

Tire Curing Press Machine

Streamline Press Performance; Enhance Throughput, Quality & Flexibility



This paper provides an overview of how an integrated control and information solution from Rockwell Automation can be used on a tire curing press machine to reduce an OEM's engineering effort and help maximise productivity.

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THINK.
SOLVE.®

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Executive Summary

As a machine builder, you are challenged to differentiate yourself amidst global competition and rapidly evolving technology. Tire manufacturing demands machines that combine high production output, consistent reliability, and product quality with low manpower requirements and low maintenance costs. Alongside high-speed production, flawless product quality is also a priority. Tire machines need to be flexible enough to adapt to trends like larger tire dimensions and more sophisticated designs.

Lower your Total Cost to Design, Develop and DeliverSM a tire curing press machine with Rockwell Automation Solutions

Whether measured from a business, commercial or technical perspective, a curing press solution from Rockwell Automation can help improve overall press productivity an estimated 20-40%. An integrated control solution can also help decrease changeover time, and pre-programmed recipe parameters can improve production time and reduce waste.

During machine operation, an integrated control solution allows for easy data collection and real time monitoring, enabling improved OEE and production planning.

What may start out as an “order-by-order” relationship, can eventually develop into a mutually beneficial business partnership because we strive for a comprehensive approach that focuses on your machine and business performance. Rockwell Automation can work with you to develop a solution that gives you a competitive advantage throughout your machine’s life cycle.



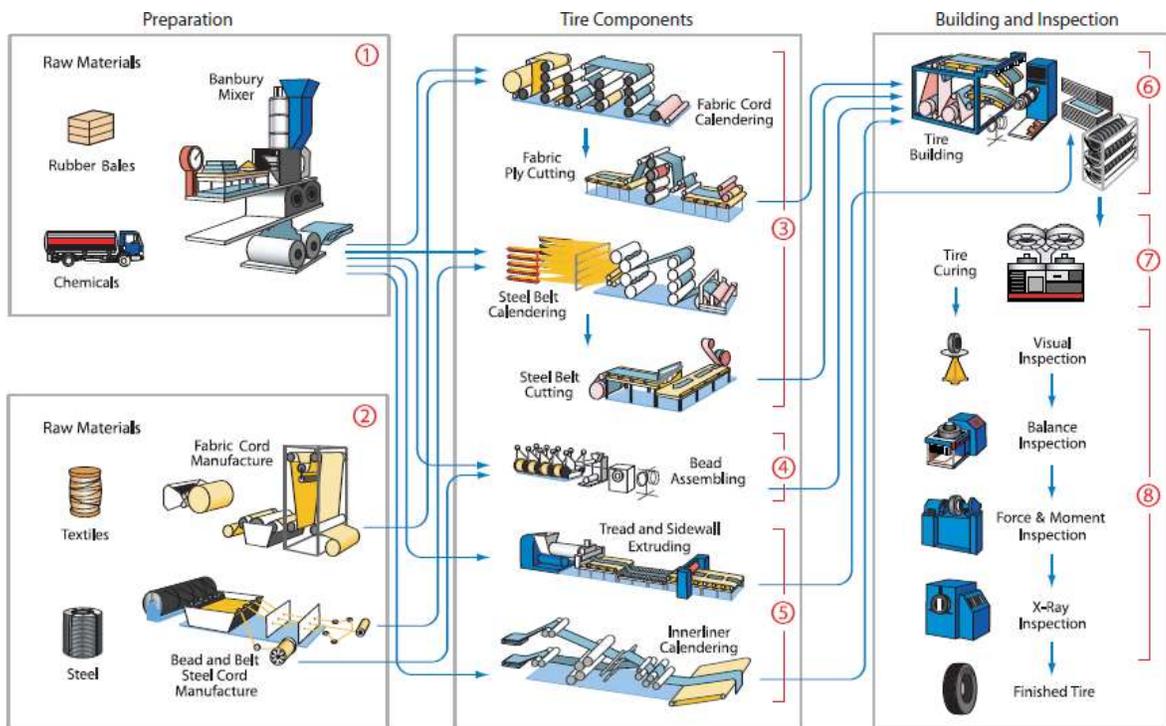
Introduction

Tire manufacturers need a fully connected enterprise to operate efficiently and compete globally. A completely connected enterprise includes the exchange of critical performance and operations information with OEMs to improve processes, increase production and reduce risks.

Improving throughput and increasing machine uptime are top key performance indicators that can cut production cost for tire manufacturers. Tire manufacturers also need to manage the manufacturing process and ensure better asset utilization to maximize throughput.

When productivity and profits are essential, manufacturers need to work with an automation supplier who understands their unique operation requirements. They also depend on reliable service and support around the world to keep operations running continuously.

Efficient, global coordination of OEMs and system integrators is key to improving uptime for manufacturers. Getting tire machines to market faster and profitably is key to OEM success.



A Sample Production Flow Chart for Tire Manufacturers
(Source: Internet)

Challenges

For **the tire manufacturer**, the curing press machine should be:

- **Productive:** To minimize curing time per phase; reduce changeover time by complex recipe management; shorten recovery time; and maximize throughput with highest quality.
- **Safe:** To meet safety compliance standards and ensure the safety of staff and equipment.
- **Flexible:** To match different tire types and building processes, including the size of the green tire and different types of components.
- **Easy to use:** Offer easy maintenance despite machine complexity.
- **IT-enabled:** Provide enterprise level connectivity via standard Ethernet protocol to MES and ERP systems.

For **the machine builder/designer**, the machine should be:

- **Modular:** Mix and match tire machine functions that are ideally suited for specific customer applications; customize functions to develop a new machine that is localized to market demands.
- **Standard:** Develop and document mechanisms common to complex tire machines that can be easily redeployed with minimum modifications, despite different machine sections/conditions that result in more complicated sequencing and interlocking;
- **Cost-effective:** Optimize mechanical and electrical components to reduce installation and start-up costs.



Why Tire Curing is So Critical

Tire manufacturers must reap the most productivity from every stage of their manufacturing process. The tires produced need to meet customers' specifications and overall quality standards. The operation of curing presses has a dramatic impact on the ability to meet these goals. Not only is curing a critical process, but for most tire manufacturers, it represents one of their largest capital investments. Factors including the number of presses in line, power consumption per press, fuel consumption, and electric consumption of the factory, are all greatly influenced by this process. In fact, the curing process usually accounts for 60 to 90% of the total steam consumption of the factory. Regardless of the scale of operation, manufacturers depend on curing presses for fast, reliable and repeatable performance.

Effective Vulcanization Process Control

Three key elements of the vulcanization process are time, temperature and pressure. Temperature and pressure will directly affect the quality of the tire. Low temperature does not produce enough sulfur content and the resulting tire rubber polymer chains do not have the desired wear resistance or high elastic properties. High temperature or high pressure produces too much sulfur, resulting in a tire with a short life and the inability to withstand high forces. If the pressure is too low, the tire will become soft and sponge-like. If the pressure is high, the life of the tire curing equipment will be reduced and energy consumption increased.

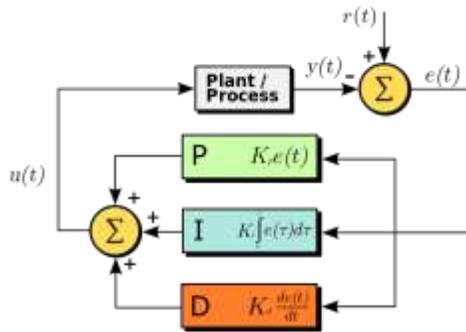
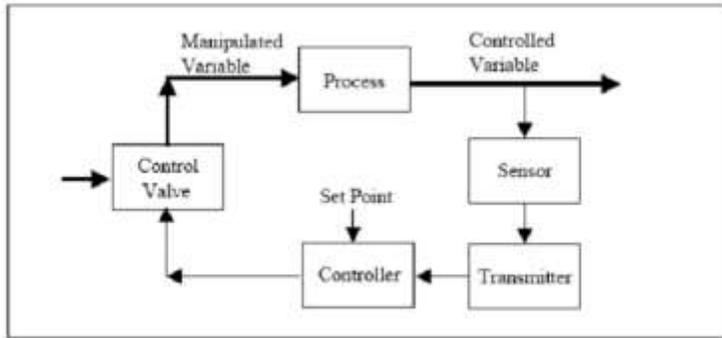
PID Control

A proportional-integral-derivative controller (PID controller) is a control loop feedback mechanism (controller) widely used in industrial control systems (e.g. PLC). A PID controller calculates an "error" value as the difference between a measured process variable and a desired set point. The controller attempts to minimize the error in outputs by adjusting the process control inputs.

The PID controller algorithm involves three separate constant parameters, and is accordingly sometimes called three-term control: the proportional, the integral and derivative values, denoted P, I, and D. Simply put, these values can be interpreted in terms of time: P depends on the present error, I on the accumulation of past errors, and D is a prediction of future errors, based on current rate of change. The weighted sum of these three actions is used to adjust the process via a control element such as the position of a control valve, a damper, or the power supplied to a heating element.

Some applications may require using only one or two actions to provide the appropriate system control. This is achieved by setting the other parameters to zero. A PID controller will be called a PI, PD, P or I controller in the absence of the respective control actions. PI controllers are fairly common, since derivative action is sensitive to measurement noise, whereas the absence of an integral term may prevent the system from reaching its target value due to the control action.

PID Control Process Schematic



PID Control for Tire Curing

Standard PID control with a single set of parameters does not meet tire curing process control requirements as it cannot address the following:

(1) Process non-linearity

Heating and cooling are two different physical processes
 Different feed rate results in different thermal characteristics inside the bladder

- heat capacity
- thermal conductivity

Actuator (steam valve) characteristic (valve opening - steam flow) is non-linear

(2) Significant transportation delay

Delay between the control action and its effect on the product temperature
 Effect of external disturbances

- Feed rate
- Heat transfer from/to the ambient environment is a function of ambient temperature

For tire curing press control, the Enhanced PID instruction offers advanced features that allow you to easily set up more advanced loop algorithms without the onerous ladder programming required by traditional control systems.

Solutions & Benefits

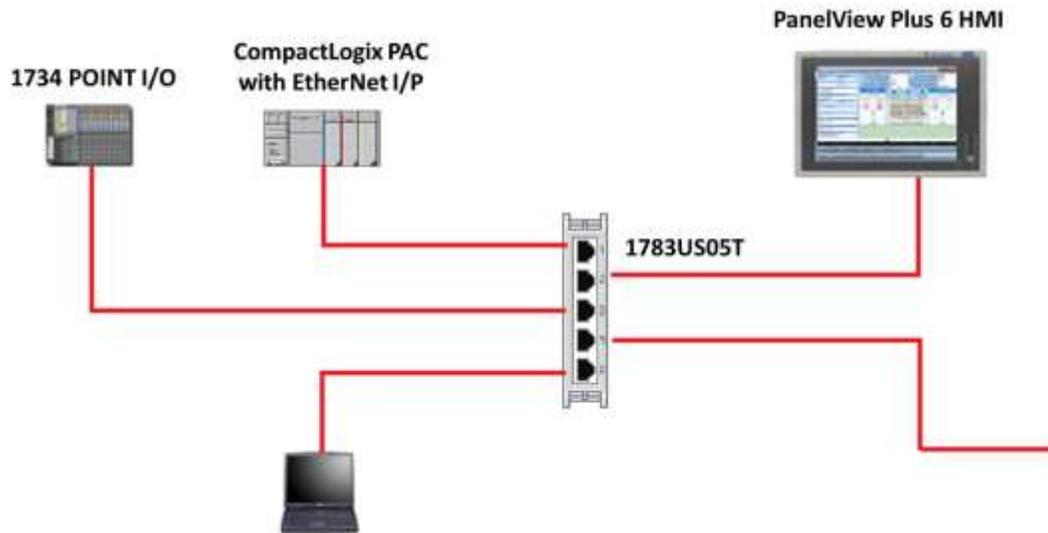
Faster throughput is just one part of the manufacturing equation. Batch to batch, curing presses require quick changeovers to meet the specifications which contains a list of parameters setting for different types of tires.

A Rockwell Automation Integrated Architecture® solution helps achieve the flexibility needed. With easy-to-use FactoryTalk® View software, the recipe parameters can be managed and stored in the central database and simply downloaded onto the plant floor as required,

In addition, an integrated control solution can help speed the qualification process at the start of each new run and help ensure tire quality. By collecting key information regarding equipment calibration, pressure levels, and other recipe parameters from the curing press during the qualification process, tire manufacturers can identify machinery or tire bladder problems quickly and make necessary repairs or replacements.

The system can be programmed to prevent press runs until a qualified tire bladder and mold are recorded in the system, thereby reducing premature runs and resulting waste.

Curing Press Machine Architecture



In this solution, an Allen-Bradley® CompactLogix™ programmable automation controller is used, which communicates to the Allen-Bradley® PanelView™ Plus 6 Human Machine Interface (HMI) through EtherNet/IP. Allen-Bradley® POINT I/O modules are used to handle remote digital inputs and outputs. The EtherNet/IP network enables connectivity from a stand-alone machine to the plant wide information system as well as group control capability.

Process Optimization

With “classic” control systems, tire manufacturing phases cannot be initiated independently during commissioning. As a result, the machines are more difficult to troubleshoot and validate on the production floor.

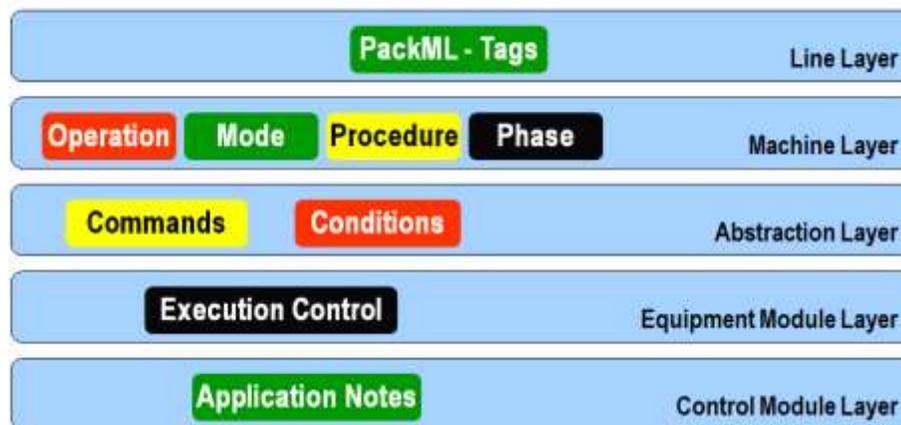
A modern control system can be implemented to allow for a manual mode where phases are run independently. The presses are designed to have three true modes of operation:

- **Manual Mode** - all machine components can be manually actuated and all processes can be carried out manually.
- **Mold Change Mode** - - for tool changes, maintenance and cleaning.
- **Automatic Mode** - tire loading and unloading functions are automated and the entire process is controlled by pressure and temperature control loops inside of the IEC 61131-3 application

In the past, manufacturers would use pen and paper to manually chart tire curing temperature and pressure throughout the curing cycle.. Today with a Rockwell Automation integrated control and information solution, manufacturers are able to, connect tire curing machines to a central server over EtherNet/IP and view chart information online via a web browser and historian.

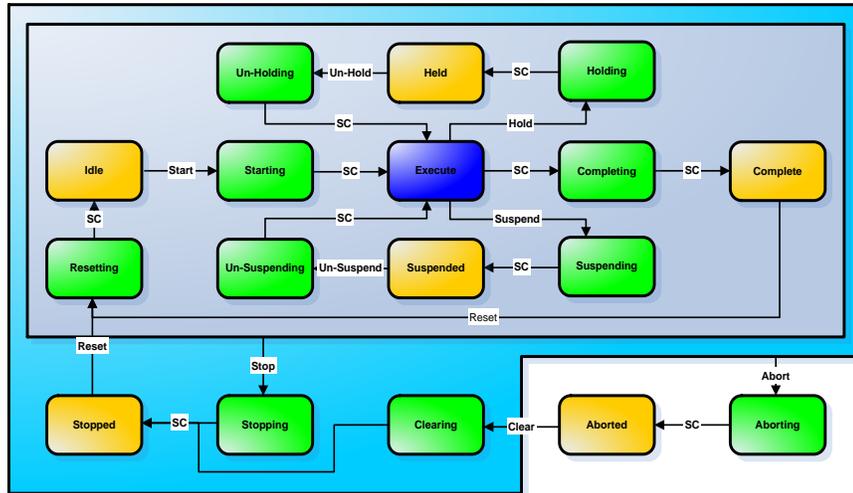
Development Tools

Structure Programming Overview



Use of Structured programming allows the OEM to develop flexible a control program that allows for future machine functions and innovation to be easily incorporated to the control program. Keeping a modular approach the development of the applications code, enables the OEM to develop standard routines that can be easily use across a variety of machines that have similar functions, saving engineering and software development time.

Program Templates allow you to view HMI using a machine state model

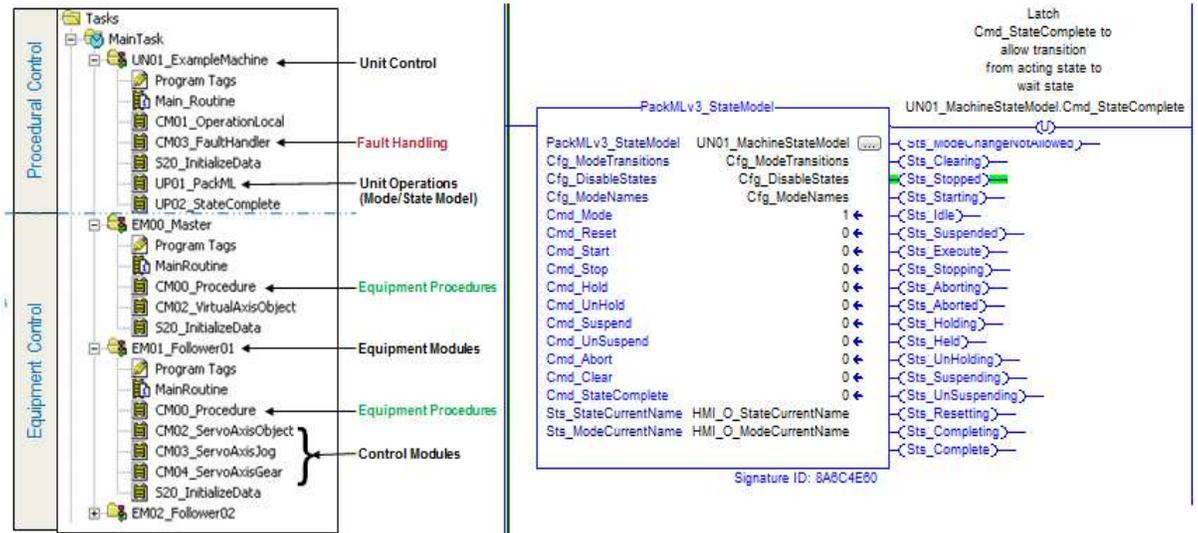


State model Template

Using a state model structure to control the machine, ensures that the machine control logic is easy to understand, and allow for easy troubleshooting, machine fault diagnosis and identification of the current status of the machine.

Rapid Application Development

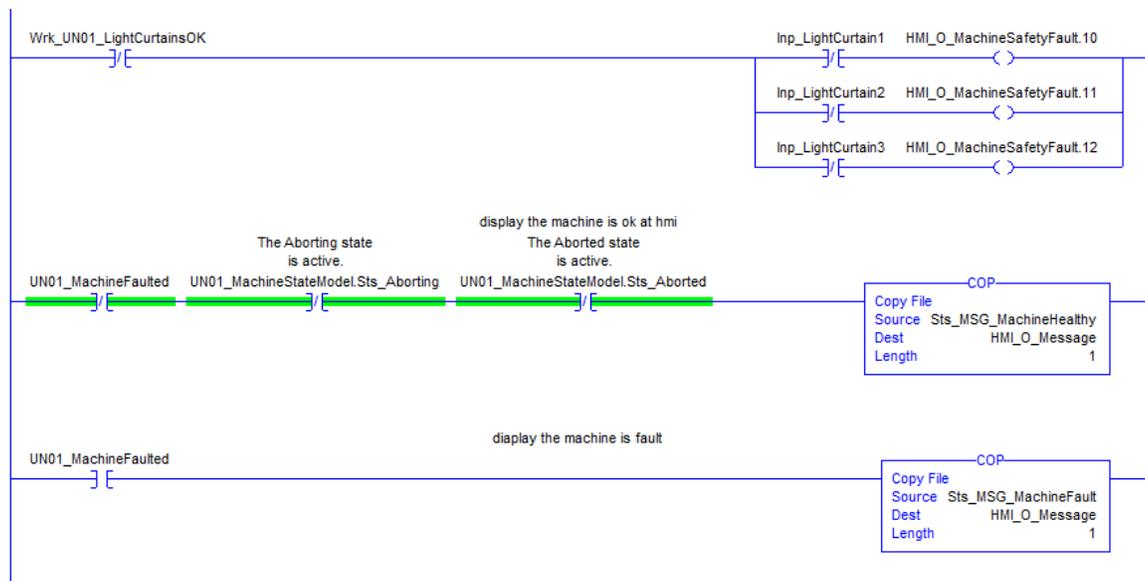
Using power programming template & state model AOI you can reuse code segments and create new instances of the program. Effectively you are reusing the same logic for different instances.



Flexible Fault Configuration and Handling

By collecting key information regarding equipment calibration, pressure levels, and other recipe parameters from the curing press, the control system helps identify problems quickly, enabling faster repairs or replacements.

Fault Messages are configured locally in the Equipment module. These messages are logged and displayed via FactoryTalk® View software. Details include the program name where the fault is logged, routine name, fault message and a detailed fault message.



OEE and MES Systems

With a Rockwell Automation information system, you can quickly access and manage a wide range of curing mold information including:

- Overall Equipment Effectiveness (OEE)
- Tire type allocation and tire grading
- Mold assignment identification
- Bladder assignment
- Cycle count for cleaning and retooling
- Production statistics
- Pressure and temperature historic analysis
- Mold retooling status

In addition, the curing mold information system can be configured to provide

- Process and recipe management
- Mold and bladder assignment recording
- Condition and tooling monitoring
- Preventive maintenance management and scheduling

Ease Regulatory Compliance

Discrete tire tracking begins in the curing process, when a bar code, RFID code or permanent marking is applied.

A Rockwell Automation information system can seamlessly link with the final finish system to provide the data needed to comply with parts traceability and product genealogy requirements around the world, including the TREAD Act, E.C.E. requirements and specific country stipulations.

Global Solutions – Locally Delivered

Whether you're around the corner or around the world, our Services & Support network can provide the skills and resources you need to optimize performance and utilization of your automation equipment, helping you meet your business objectives.

- Global emergency support 24/7
- Offices and agents in more than 80 countries
- 35,000 distributors and agents
- 1000 service engineers, consultants and project managers worldwide

Summary

A Rockwell Automation integrated solution delivers critical, real-time information throughout the curing process to help enable “just-in-time” operation. From the curing workstation HMI to the line supervisory, plant and business enterprise levels, the information system seamlessly links with the Logix controllers to provide the data needed to monitor the tire curing process, create realistic production schedules, improve overall equipment effectiveness (OEE), and track tire production.

Running on standard, open networks, the information system combines the capabilities of an off-the-shelf performance and visibility software platform (FactoryTalk® View) with production management (FactoryTalk® Metrics) and finite capacity analysis (FactoryTalk® Scheduler) applications to provide a complete solution.

Significant financial savings can be realized, including achieving increased manufacturing throughput as well as benefits from greater visibility, tracking and control of operations.

Let Rockwell Automation be your solution experts in tire curing. Helping your business succeed and grow is what we do best, with power, control and information solutions designed to give you a competitive advantage. Our in-depth understanding of the policies and requirements affecting you can help you reduce business risk, improve operational efficiency and achieve faster time to market.

Let Rockwell Automation be your answer today!

With the Rockwell Automation Integrated Architecture system, EtherNet/IP technology and PID/PIDe functionality, the MESNAC curing press machine was able to

- Control the temperature within a range of ± 1 degrees. The pressure can be controlled within a range of ± 0.1 MPa.
- Improve productivity by 10% thanks to cycle time reduction, repeatable performance and integrated information.

“After adopting the Rockwell Automation control system, we have achieved a more flexible equipment control architecture for the curing presses. Control speed has increased and data collection is more convenient, which has enabled the quality of the equipment to improve significantly...”

MESNAC



Customer Case Study

MESNAC is a leading tire and rubber tire machinery supplier. By implementing a Rockwell Automation Integrated Architecture system, they increased curing press temperature and pressure control accuracy by 50%, and improved productivity by reducing cycle time.

Temperature and pressure control is crucial to the curing process. In a typical curing application, pressure and temperature is controlled throughout a dozen or more incremental processing steps. The previous MESNAC tire curing machines used electro-mechanical limit switches and drum timers to control these steps in accordance with specific set points. Typically, these systems had a cycle time of 8–20 minutes per tire.

Results of Implementing a Rockwell Automation Solution

Improved Curing Cycle Time

By replacing existing limit switches and timers with a Logix control system, curing presses are able to reach the appropriate pressure curve for each curing step quickly and accurately. With repeatable performance, orders are easier to schedule and sequence. And thanks to built-in diagnostic capabilities, operators can quickly troubleshoot equipment and make necessary repairs. As a result, press productivity has improved up to 10% overall.

Optimized Process with Information

From the curing workstation HMI to the line supervisory, plant and business enterprise levels, the curing mold information system seamlessly links with the Logix controllers providing data to monitor process, improve overall equipment effectiveness (OEE), and track the production.

Resources

Call a Rockwell Automation sales office or an authorized distributor today or visit us online at: www.rockwellautomation.com/solutions/oem

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