly simplifying and speeding up maintenance. Valves with fewer parts and a rugged construction also have longer life spans, with over one million cycles.

5. Wide Temperature Performance Range

Some industries—like mining, cement and metalworking—operate in extreme conditions, and many industries that use dust collectors make their homes in locations that experience

plunging temperatures. In these environments, dust collectors that use valves that operate in a limited temperature range are at risk of early failure, and therefore unplanned downtime.

In order to ensure dust collectors can operate in all environments they're needed in, it's important to look for reliable valves that offer long-term operation in an extreme range of temperatures.

Some manufacturers offer valves that perform in temperatures as low as −40°F (−40°C) and as high as 284°F (140°C). Equipping dust collectors with valves that provide long-term operation in an extreme range of temperatures ensures fewer valve failures and higher system efficiency.

PULSE VALVES IMPROVE PERFORMANCE

Knowing which features to look for in a pulse valve is the first step toward building a better dust collector system, but the second step is knowing what to look for in a supplier. The right supplier should have the knowledge, support and portfolio that makes building a better dust collector easy.

In addition to pulse valves, it's important that suppliers have a complete range of dust collector solutions, including monitoring and diagnostic options, that meet all certifications, ratings and approvals. To keep your processes moving, find a supplier that offers quick shipments and short lead times. Consistent technical support is also essential—an expert and qualified source to answer questions, troubleshoot issues and provide recommendations.

In the often-harsh environments where they operate, dust collectors protect the health and safety of employees and equipment. Pulse valve performance can make a remarkable difference in the overall dust collector system's performance and efficiency.

Pulse valves with high peak pressure and fast valve response time will more efficiently clear particulates from the air, while reducing expensive air consumption. A longer pulse valve life and a faster, easier installation will lower plant costs. By taking these features and benefits into consideration, OEMs can deliver more value to their customers. End-users can see the results in cleaner, healthier plant environments and more efficient operations. hp

MICHAEL RUSSO has been with Emerson since 2007 and is the product marketing manager of dust collector systems. In this role, he leads Emerson's industrial marketing direction and strategic vision for dust collector systems.

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Getting the Right Stepper or Servo Motor for Electric Actuators

As usual, the needs of the application play a major role in determining which is the best type of motor to use.

Here are two servo motors and a stepper motor.

As the shift to automation continues to gain momentum in the industrial sector, servo motors and stepper motors with electric actuators become ever more important. When selecting a motor for an application, it is the functions that are important, not necessarily the construction.

Here's a look at servo and stepper motors' characteristics as they relate to linear motion. (Brushless DC motors will be considered servo motors for this article.)

TORQUE VS. SPEED

Servos have a constant torque over their total usable range of speeds. So, if a servo motor has 1.2 Nm of torque at 10 rpm, then it also has 1.2 Nm of torque at 3,000 rpm.

Steppers on the other hand, have their maximum torque at low or zero speed and it falls off quickly at the much lower speed of a servo. If a stepper has 3.4 Nm of torque at 1 rpm, it is not unusual to see a drop to 0.2 Nm at 1,200 rpm.

Engineers should look at each motor's torque curves to select the proper size motor for an application.

Servos go faster than steppers no matter what the torque is. In some applications, this lets a gearbox be used with a servo to increase the torque for the application. The gearbox multiplies the torque by its ratio and the motor rpm will go up by the same ratio. Engineers should be careful not to exceed the motor's maximum rpm.

For example, a motor with a torque of 2.3 N m at 500 rpm when used with a 3:1 gearbox will have a 6.9 N m output, but the motor's rpm will climb to 1,500 rpm to drive the gearbox. Steppers' higher torque and lower speed curve generally mean they will not use a gearbox.

FEEDBACK

Steppers are generally open loop. Position is determined by the number of steps or pulses given to the motor for it to rotate. The total number of steps equals the motor shaft's amount of rotation or rotations. If a pulse is missed or the motor cannot move after the pulse because it lacks the power to rotate the shaft, then a position error is introduced but the motor/drive does not know it.

This can be a problem in some applications and is taken care of by re-zeroing the system back to home. Also, an external sensor or encoder (rotary device

mounted to motor that outputs shaft position) can be used.

Servos, on the other hand, are inherently closed loop and use an encoder. Using an encoder lets them constantly monitor their position, current and speed versus what the motor has been told to do. If position falls behind, the controller can increase parameters to catch up. As such, the motor is always under control. If it cannot catch up, the controller knows it and will generate an error alert to make the problem known.

Automation engineers are a good resource when designing complete systems and they can offer more details specific to an application.

LOAD HOLDING

Actuators often need to hold position at zero speed. How this is done by servos and steppers differs and often not considered by designers.

A stepper, as noted above, has maximum power at zero speed. It will hold this position with full torque until another pulse is received telling it to move. It is open loop with no feedback. As long as the holding torque is enough, generally sized for 50% more than needed, this can be ideal for holding a load at a standstill.

If the stepper is not sized correctly and the load changes, the motor can stall, and pulses are missed. There is no feedback for this, so there ends up being an error in positional accuracy. However, steppers are the most economical solution, and in low-speed applications they deliver more torque than a servo.

A servo does not use the same procedure. Instead, it monitors the encoder to stay at a zero-speed position. Usually, a programmed plus and minus window is used to define In Position. This means the motor is told to move back to a position when the controller sees a difference that puts it outside the In Position window. This movement must be planned for in critical applications by using motor resolution that is more than the application needs, so that position hunting or dither is not seen by the actuator rod or carriage.

Servos can usually generate up to three times their constant torque for a short period. This gives them reserve power needed to compensate for load changes without being greatly oversized. The servo monitors the encoder position and can increase speed or current to get back in position when it sees a difference.

ACCURACY AND REPEATABILITY

Both motors are generally accurate and repeatable enough for most industrial linear motion applications, mainly because of a gear reduction. This can be the ball screw's pitch or a gearbox giving advantage of more position counts on a measured linear position. Remember, these actuator applications typically use belt or screw drives. A 1,024-count encoder used with a 5-mm pitch ball screw has a control resolution of 0.005 mm per count (5 mm/1024 = 0.005 mm/ct.). For general industrial application, this is normally very good and can easily be increased if needed.

These resolutions need to be calculated for each application, but any required positional resolution can be done for most industrial applications.

MOTOR SELECTION

Here are some general guidelines for choosing between steppers and servos:

- If low cost is needed, a stepper is a good choice.
- If loads are unpredictable and create extra torque requirements, a servo is a good choice.
- If complete reliability even with power loss is needed, a servo should be chosen.
- If it's a low speed or low torque application, a stepper should be used.

Engineers may need to go through the specific characteristics of the motors and look at the pros and cons of each for applications they are working on.

However, if there is no clear choice on motor type because features of both steppers and servos are needed, perhaps a stepper with servo control is a good option.

There is also a new type of motor being used: the hybrid stepper. The ServoStep motor offers the benefits of steppers and servos by having some characteristics of both. They provide a closed loop on the stepper motor to get some of the advantages of the servo control.

Stepper and servo motors offer a wide array of features that can benefit specific applications. The key is understanding what the application requires and selecting a motor that best meets application requirements and complies with engineering specifications. While this article offers the basic information needed to choose the motor type for an electric actuator application, there are also other elements needed to complete the system. These include a drive/controller, smart controller, serial or discrete control, and proper sizing for the application.

Automation engineers are a good resource when designing complete systems and they can offer more details specific to an application. hp

ED HESS is a senior automation engineer at Flow Products Inc.

DAN PHILLIPS | Regal Beloit Corp.

Leveraging Sensor Data to Manage Assets

When you can see the temperatures of motors, the speeds of conveyor belts, and the vibration levels of bearings and gearboxes, you can predict the future.

Monitoring, recording, analyzing and reporting the performance of equipment in manufacturing and production facilities or distribution centers (DCs) lets companies improve operations and reduce costs. Connecting and tracking equipment with advanced sensors and other Internet of Things (IoT) hardware and software also help maximize the benefits of preventative maintenance programs.

But to enjoy all those benefits, companies need to do some old-fashioned legwork.

SO MANY ASSETS, SO LITTLE TIME

The first step in effectively implementing a proactive maintenance program at a facility, as well as intelligent diagnostic services and predictive approaches, is for companies to identify every machine and system in a facility. They should also locate and count every spare part, each replacement unit and all the consumables sitting in inventory for maintenance and repairs. Depending on the size and complexity of the plant or DC, there could be tens of thousands of stock keeping units (SKUs).

That's a big job, one best handled with cloud-based software. This software tracks, reports, communicates and shares performance data for supporting preventative maintenance. It also lets companies better manage the spare parts and components needed to keep production and distribution operations on schedule and within budget, as well as a wide variety of other tasks.

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None of that can happen, however, without first completing a thorough asset inventory. And none of the data generated by sensors installed on production and distribution machinery will make much sense if companies haven't decided how to manage maintenance processes and all those SKUs for repairs and replacements. Few companies or plant managers want to just buy data from a sensor. Ultimately, that data needs to do something to improve operations.

Companies need to make an inventory audit and record appropriate for the scale of their operations. There are ways to mark every asset with a QR code during the audit. Later, technicians can scan QR codes to correctly identify units and minimize errors. This lets them get the right parts at the right time to maintain safe and productive operations. An accurate and accessible inventory, combined with condition monitoring, lets users remotely identify equipment problems, respond if equipment has a problem or act before there is unplanned downtime.

These types of programs also facilitate the standardization and improvement of maintenance, repair and operations (MRO) inventory by minimizing the number of SKUs. This lets companies get replacement equipment faster and installed during scheduled maintenance times, reducing costs and downtime.

AUDIT INVENTORY AND WHAT'S ESSENTIAL

The first step, however, is for companies to understand what parts they have and where they are. That's accomplished by completing an old-fashioned inventory audit. Then companies can categorize and codify the different machinery, parts and pieces, and decide what's essential to keep in inventory to support operational targets and financial objectives. Questions to ask include:

- Which units must be in inventory?
- How can these units be standardized?
- How can the number and variety of units be reduced?

Companies of all sizes can execute this initial step. It doesn't require sensors connected to individual equipment or networked to an IT infrastructure. Begin with a simple survey of what's in inventory and tag each item with a QR code. These actions alone can yield significant savings. Technicians will spend less time walking or climbing to find equipment or parts.

Step two is to invest in putting sensors on equipment and adding them into an enterprise resource planning (ERP) system or cloud-based intelligent software for analysis and reporting. Storing informa-

tion about each SKU in inventory along with "how to service" or "when to replace" instructions make vital information readily available to technicians and help reduce maintenance and repair costs and downtime. If there is no IT infrastructure, sensors can be connected using cellular technologies.

There are ways to mark every asset with a QR code during the audit. Later, technicians can scan QR codes to correctly identify units and minimize errors.

TRUE VALUE OF DATA

Creating a sensor network will not give operations managers or technicians the insights needed to make well-informed business decisions. The sensors by themselves just generate a bunch of data. That's why the initial inventory audit to determine how the data will be used is so important.

To realize the most value from investments in sensors and intelligent asset management software, companies must assess the importance or criticality of each piece of equipment, part or SKU in inventory. Knowing the operational aftermath if a part fails and causes unplanned downtime can lead companies to understand how much data really is needed from a sensor. Examples include:

- Will the company continuously stream data 24/7 because an operation is so transient, or are there different operators controlling the equipment and the company wants to see continual changes?
- Can the company pull data samples from a machine four times a day and get more than enough information and insights?
- Or is the equipment generally trouble-free, and the company really only needs to see and understand overall trends and when there are deviations from normal operating ranges?

These questions should be answered in the inventory audit. By doing so, a company can prepare to select sensors and asset software that best match their technologies to the failure modes of its production or DC equipment and the various operating states they go through daily.

Likewise, inventory audits should identify what's important to know about each piece of equipment. Vibration monitoring sensors can detect micro fractures, but does the company need that for a small-horsepower conveyor motor? It may only need to monitor the motor's temperature and then alert technicians when it exceeds a certain range. Then they will know it's time to change out the motor.

IoT technologies can monitor equipment vibration, temperature, belt speed, lubricant and motor current. The resulting real-time or near-real-time data and insights they generate can be used to streamline processes and provide unprecedented access to engineering and design information. They also can help in training, installation, repair and support services, all of which adds up to new capabilities to avoid disruptions to operations and related costs. hp

DAN PHILLIPS is technical director of monitoring and diagnostics at Regal Beloit Corp.

ANDREW ZASKE | Tolomatic Inc.

Comparing Electric and Fluid-Power Actuators

Why are electric actuators increasingly replacing hydraulic and fluid-power actuators in demanding applications?

An electric rod actuator with a ball-screw drive replaced a hydraulic cylinder in a log-cutting operation.

Electric rod actuators are replacing fluid power actuators for many high-force applications throughout industry. Tasks once limited to hydraulic and pneumatic cylinders such as pressing, holding, lifting and spot welding are now handled by electric actuators, in part because of their lower life-cycle costs. What's more, electric actuators' speed, accuracy and flexibility can increase production and make machines more flexible and adaptable.

Here's a look at some of the advantages electric actuators bring to designers and engineers.

ENERGY EFFICIENCY

Electric actuators typically operate in the 75 to 80% efficiency range. In comparison, hydraulics typically range from 40 to 55% in efficiency and pneumatics have efficiencies in the 10 to 25% range. Many factors determine the efficiencies of fluid-power systems, including temperature, pressure, compressor designs, seal integrity and system leaks.

A significant factor in electric actuators' efficiencies is that they only consume current in the drive motor when it is required. When at rest, electric actuators require little, or no (with a brake), current to hold position. Fluid-power actuators, on the other hand, always need pressurized fluid, which is an inefficient use of power.

QUIET AND COMPACT

Not only do electric actuators save energy, but they also save overall space, which can be useful on crowded factory floors. Hydraulic systems require a cylinder, a power unit to provide oil pressure, control valves, filters and other ancillary components. Electric systems only require the actuator and motor itself and a relatively small control cabinet for the drive, which can usually be conveniently located near the point of use.

Power units running fluid cylinders are typically noisy, a nuisance and have the potential to damage the hearing of anyone working or even walking near them. Electric actuators are significantly quieter.

ACCURACY AND REPEATABILITY

Although standard fluid actuators are good for end-to-end stroking applications, mid-stroke positioning is more complicated, requiring a control valve and operator assistance. More advanced servo hydraulic controls can give fluid systems greater precision and repeatability, but at a considerable increase in cost and complexity. Electric actuators offer infinite positioning as a standard, are much less complex and, once programmed, require little intervention or maintenance to remain accurate and consistent.

CLEAN AND GREEN

Leaks from hydraulic systems can create hazardous messes on factory floors. In addition, hydraulic leaks can contaminate key processes; the environment (when outdoors); and products such as food, pharmaceuticals and medical devices. In pneumatic systems, air leaks create unwanted noise, questionable air quality, and wasted energy. Electric actuators have none of these drawbacks.

For example, a lumber-processing equipment company needed to replace a hydraulic cylinder in a log-cutting application to eliminate the potential of hydraulic fluid leaks into the environment. The company chose to go with a Tolomatic electric ball-screw rod actuator with a 42-inch stroke to move the saw blade. It has an IP67 rating,

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indicating the actuator was built to be protected from splashing water and debris. The actuator was also lubricated with a high/low-temperature grease for consistent performance in all weather conditions.

Electric rod actuators come in a variety of shapes, sizes and performance characteristics to fit almost any application. Here are several from Tolomatic, including its (clockwise from top left) ERD, RSA, RSX, IMA and ServoWeld actuators.

MINIMAL MAINTENANCE

Properly sized electric actuators typically require little or no maintenance. In demanding performance applications, electric actuators may need to be re-greased, but it is usually an infrequent, simple and low-cost procedure. Fluid power devices, while typically rugged and easy to deploy, require considerable maintenance as a tradeoff. Air and oil maintenance, for example, are needed to prevent humidity and contaminants from prematurely destroying seals and other system components.

For example, a steel mill recently switched from hydraulics to electric actuators to replace maintenance-intense hydraulic cylinders. But the mill still needed powerful actuators. Pulling hot castings out of the molds required about 15,000 lb of force (66 kN), and whenever castings were left to cool in the molds, it took a peak of about 40,000 lbf (177 kN) to break the casting out of the mold.

The plant managers eventually chose two rod-style electric actuators from Tolomatic and high-capacity roller-screws to reduce maintenance and meet peak thrust requirements. The actuators could deliver the force necessary and carried IP65 ratings which maximized their life in the hot, dirty foundry.

IMPROVE PRODUCTIVITY

Electric actuators can improve overall productivity better than fluid cylinders in many applications. For example, an electric rod actuator might need to go out six inches and return for set-up purposes, and then only travel three inches back and forth for production runs. Fluid actuators, on the other hand, have poor positioning capabilities and can only move the entire six inches out and back, wasting time and efficiency on each cycle. Electric actuators are fully programmable and can be set up to do both six and three-inch runs, thereby saving time and increasing throughput.

In one example, an OEM that made a variety of automotive wheel-bearings and wanted to replace the hydraulic cylinders in the process to improve control and reduce energy consumption, as well as eliminating hydraulic fluid leaks. The hydraulic cylinders were configured to handle different sized wheels, and this meant the operator had to make several adjustments every time a different wheel was going to be sent down the line. This led to lost production time and, sometimes, additional rework.

The OEM switched to roller screws with a servo-controlled electric actuator that could provide up to 17,000 lbf of consistent, repeatable force. The servo controls let the company create quick and easy changeover control program procedures for changing over to wheels of any size quickly with the push of a button.

LOW LIFE-CYCLE COSTS

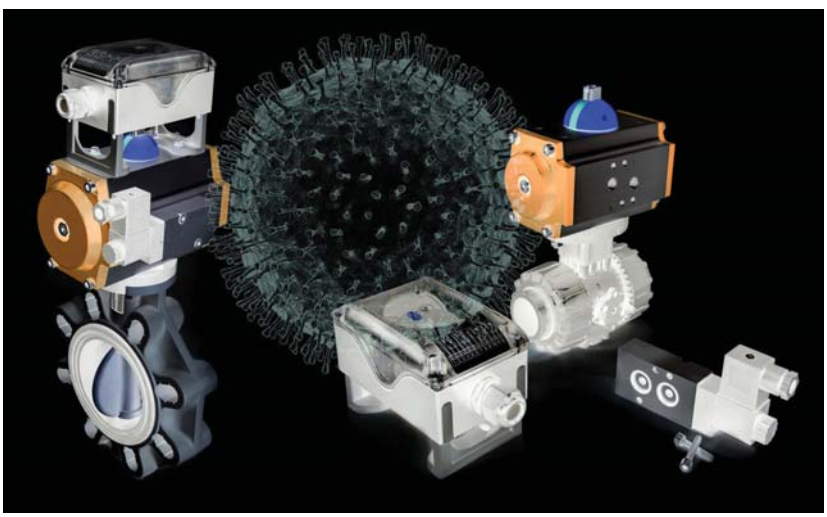
Electric actuator systems are twice as efficient as hydraulic systems, but they can have higher upfront costs. However, the costs over the actuator's life are substantially less if the increased performance, system flexibility, lower maintenance, process improvements and lower utility costs are factored in. hp

ANDREW ZASKE is vice president of sales and marketing at Tolomatic Inc.

NIKHIL KAITWADE | Future Market Insights (FMI)

Post-Pandemic Future of the Pneumatic Actuator Market

The transportation, industrial automation and mining industries are slated to have a major impact on the pneumatics actuator market going forward.



2020 was an exceptionally bleak year for the pneumatic actuator market as the COVID-19 pandemic adversely affected the market's key consumer industries. One of the worst-affected sectors by the pandemic was the transportation sector, which accounts for around a third of total global pneumatic actuator sales.

The value share of the transportation sector in the pneumatic actuator market was $4.88 billion of a total global market value of $14.42 billion in 2020. In several ways, this sector continues to bear the brunt of the second, third and fourth waves of the pandemic since the pandemic and associated restrictions have reduced inter and intra-country travel, besides also affecting movement of certain goods.

Additionally, the economic impact of the pandemic has affected other key consumer industries such as manufacturing and mining. While the overall drop in consumption has affected manufacturing and left several industrial production lines idling, the regulations over social distancing in several countries has led to a drop in overall mining output.

These developments have proven significant for the market since mining accounted for $3.43 billion worth of sales of pneumatic actuators in 2020, while another $2.1 billion worth of consumption of pneumatic actuators came as a result of industrial automation being undertaken in production lines. However, as macro-economic factors have witnessed an improvement, optimism that the pneumatic actuator market will return to its previous growth trajectory has become more commonplace.

FUTURE GROWTH PROJECTIONS AND DEMAND SHIFTS

Given that transportation, industrial automation and mining accounted for around 75% of sales of pneumatic actuators, the recovery of these sectors is slated to have a major impact on the market.

Given their estimated recovery curve, the pneumatic actuator market is slated to grow at a CAGR of 5% over the next 10 years (1% higher than the CAGR of the 4% recorded in the previous five years). The key reason for this increase is attributed to increasing applications of both rack and pinion type and scotch yoke type pneumatic actuators in existing consumer industries.

Currently, sales of rack and pinion type pneumatic actuators account for $4.6 billion worth of sales, while scotch yoke type pneumatic actuators account for $9.8 billion.

Increasing adoption by smaller units and players is also slated to fuel the market's growth. However, the impact of this is likely to be asymmetrical, as smaller consumers have shown a clear preference for light duty pneumatic actuators.

As a result, the sales of light duty pneumatic actuators is expected to increase manifold, and the existing gap between sales of light duty and heavy-duty pneumatic actuators is expected to grow.

However, the key to these growth projections is recovery in macroeconomic factors and indexes. Growth projections for the pneumatic actuator market are positive in more than 20 countries over the next 10 years. Of these countries, the markets in the United States, Germany, China and India are estimated to be the most lucrative.

At the same time, it is being observed that this recovery is moving at a different pace in different regional segments.

Thus, the market's growth rate in the different regional segments is likely to differ.

EUROPE'S RECOVERY SENDS POSITIVE SIGNS

With European economies opening up and recovering from the pandemic, Europe's pneumatic actuator market is likely to see rapid growth in the near future. Notably, the West European segment is the largest regional segment for the market and was valued at $4.4 billion in 2020.

Key countries in Western Europe that the market is looking at keenly include Germany, France and the U.K. Major developments in this region are expected to center on an overhaul in technology in the transportation sector. Additionally, return of post-lockdown industrial activity is also likely to increase pneumatic actuator sales.

LOGISTICS & MANUFACTURING SECTOR TO DRIVE NORTH AMERICAN SALES

The North American regional segment of the pneumatic actuator market was valued at $3 billion in 2020. This segment is mainly centered on the United States, which accounted for around 75% of the region's market share. Within the United States, the logistics sector, which accounts for nearly 8% of the country's gross domestic product (GDP), is the leading consumer of pneumatic actuators, followed by industrial manufacturing.

While the logistic sector had remained strong despite the pandemic thanks to avoidance of extensive lockdowns, industrial manufacturing took a substantial hit due to macroeconomic factors and supply-side shortages of raw materials, including technology-related raw materials. The shutdown of the country's automobile manufacturing units was a major setback for the pneumatic actuators market.

However, these disruptions are now easing due to the United States' economic recovery. This recovery is a combination of a slowdown in the virus' spread (in part due to the country's robust vaccination program) and economic policies of the newly installed government of President Joe Biden.

While several industry players have voiced concerns over Biden's social welfare-oriented programs, these concerns are considered unwarranted for the pneumatic actuator market since the injection of stimulus packages in the economy are estimated to increase the demand for pneumatic actuators in the coming years.

ASIA-PACIFIC REMAINS A MIXED BAG

The Asia-Pacific region is sending mixed signals for the market, since China is considered more-or-less out of the pandemic—and was the only major economy to grow in 2020—but other key national markets, like Japan and India, continue to reel under the pandemic socially and economically. The Asia-Pacific Except Japan (APEJ) segment of the pneumatic actuator market was valued at $3.3 in 2020 and is estimated to be the fastest-growing market over the next 10 years. Japan accounted for another $1 billion worth of sales in 2020.

Growth in the APEJ market is premised upon growing economies of China, India and South East Asian nations, and the region is estimated to overtake other regional segments in the long run.

Consumption of pneumatic actuators is estimated to grow due to a rapidly expanding transportation sector in the region, as well an increasing automation in manufacturing processes. The estimates of growth gain further traction from the economic center of gravity shifting from the West to the east.

However, given that these countries are estimated to follow varying rates of economic recovery, the short-term growth prospects for the pneumatic actuator market vary from country to country despite the overall increasing robust growth rate expected over the next ten years.

MINING & OFFSHORE ACTIVITIES

The Latin American ($623 million) regional segment and the Middle East and Africa segment ($427 million) of the pneumatic actuator market trail other regional segments by a substantial margin. But these regions have huge mineral and offshore reserves. Mining of these reserves is a process that is increasingly adopting newer technology tools, which presents a huge opportunity for the market.

Notably, the consumption of pneumatic actuators for offshore activities in 2020 was worth $1.1 billion of the total market value of $14.2 billion. Thus, growth estimates for these regions too remain robust as the demand for resources continues to remain high amid a rapid increase in the global population.

A REVERSAL IS AROUND THE CORNER

While the effects of the COVID-19 pandemic continue to ail the pneumatic actuator market, this impact is a temporary disruption in an otherwise steady growth trajectory. As a result, the pneumatic actuator market is expected to make a comeback soon and a turnaround in its fortunes is just a matter of time.

This comeback is, however, contingent on various factors that are being realized differently in different parts of the world. This makes the growth of the pneumatic actuator market a staggered process, and it is important for key players in the market to know short-term, medium-term and long-term market developments to correctly leverage this growth potential. hp

NIKHIL KAITWADE heads the Industrial Automation domain at ESOMAR-certified market research and consulting firm Future Market Insights (FMI). The firm is headquartered in Dubai, with offices in the U.S., U.K. and India. The insights presented in this article are based on a report by FMI on the pneumatic actuator market.

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THE CORDIS FLOW controller utilizes a fast-reacting mems technology sensor upstream from a proportional valve, with the option of a DR-2 regulator for accurate and precise pressure control in a small package. Unlike other mass flow controllers that require a 30 min. warm-up time, large differential pressures and limited flow ranges, the Cordis requires less than one minute warm-up, its pressure drop is ≤14 in. H2O, and it features flow ranges as low as 0 to 30 sccm. Standard control options include 0.2 to 10 V DC, 4.32 to 20 mA and 3.3 V DC serial. The Cordis flow controller is adaptable to a variety of sensors that can close the loop around flow.

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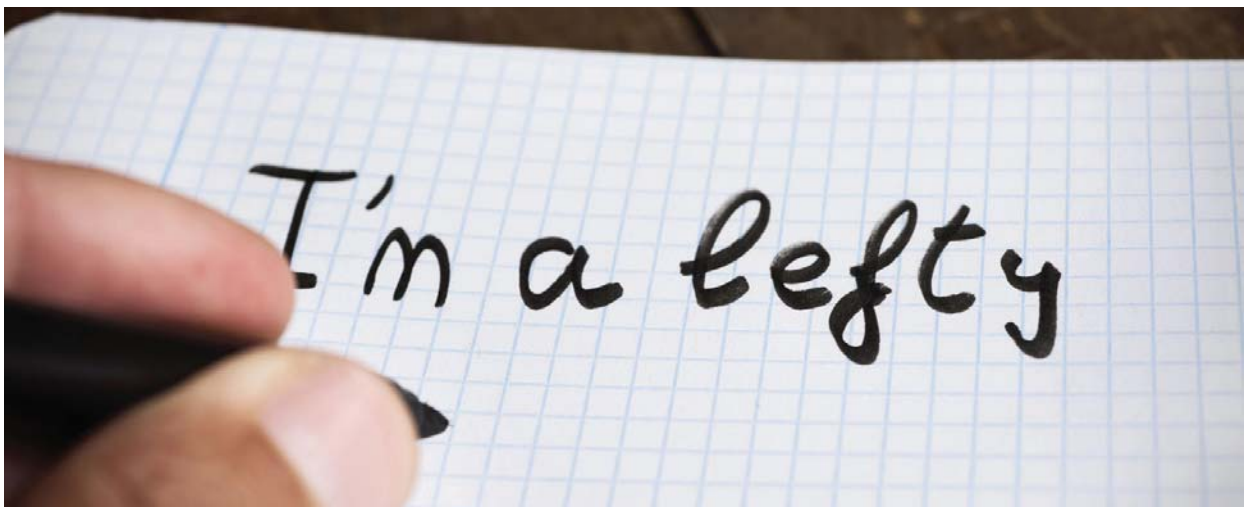

It's Not All Right

A left-handed engineer finds value in considering the other hand.

Roughly 10% of the people in the world are left-handed, an increase of just three percentage points in the last 100 years. Barack Obama, Oprah Winfrey, Bill Gates, Paul McCartney, Marie Curie, Jimi Hendrix, Ruth Bader Ginsburg, Leonardo da Vinci, David Bowie and Lady Gaga are among more famous lefties.

So why aren't more products designed to include the southpaw user experience? As a lefty myself, I pursued my engineering career in part because of my frustration over the lack of left hand-friendly consumer products.

Ever think about how left-handed people zip up their jackets, use scissors or swing golf clubs? If you're not a lefty, probably not. Righties don't often consider that the world was designed for them—for example, all door handles turn to the right. The lefty experience is backwards.

Centuries ago, product inventors were more thoughtful. Think of the design of a paint brush: It doesn't matter which way you hold it. But now that product design is faster and technically driven, considerations like that often fall by the wayside. Here are my tips for making sure your product design is not "left out."

Put buttons and handles in the middle. Whether it's a website, microwave oven or chainsaw, your left-handed consumers are going to appreciate not having to awkwardly reach or drag their mouse to the right to make things work. A center location is easy for everyone. But if you absolutely must put buttons or handles on the right, consider making them extra-large.

Remember that it's not just easy-to-reach button and handle placement that improves the product effectiveness for lefties: Oftentimes, something as simple as using a right-handed pen can be physically uncomfortable for a southpaw, as their stronger hand is not doing the work. Making things more ergonomically correct for your left-handed consumers will also encourage brand loyalty.

Test-drive your product with both hands. Besides the 1% ambidextrous population, everyone has a dominant side and it's easy to forget dual-handed product testing. Mark this off a checklist before your design is complete.

Be friendly, but don't go nuts. If you design specifically for a left-handed market, note that the consumer price for your product will be higher than similar right-handed items, as there is less demand for them—although many lefties would argue that they'd happily pay to make their lives considerably easier. Most product design, especially with software and online or electronic products, is more of a balancing act.

In reality, the percentage of left-handed consumers actively using your product is probably lower than that of your physically impaired or colorblind users. Moving keys or rearranging layouts for lefties doesn't make sense if it damages user experience for right-handed people. A magnified above-finger view on a touchscreen, for example, helps all consumers navigate websites easily. hp

MICHAEL SPRAUVE is president and CEO for Speck Design, brings more than 20 years of engineering leadership to his Silicon Valley product design company. He earned his Bachelor of Science in electrical engineering from Boston University.

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