



HOW DIGITALIZATION & ELECTRIFICATION IMPROVE EFFICIENCY IN FLUID POWER

FEATURING EXCLUSIVE INSIGHTS FROM:

rexroth
A Bosch Company

CASAPPA
FLUID POWER DESIGN

ifm efector

Parker

POCLAIN
Hydraulics

THIS E-BOOK WILL REVIEW



ELECTRIFIED TECHNOLOGY'S
CHANGES TO THE FLUID POWER
INDUSTRY



INPUT FROM LEADING INDUSTRY
EXPERTS ON CHALLENGES



THE INDUSTRY'S FUTURE
DIRECTION

THE EXPERTS QUOTED IN THIS
E-BOOK ARE PART OF THE

OVER 375
FLUID POWER LEADERS

EXHIBITING THIS TRANSFORMATIVE
TECHNOLOGY AT THE
INTERNATIONAL FLUID POWER
EXPOSITION (IFPE)

IN MARCH 2023, CO-LOCATED WITH
CONEXPO-CON/AGG.



THE INTERNATIONAL FLUID
POWER EXPOSITION

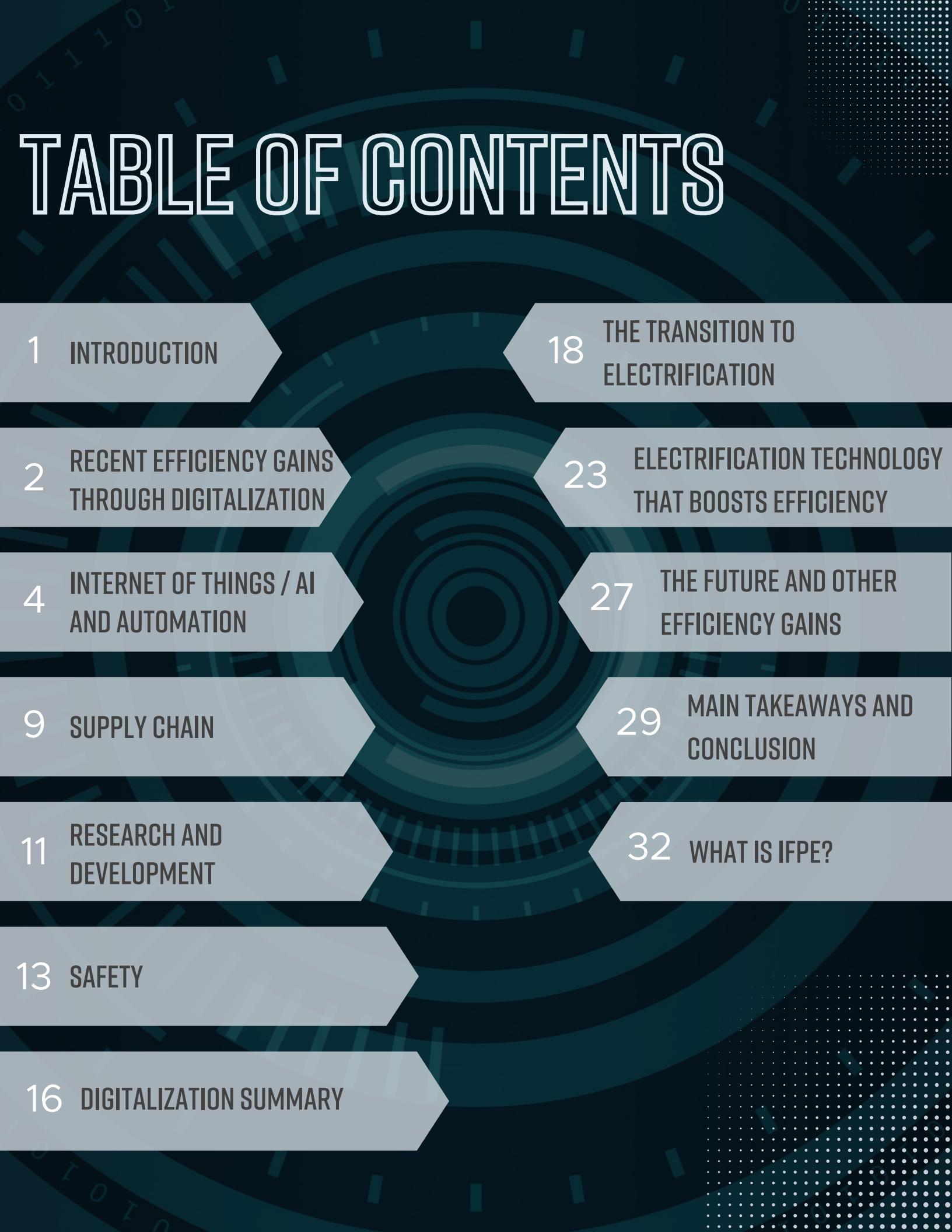
IFPE

IS AN INDUSTRY-FOCUSED TRADE SHOW HIGHLIGHTING:

- THE PEOPLE
- THE TECHNOLOGIES
- THE APPLICATIONS PACING INNOVATION

IN MOBILE AND INDUSTRIAL
FLUID POWER

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INTRODUCTION

The fluid power industry is changing due to global trends, such as

- urbanization and population growth
- the need for infrastructure replacement
- regulation-driven climate change sustainability initiatives

The world's population is trending toward living in larger cities, and high-population regions like Asia are still below the global average for urbanization.

This fact signals a likelihood of accelerated movement to cities in those regions. The three trends are also related since higher numbers of people in a given area will wear out the infrastructure faster and emit more kilograms of carbon per unit area, increasing the need for regulation.

Fluid power can respond to all three trends by accelerating the transition to electrification. Incorporating electrified systems can reduce maintenance and downtime that hinder the pace of construction and reduce emissions at higher efficiencies while enabling autonomous operation. And the data confirms this point: despite continued pressures from the war in Ukraine, inflation, and supply chain execution, fluid power as a market will grow by 7% in 2022.

Fluid power's anticipated growth and increased demand for electrified solutions offer an exciting opportunity for industry participants. Engineers have already begun preparing for the transition to electrification by challenging the scope of what has been possible through increased digitalization. However, it remains critical to balance pursuing the benefits of technology with the end goal of all of this dynamic change. The overall goal is a simple concept that manufacturers can achieve through many paths: improved efficiency.

RECENT EFFICIENCY GAINS THROUGH DIGITALIZATION

IN PURSUIT OF IMPROVED EFFICIENCY, IT IS WORTH DEFINING
ELECTRIFICATION AND DIGITALIZATION.

RECENT EFFICIENCY GAINS THROUGH DIGITALIZATION

In pursuit of improved efficiency, it is worth defining electrification and digitalization.



Photo courtesy of
Pojain Hydraulics

"Electrification" is the process of replacing fossil fuel technologies with electrically-powered ones. Electrified platforms often leverage batteries but can also use fuel cells or coil elements. As a result, it is significantly more efficient than combustion (factor of 2x or better in most cases). In addition, it emits substantially less carbon as more input energy converts to useful work through higher efficiency.

"Digitalization" refers to leveraging digital technologies to enable or improve a process and is a critical enabling step toward realizing the full benefits of electrification. It has already demonstrated improvements for fluid power in several areas through increased data collection and analysis.



INTERNET OF THINGS / AI AND AUTOMATION

DATA IS THE CURRENCY OF INDUSTRY 4.0, ALLOWING
MANUFACTURERS TO "PURCHASE" INTELLIGENT OPERATIONS.

INTERNET OF THINGS / AI AND AUTOMATION

On-board or centralized processing technology can collect performance data for a piece of equipment and autonomously optimize its performance.

Adding this capability to components like valves, pumps, and control elements can provide optimized performance and reduce maintenance over the machine's life, accounting for part wear over time and extended use.

ACCURATELY PREDICTING MAINTENANCE ENABLES HIGHER ACCURACY IN LEAD TIME QUOTING, AND THE INCLUSION OF SMART COMPONENTS CAN ALLOW A FASTER RESPONSE TO CUSTOMER DEMANDS. THIS APPROACH CAN ALSO HELP TO OPTIMIZE BATTERY PERFORMANCE IN AN ELECTRIC APPLICATION.

INTERNET OF THINGS / AI AND AUTOMATION (CONT.)

Enrique Busquets, Director of North American Mobile Electronics and Electrification at Bosch Rexroth, offered insight into this topic. "Every customer will find very different use cases and benefits, but many customers have common ground on serviceability...but being able to diagnose and understand the machine remotely can provide solutions in many different ways." Indeed, collecting the data enables creative ways to use and optimize systems to improve efficiency.



Photo courtesy of Bosch Rexroth

BOSCH-REXROTH WILL BE FEATURING DIGITAL AND ELECTRIC PRODUCTS THAT HELP DELIVER THIS CRITICAL EFFICIENCY AT IFPE.

This technology includes electric motors, power distribution units, onboard chargers, and a new series of electronic controllers that incorporates a step up in performance for high controllability and automated function control.

INTERNET OF THINGS / AI AND AUTOMATION (CONT.)

While the IoT helps OEMs improve efficiency, the end-user also benefits.

Michele Barbetti, Group Marketing Manager & US branch GM at Casappa, said, "we need to understand what would be the value for the customers of our customers – in the end, we're selling data. So how is it useful? What's the end-user value?"

For example, predictive maintenance is good for manufacturers and immediate customers. But the IoT likely has more for the end-users." This theme is especially true for equipment operators and rental companies, who can receive automatic alerts from the analyzed data and react much faster to address a performance or maintenance issue.

**"IN THE END, WE'RE
SELLING DATA.
SO HOW IS IT USEFUL?
WHAT'S THE END-USER
VALUE?"**

INTERNET OF THINGS / AI AND AUTOMATION (CONT.)



CASAPPA SMART PISTON PUMP
(OPEN)



CASAPPA SMART PISTON PUMP
(CLOSED)

Casappa has recently launched a specific product to enable intelligent solutions through digitalization.

A smart piston pump integrates the pump, ECU, and sensors in one item to enhance digital control.

This integration improves efficiency by measuring drain pressure and temperature, speed, and load sensing and analyzing the data to optimize hydraulic power management and provide condition monitoring.

Collecting this performance data also enables predictive maintenance, a critical benefit to extending asset life.

BARBETTI SEES DIGITIZATION AS ESSENTIAL IN THE NEAR/MEDIUM-TERM AND WILL BE DISCUSSING IT AT CASAPPA'S BOOTH AT IFPE.

SUPPLY CHAIN

SUPPLY CHAIN

The past two years have demonstrated the importance of high supply chain efficiency and how disruptive life becomes when it's not. Add to that the pain of inflation, and these factors begin to impact the speed of electrification.

But with challenge comes opportunity, as described by Guillaume Besnouin, Marketing Manager at Poclain Hydraulics. He explains how 3D-printed parts accelerate product development.

"3D printing is being introduced for basic [product development] tests... developing the product faster and cheaper."

THE PROCESS DOES NOT REPLACE FIRST ARTICLE INSPECTION AND QUALITY CHECKS, BUT IT SHORTENS THE PROOF OF CONCEPT EVALUATION BY CONFIRMING HIGH-LEVEL PERFORMANCE WITHOUT DISRUPTING PRODUCTION OR THE SUPPLIER.

RESEARCH AND DEVELOPMENT

RESEARCH AND DEVELOPMENT

Development engineers can also influence efficiency through part design updates based on data collected through digital channels.

For example, they may add a safety margin to a first-generation design to assure the durability of the first parts. Following the performance and field testing, they can analyze the data they receive to reduce the material, size, or thickness of a component to reduce its weight or size.



Durability modeling is another beneficial tool to optimize and assess a product change. Numerical 3D simulations enable engineers to rapidly evaluate changes' impact to converge on an optimized design. The most effective way to use durability modeling is by developing fitting correlations from test data.

Increased digitization can improve this step by minimizing design iterations.

SAFETY

NO ONE WINS IF THE EQUIPMENT DOES NOT ADDRESS SAFETY.
FLUID POWER WORKERS ARE HIGHLY SKILLED, BUT THE POSSIBILITY
OF HUMAN ERROR ALWAYS INVITES AT LEAST THE CHANCE OF A
SAFETY ISSUE.

SAFETY

Digitalization has a direct correlation to improved safety, which enhances efficiency indirectly. Higher safety translates into fewer incidents, repairs, and lost time and delivers the primary objective of high-risk industries: protecting the workers, bystanders, and surrounding areas.

One way digitalization delivers safety is by enabling regulations. Chris Griffin, Electrification Business Development Manager at Parker Hannifin, says, "safety standards govern [fluid power] vehicles, and understanding how that's evolving is important. That way, we can deliver not only on the safety data but the redundant circuits or networks as needed." Building in safety redundancy to monitoring ensures safety is an "always-on" consideration and complies with evolving fluid power regulations that require it.

Parker continues to develop sensors, connected hydraulic valves, and other components with less wiring and cables that could fail. They also offer intelligent machine controllers that leverage AI to make logical decisions automatically before sending the data to the cloud.

THESE PRODUCTS AND APPROACHES WILL BE CENTRAL TOPICS AT THEIR BOOTH AT IFPE.

SAFETY (CONT.)

Digital technology also provides a safety net for the equipment operators while adding autonomous features to the experience. These features remove sources of human error to improve safety.

For example, Kevin Vanderslice, Director of Sales at ifm efector, said, "autonomous vehicle technology that ensures you don't run into other things, such as:

- backup cameras
- cruise controls
- parking cars helps with safety

And safety practices in a larger, more general sense helps the operator make safe decisions."

Adding in safety features, in response to regulations or as proactive measures, extends equipment life & increases efficiency by reducing incident rates and downtime. It also provides the operators the confidence that they are safe while performing high-skill work.

DIGITALIZATION SUMMARY

DIGITALIZATION WILL DELIVER EFFICIENCY GAINS IN THE SHORT AND MEDIUM-TERM WHILE ENABLING ELECTRIFICATION.

DIGITALIZATION SUMMARY

The future of hydraulics will likely be a combination of traditional hydraulic power, ideal for heavy-duty applications, enhanced by digital features and technology to improve the efficiency of the processes. Enhancements to motors, pumps, and other components could maintain power and deliver efficiency.

An example could be higher-RPM gear pumps, offering more performance from a single part. The innovation will focus on efficiency, but performance will continue to be critical given the increasing demand and frequently urgent timing of construction projects.

Barbetti summarized this well:

"I THOUGHT IN THE LONG RUN, THESE IOT WORKING APPLICATIONS WILL MAKE SENSE IF THE COLLECTED DATA HAS A TANGIBLE VALUE TO BE SOLD TO THE END-USER. IT'LL PUSH ALL THE SUPPLY CHAIN WITH THIS NEW TREND. FROM A SUPPLY CHAIN MANUFACTURER, WE NEED TO BE READY WITH SOMETHING THAT CAN SPEAK WITH THE ACU OF THE MACHINE AND SEND SIGNALS TO THE CLOUD REGARDING OUR PRODUCT, BUT THE FINAL DECISION WILL COME FROM THE MARKET.

SO WE NEED TO MAKE THIS DATA AVAILABLE TO OUR END-USERS, WHO WILL BENEFIT THE MOST FROM IT."

THE TRANSITION TO ELECTRIFICATION

NOW THAT DIGITALIZATION HAS BEGUN SIGNIFICANTLY PERMEATING FLUID POWER, THE INDUSTRY IS COLLECTING THE DATA NEEDED TO ENABLE ELECTRIFICATION.

THE TRANSITION TO ELECTRIFICATION

There are two approaches to determine the best way to design systems for electrification:

- Retrofit existing
- Design new

SYSTEM INTEGRATION

OEMs often want to leverage existing components or use components from adjacent industries to extend the already-depreciated assets' useful life.

Instead, the best practice to get the highest efficiency benefit from an electrified system is to design a fully-integrated, electro-hydraulic system with an optimized control strategy to maximize the performance of all system components.

Terzo Power invented HydraPulse, which integrates an inverter with the motor and pumping work function. This architecture enables the control of multiple system functions, such as powering actuators, cylinders, or a standard valve bank.

THE TRANSITION TO ELECTRIFICATION (CONT.)

ELECTRO-HYDRAULICS

According to Besnouin and Mary Boulven-Moore, Community Manager at Poclain, the transition to adding electrified components will be gradual.

"The transition will require a combination [of electric and hydraulic components], especially with current trends. I think there's got to be some intelligent engineering that understands the challenges and time frame. Maybe it's not the right time for fully electric to limit that change, but more toward an electro-hydraulic machine, to maintain infrastructure but still meet needs."

Poclain noted the trend toward zero emissions through electrification and integration of electro-hydraulics. Their electro-mobility team is electrifying hydrostatic transmission by combining rugged hydraulics with state-of-the-art power electronics to boost the performance and efficiency to the level of current diesel architectures in two innovative technologies.

- One uses a single electric motor for propulsion with a closed-loop variable displacement pump with an open-loop pump for auxiliary functions.
- The second uses two discrete electric motors, one for propulsion and another that acts as an APU with an open-loop pump.

THE TRANSITION TO ELECTRIFICATION (CONT.)

TO ILLUSTRATE STRATEGIC COMPANY SHIFTS TOWARDS ELECTRIFICATION AND IOT/CONNECTED ENGINEERING, POCLAIN WILL PRESENT THEIR ELECTRO-HYDRAULICS SMART ARTICULATED MINI LOADER AT IFPE.

It will also be the first opportunity in North America to learn more about Poclain's technology partner, EMSISO, their emDrive® advanced motor controllers for electric propulsion systems, and their R&D capabilities in the field of power electronics. EMSISO contributes a technological brick to the core performance of electric powertrains that feeds POCLAIN's electrohydraulic system offering.



ATTENDEES WILL HAVE THE OPPORTUNITY TO MEET WITH POCLAIN EXPERTS AT IFPE, WHICH WILL ALSO BE THE ONLY OPPORTUNITY TO SEE THIS MACHINE IN NORTH AMERICA IN 2023.

THE TRANSITION TO ELECTRIFICATION (CONT.)

Busquets also provided an example from Bosch-Rexroth's perspective to support this point:

"For example, EOC (electronic open circuit) is an open circuit pump that on the component level has been optimized for cost and performance. Through software, we've created an 'ECO+' functionality that significantly extends the system efficiency, which is different from traditional ECO modes relying on maximizing pump vs. prime mover speed. But with EOC, we've gone well beyond since the pump can go over center for energy recuperation."

TO underscore the benefit of continuing to innovate hydraulics while developing electric components, Bosch-Rexroth will bring a new A36VM hydraulic motor to IFPE.

This new motor offers a first-in-the-world extended maximum displacement range of 38° and up to 530 bar pressure.

ELECTRIFICATION TECHNOLOGY THAT BOOSTS EFFICIENCY

ONCE THE TRANSITION TO ELECTRIFICATION TAKES OFF, THE LEVERS TO INCREASE EFFICIENCY ADD ANOTHER VARIABLE: THE BATTERY.

ELECTRIFICATION TECHNOLOGY THAT BOOSTS EFFICIENCY

Large, fully-electrified systems require large batteries to provide the power. These batteries carry significant mass, which reduces performance and efficiency. The system must allocate disproportionate ability to haul the battery during operation.

ON-DEMAND HYDRAULICS

One way to mitigate this is using digital controls to provide more on-demand hydraulic pressure. Griffin quantified the level and magnitude of what represents a significant efficiency improvement, saying, "as hydraulics are connected to electrified systems, efficiency becomes crucial. Anything to minimize the cost and weight of that battery is key. It also means redesigning the hydraulic system to run more efficiently, such as only producing pressure and flow when you need it.

Hydraulic systems are typically maybe 40% to 50% efficient, so there can be a lot of loss. Increasing that rate to even 60% is a huge gain."

Two other emerging technology areas could increase efficiency as the transition to electrification continues.

THERMAL MANAGEMENT AND HEAT PUMPS

Hydraulic systems are inherently inefficient, as noted above. The hydraulic valves restrict the flow to create a pressure drop, an irreversible hydrodynamic loss, as the control mechanism to increase power.

As a result, higher power requires higher pressure drop and, by extension, higher peak operating pressure.

ELECTRIFICATION TECHNOLOGY THAT BOOSTS EFFICIENCY (CONT.)

Even in well-operating systems, pressure drop and high flow velocity create heat. This heat can break down the oil, leading to metal-metal contact and similar failure modes. Implementing heat exchangers to dissipate excess heat in known areas can help avoid these issues and improve efficiency.

In addition, it is essential to optimize the pressure drop through the heat exchanger to ensure proper flow distribution but not consume excessive pressure drop that the machine needs to operate.

Engineers design hydraulic systems to operate within a specific temperature range. Li-ion batteries also operate at peak efficiency between 15-35°C, meaning managing excess heat is even more critical for electrified hydraulic systems. Battery electric vehicles offer substantial differences in thermal management.

Griffin concurs, stating, "thermal management is important as well. Different cooling technologies to keep things at a reasonable temperature. Keeping a battery and the electronics cool is critical. It also comes back to safety and efficiency."

Liquid immersion cooling is emerging as an advanced technology to regulate battery temperatures. Heat pumps utilize outside energy to generate cabin heat at efficiencies up to 3x higher than electric resistance heat in electrified machines. These technologies are significant trends enabling high-efficiency electrification.

ELECTRIFICATION TECHNOLOGY THAT BOOSTS EFFICIENCY (CONT.)

HYDROGEN

Finally, hydrogen is still present as a potential "electric fuel" competing with Li-ion batteries – fuel cell vehicles are electric vehicles.

Hydrogen offers the highest advantage for larger vehicles, given the large battery mass, but the industry will need more infrastructure and investment for clean hydrogen production and delivery technology.

Griffin offered this perspective on hydrogen: "There are two areas we're seeing hydrogen movement:



- Fuel cell technology – a slow evolution, but it can provide the electricity to charge batteries. However, the delivery and production are still evolving, infrastructure is not totally there, and it involves a lot of electricity; so much to figure out here.
- Hydrogen as a combustible fuel, adapting existing engines to the hydrogen. This makes much less of a business case to electrify at that point, although the quantity needed is really tough."

THE FUTURE AND OTHER EFFICIENCY GAINS

THE ROAD TO ELECTRIFICATION WILL BE GRADUAL BUT HAS ALREADY
STARTED.

THE FUTURE AND OTHER EFFICIENCY GAINS

Vanderslice summarized this transition: "today, the way things are built, we control the hydraulics. We do the readings, turning valves on and off, pumps, etc. With electrification, now you're sending and receiving data to the battery system, for example, monitoring the battery's health. Now you're controlling actuators and more, you're becoming a hub—or "brain"—reading inputs and moving actuators and motors to get the vehicle in its operating state."

The shift to a more data-driven, integrated approach to fluid power is critical to leveraging the benefits – it's more than just collecting data. Vanderslice summarizes this:

"HOW DO WE TURN MACHINE DATA INTO MACHINE WISDOM?"

IFM WILL BE ENGAGING IFPE CONFERENCE MEMBERS ON THESE POINTS AT THEIR BOOTH.

The IoT is about connecting functions together to improve the whole. Leveraging technology to connect one engineer with another—automatically—can leverage the expertise of both disciplines to achieve the maximum possible efficiency beyond the individual component level.

Designing modular components that engineers can arrange and integrate into customized systems seems to be the enabler of elevating fluid power efficiency beyond anything possible today.

MAIN TAKEAWAYS AND CONCLUSION

MAIN TAKEAWAYS AND CONCLUSION

Digitalization enables electrification, which can help the fluid power industry meet emission and regulatory targets while keeping up with the ever-increasing demand for its services.

Industry experts' perspectives of industry experts offer glimpses into:

- What has worked
- What will work
- What the industry is going through

THESE THEMES WILL BE ON DISPLAY IN MARCH 2023 IN THE CONTENT AND ON THE SHOW FLOOR OF IFPE – THE SHOW THAT HIGHLIGHTS THE LEADING EDGE OF FLUID POWER.

But one thing they agree on is that the most crucial consideration when developing new technology for the electrification movement is this: companies that build technology that maximizes overall system efficiency will win, and society will be the beneficiary.

ABOUT THE AUTHOR

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Adam Kimmel has nearly 20 years as a practicing engineer, R&D manager, and technical consultant.

He creates white papers, technical SEO content, case studies, and blog articles in vertical markets, including automotive and mobile applications, industrial/manufacturing, technology, hydrogen and alternative energy, and electronics.

Adam has degrees in Chemical and Mechanical Engineering and is the Principal and founder of ASK Consulting Solutions, a technical content writing and strategy firm.



THE INTERNATIONAL FLUID
POWER EXPOSITION

WHAT IS IFPE?

THIS IS WHERE YOU'LL LEARN EVERYTHING TO HELP YOUR COMPANY STAY AT THE FOREFRONT.

IFPE is an industry-focused event highlighting the people, technologies, and applications pacing innovation in mobile and industrial fluid power.

Your benefits by attending:



Gain early insight into how hydraulics, pneumatics, and other technologies are evolving.



Learn how to boost your productivity, increase your equipment's efficiency, and meet your toughest challenges.



Create new partnerships to strengthen your product development process.



Grow your network! Meet face-to-face with the brightest minds in fluid power.

NO OTHER SHOW BRINGS AS MANY SECTORS OF THE FLUID POWER, POWER TRANSMISSION, AND MOTION CONTROL INDUSTRIES TOGETHER IN ONE PLACE.

This event only happens once every three years in conjunction with CONEXPO-CON/AGG, the largest international gathering place for the construction industries—next show: March 14-18, 2023

WANT TO LEARN MORE?

Visit <https://www.ifpe.com/>, or contact Tina Hamberg at thamberg@aem.org