Automation in Gas Fired Heat Treat and Forging Operations

By Justin Dzik

Automation has been present in the gas fired heat treat and forge marketplace for many years. The current state of automation within heat treat and forge commonly consists of individually controlled processes, such as furnace heating cycles, material movement, press operation, and quench cycles.

A full cell automation approach, which consolidates all these automated steps into a closed off cell, is uncommon in the domestic marketplace today. The future state of heat treat and forge automation is trending toward connecting the individual processes within a single closed off work cell, and implementing an end-to-end process control system.

There are many advantages to full cell automation, such as safety, productivity, and quality. With all moving equipment fenced in, most of the safety hazards could be contained away from human interaction. Productivity and quality are also maximized as heating times, door opening times, quench times, and movement times are consistent. The automated system can track individual parts as they make their way around the process, allowing for quicker part failure detection and troubleshooting of the issue, while automated data collection and production reports provide information that suppliers can present to their customers.

Prior to full cell automation, it is worth discussing different items that make up a typical cell. These will be called Level I devices. Furnaces, manipulators, robots, and quench tanks will all have Programmable Logic Controllers (PLC) that run the device. These will be programmed to control the device, but in general, they do not have knowledge or awareness of the other devices in the cell. The interaction between them is usually manually driven through human interaction.

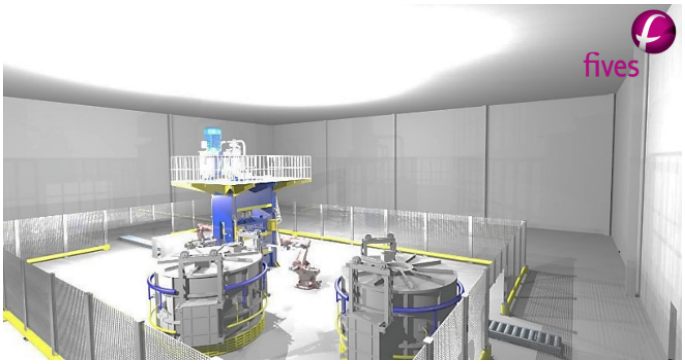
Full cell automation requires the implementation of a central Level II control system. The Level II system will control and coordinate all Level I devices. Depending on the configuration and process, some cells are first in/first out (FIFO) and some require material movement optimization and scheduling. The Level II system can handle these tasks with custom-written software to fulfill the needs of the end user.

The Level II control system is usually a custom-written computer program that communicates with all Level I devices and directs the actions of the cell. Level II is the brains of the operation and, as such, is responsible for coordination and optimization if required. These highly intuitive controls provide real-time data, presenting information like piece scheduling, position, and temperature. Fives DyAG in Farmington Hills, Michigan is a controls integrator capable of writing fully customized code in a multitude of programming languages and PLCs, making them very well suited to create solutions for this market.

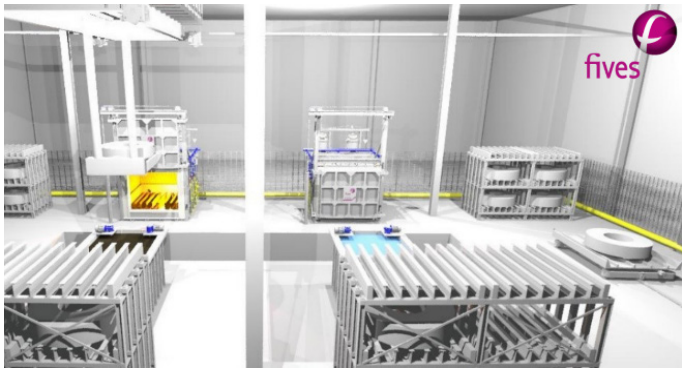
Closed cell automation can be applied using almost any type of furnace. Most commonly used furnaces in fully automated cells are rotary furnaces, box style furnaces, or tip up furnaces. Rotary furnaces are primarily used in FIFO type operations where more continuous type operation is required. Box style or tip up furnaces can be used in cases where more optimization or customized loads would be required. These are no set rules for each cell, rather generalizations made through observations of domestic forge and heat treat shops. A typical box forge supplied by Fives North American Combustion and North American Construction Services is shown in the picture.

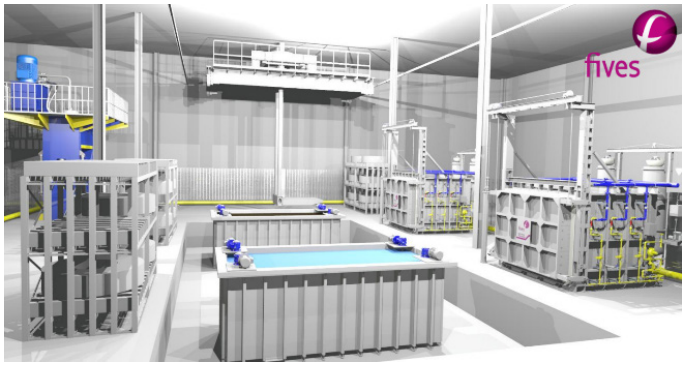
Material movement can be handled by a robot or a manipulator. Smaller weight pieces where furnaces are closely coupled to the next operation could be handled by a robot. Larger pieces or operations that require longer travel would need to be handled by a manipulator. Manipulators are usually custom devices that could be rail bound, wheel bound or overhead. A common type of rail bound manipulator supplied by Dango & Dienenthal is shown in the picture.

Two examples of automated gas fired forge and heat treat cells are presented. The first is a FIFO type operation with rotary furnaces, a forging press, stationary robots, and ancillary equipment on the downstream side including piece inspection and piece marking. In this cell, pieces are presented using an incoming roller conveyor. From there, they are picked up by a singular charging robot and put in one of two rotary furnaces. After a full rotation in the furnace and the piece is heated, the same robot discharges and places the piece in the press for the forming operation. A die lubrication robot and a discharge robot complete the automated movements. A Level II control system in this cell would control all movement, furnaces and the press, and record all data for a part history report.



Another example includes box style furnaces, quench tanks, an overhead style manipulator and incoming conveyors that present the parts to the cell. In this example, the parts are presented and placed in storage. The Level II system will develop a schedule based on operating parameters to that specified load. Based on the parameters, Level II would control the furnaces and their temperature, quench tank temperatures and transfer time from furnace to quench tank. After all operations are finished, the manipulator would place the pieces back on the transfer car to exit the cell.





There are many other automation opportunities that exist in a forge and heat treat facility not discussed here, such as part inspection, part marking, and quenching within a cell. Other opportunities exist outside the cell upstream and downstream of the cells, such as intermediate and final finishing machines, all able to be scheduled and optimized by a larger control system. However, the Fives North American Combustion automation process presented increased safety, productivity, quality, and provided real-time cell data—saving down time, reducing production loss, and easing troubleshooting processes. Combined with the fully customizable, level II controls technology of Fives DyAG, along with other industry leaders such as Dango & Dienenthal for movement, the Fives North American team is successfully positioned to provide fully automated services into the market. ■

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