White Paper

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Electromechanical Actuators Provide a New Spin on Tire Manufacturing Methodology

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Electromechanical Actuators Provide a New Spin on Tire Manufacturing Methodology

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In an industry where a single product failure is one too many, safety is the number one concern of tire manufacturers throughout the world. Every tire produced must meet strict quality requirements to ensure driver safety. However, with ever-increasing demand for tires outpacing current production capacity, global competition is on the rise and manufacturers are under increasing pressure to meet production targets while also enhancing shareholder value. Often running machinery to its limits, any downtime or bottlenecks in the production process are costly and demand immediate attention. To meet these and other challenges, manufacturing engineers and operations managers are embracing a paradigm shift from conventional, hydraulics-based process automation systems to clean, flexible, and efficient electromechanical actuator-based solutions that realize incremental gains in productivity, quality, and reliability across all phases of production.

Electromechanical Actuators – Lean, Clean & Green

For decades, fluid power technology has been a proven, de-facto standard throughout the tire industry. Consequently, the technology is well understood, easily applied and readily available from a plethora of sources. It is not without its flaws, however. Chronic leaks, frequent maintenance, and limitations in overall flexibility and precision prevent manufacturers from achieving potential throughput improvement goals. While this technology has improved significantly over the years, the inherent performance limitations, inefficiencies, maintenance, and most importantly, downtime headaches remain. In an industry where demand greatly exceeds capacity, tire manufacturers need to look for innovative changes that result in breakthrough gains in throughput.

In contrast to hydraulic solutions, current electromechanical actuators marry precise and programmable servo controls and motors with rugged and reliable mechanical screw mechanisms. Free from fluid power's noisy pumps and compressors, (as well as complex spider webs of hoses, fittings and valves), electromechanical systems offer simple installation, repeatable and programmable motion, lower overall energy consumption, and a long, maintenance-free service life. These advantages, coupled with advancements in mechanical screw technology that offer a force density approaching that of a hydraulic cylinder, create a compelling business case to "go electric".

Application Solutions for Tire Manufacturing

Fluid power actuators are ubiquitous today across nearly all tire-manufacturing processes and each one may be a potential candidate for migration to electric. However, some applications are more critical or present more of a process bottleneck than others. In general, the following types of applications will benefit the most from conversion to electric, including the fastest ROI:

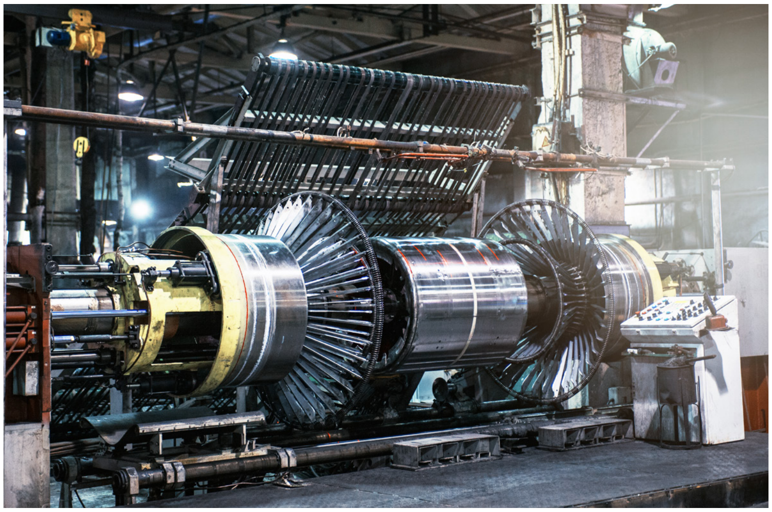
- Belt and ply calendering
- Tire building
- Vulcanization & tire molding

Calendering. The tire manufacturing process is very involved, with dozens of processes all reliant on one another to create high quality, long-lasting tires. One of the most critical to quality processes is belt and ply calendering. The calendering process presses rubber on and into steel and fabric cords with heavy-duty rollers. This procedure bonds fabric to rubber and rubber to steel, reinforcing the tire to withstand the heavy loads expected in operation. Calendering machines tension and pull a preset number of fabric or steel cords through steel rollers. The machine introduces the engineered rubber compound immediately before the rollers to create the plies to construct the tire. Fluid power actuators or manual cranks apply loads to the rollers to press the rubber compound into the cords and control ply thickness.

As vehicle operators are pushing tires to the limits of performance, innovation and quality improvement are key initiatives for manufacturers. To improve quality, manufacturers are reviewing the tire building process. On calendering machines, manual and out-of-date hydraulics are being replaced by electric actuators to load the calendering wheels. Electric actuators precisely and repeatedly position the calendering wheels to control ply thickness. Improved quality on the front end of the process reduces downtime and increases throughput through the rest of facility.

In addition to delivering advanced quality and throughput improvements, electric actuators are easily programmable, providing tire builders increased line flexibility and quick changeovers when switching production from small to larger tires. With improved flexibility, tire manufacturers require fewer machines to build their product portfolio, thus minimizing the overall footprint of the facility, saving thousands of dollars in plant, property, equipment, and overhead expenses.

Tire building. Layering ply after ply to build up the layers of a tire has traditionally been a tedious and labor-intensive process. The process starts with “wrapping” the inner liner around a rotatable and inflatable drum, followed by the casing ply, lower beads, and sidewalls. The initial layers of the tire then go through a confirmation process which inflates the rubber plies into a basic tire form. Operators or machinery then install the last layers of the tire consisting of metallic belt plies, textile belt plies, and the tread band to create a “green tire.”



The calendering process creates a continuous rubber sheet which then enters the cutting and stamping line to create the individual plies. High-force actuators drive the stamping and cutting machines to cut the sheets of material into the appropriately-sized plies to meet the build characteristics of specific tires. After stamping, the plies are moved into the tire-building cell. Traditionally, tire-building cells require an operator to layer ply after ply onto the tire-building drum to construct the tire. This repetitive, labor-intensive process is a prime candidate for automation.

Additional examples of tire-building automation include adjusting the tilt table that sets the height of the ply as it enters the drum, placing the lower beads, and rotating the tire drum to wrap a ply. Replacing the manual processes with electric solutions can greatly improve throughput and instantly improve quality.

Taking a holistic view of the entire tire building process, there are opportunities to automate nearly every step of the process. Automation also allows manufacturers to complete processes in parallel, immediately doubling throughput vis-a-vis a traditional tire-building process. In addition to increasing the number of tires manufactured per shift, increases in energy efficiency can keep machines running longer at lower cost. The benefits of achieving more than double a facility's output without expanding the facility or adding more machines are impressive. All of these breakthrough improvements are possible by simply introducing electromechanical actuators into the tire-building process.

Vulcanization and tire molding. Once the tire reaches the "green" form, it enters the molding and vulcanization process to form its final shape and improve its properties. Vulcanization is a high-temperature, high-pressure process in which sulfur cross-links with the rubber's natural polymers to improve the rubber's durability, strength, and other mechanical properties. Operators place the "green" tire into the mold and pump hot fluid containing sulfur to vulcanize the rubber and mold it to the final tire form. The mold must remain closed and withstand the high pressures associated with vulcanization and molding.

Typically, high-force hydraulic actuators hold molds closed. While this technology has been effective in the past, manufacturers are looking for more advanced technologies to improve flexibility and reduce the messiness and maintenance associated with hydraulic actuators. Electric actuator force capacity is approaching the force output of many hydraulics, opening the door for manufacturers to achieve their flexibility goals and realize the additional benefits of electrics.

In many cases, replacing hydraulic actuators with electric actuators can further increase throughput and lower costs through increased speed, reduced downtime, and improved energy efficiency. A recent example involves a tier 1 steering wheel supplier for a major automotive manufacturer. The supplier changed actuators on its mold presses from hydraulic to electromechanical and increased throughput by approximately 85%. Considering the numerous hydraulic cylinders found in a tire manufacturing plant, the opportunity for similar improvements are impressive.

The table below includes additional processes and applications that benefit by leveraging the advantages of electromechanical actuators.

Process	Typical Application	Electric Actuator Benefits
Stamping	Stamping rubber ply sheets	Energy savings
		Flexibility to accommodate varying materials
Quality control testing	Load and puncture testing	Flexibility to cope with varying designs
		Closed loop control and feedback
Extruding	Tread and sidewall extrusion	Energy savings
		High system efficiency
Cutting	Fabric ply cutting (saw positioning)	High speed
		Precise control
Slitting and perforating	Rubber ply stripping (blade positioning)	High speed
		Energy savings
Raw rubber testing	Tensile testing	Precise control
		Force measurement

Conclusion

Staying ahead of the technology curve and embracing change is critical to creating and maintaining a competitive advantage. Identifying and prioritizing applications that best leverage the advantages offered by electromechanical actuation is a key factor in meeting customer expectations for delivery, quality, and cost. Compared to traditional fluid power, implementing electric actuator solutions today will result in significantly reduced maintenance costs and associated downtime, superior process control, lower energy consumption, and ultimately a lower cost of ownership.

About Curtiss-Wright / Exlar Automation

Curtiss-Wright's Exlar electromechanical actuators provide some of the most compact and lightest actuator solutions available. Exlar's unique roller screw technology delivers higher force in a smaller package than comparable ball screw technology, as well as greater flexibility, higher efficiency, and lower overall maintenance than traditional fluid power solutions. Exlar actuators are being used in thousands of applications around the world, improving efficiency and throughput.

For more information on electromechanical actuators go to www.exlar.com.