PROCESS AUTOMATION IS REDEFINING HOW fastener parts ARE HEAT TREATED

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Today, fastener manufacturers want controlled uniformity in the mechanical properties of their heat-treated parts. The major challenge has always been in maintaining the process requirements as the parts move through continuous furnace applications. The manual methods of controlling multiple zones of temperature, atmosphere, agitation, belt speed(s), loading, unloading, quench media, etc., add up to many opportunities for error in maintaining exact specifications. Fastener manufacturers who must meet higher quality certifications, quicker turnaround and documented proof of performance don't have the time or the profit in their jobs to waste on trial and error.

Peter Hushek is president of Phoenix Heat Treating, a fourth-generation heat treater, and owner of one of the largest and leading heat treating companies in the southwest. "A bad atmosphere that's even slightly out of calibration can cause many delayed onset problems for fastener manufacturers," Hushek said. "Why take chances when there have been significant advances in heat treating that guarantee that the process has been performed exactly as you have specified?"

Precise measurement and control can be challenging when operated manually, but the new technology has led to tighter process control and higher quality standards, while keeping costs down. Temperature and atmosphere control affect the composition of the part as it is heated and transformed. Typically, atmosphere is controlled by using endothermic gas to either carburize or prevent decarburizing on the parts processed. If the temperature or atmosphere deviates, the desired results cannot be achieved.

Hushek is a pioneer in the use of heat treating automation. In 2001, his collaboration with Steve Thompson of Super Systems Inc., based in Cincinnati, Ohio, led to the development of logic control systems that allow temperatures and atmospheres to be guaranteed based on customer variables. Because of pioneers like Hushek and Thompson, huge advances in control-sensor technology and automation have driven processing requirements to acquire more detailed information and achieve greater accuracy, maintain safeties and reduce opportunities for error. Today's process control is really about providing fastener manufacturers with a greater ability to achieve repeatable performance, remain cost competitive and have access to all the data that backs up the required results in real-time.

"I think about quality processing all the time," said Paul Tiffany, manager for Copper State Bolt and Nut Company's Phoenix manufacturing division. "We sell fasteners all over the world and have to maintain customer-defined specifications on every shipment. Having verifiable data assures us that our quality is consistent."

A common practice is controlling the endothermic gas up-stream on the endothermic generator. The endothermic generator creates an atmosphere to provide a positive pressure in a heat-treating furnace and a platform on which a carburizing or decarburizing environment can be formulated. The most common source of endothermic gas is the reaction product of air and natural gas. Gas providers today are obligated to provide customers with a gas meeting a BTU rating, but that does not mean the gas being provided is made up of just methane. In this situation, the endothermic gas produced may not provide the necessary atmosphere the process requires. This is where automated controls working with sensor technology are used to maintain a quality atmosphere that the parts are exposed to. Microprocessor-based controllers calculate and display dew point, control output for maintaining the dew point set point and generator temperature. With these inputs, the controller regulates the addition of enriching gas or dilution air to achieve that critical atmosphere necessary in the furnace.

"It's paramount to keep threaded components free of surface contamination, which can be managed with real-time visibility in the automated furnace," Hushek said. "The programmable controller can be set to hit your target values from start to finish."

The precision control of the variables of heat ramp-up, carbon-boost and carbon diffuse, cool down and quench delivers a guaranteed process that can be duplicated by logic systems to be the same every time. Simulation software such as Super Systems CarbCALCII carburizing simulation and control software can be used to identify how an out-of-control situation related to temperature or atmosphere can produce undesirable results before the parts are run. The nature of a continuous furnace is such that furnace openings and impurities from parts and quench oil are always playing a factor in control. However, atmosphere control in multi-zones provides precision control that fastener manufacturers desire. Phoenix Heat Treating has multiple oxygen-probes that are used to ensure proper atmosphere, one located at the beginning of the heat cycle and one just before quench. The oxygen sensor is connected to a microprocessor-based controller that uses that information to determine if the atmosphere is at the desired set point. The automated PID (proportional integral derivative) controller uses the information, along with numerous con-

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Peter Hushek and the automated, continuous cast link belt furnace that is used to process fasteners, stampings and screw machine parts. The furnace can handle 2,500 pounds an hour for either neutral or light case work.

trol parameter settings, to add enriching gas or air to meet the desired set point. Most conventional heat treaters will use either fixed gas flows or a single oxygen probe.

When using process automation, customers can be assured that parts are delivered to pre-defined specification with proof of process using data acquisition. Another advantage is the ability to run different processes for different fasteners on the same furnace. Because of the variation of speed, temperature and atmosphere, the more in-situ sensors tied in with controls, the greater the utilization of the furnace without compromising the results.

Process automation has led to simplification. Phoenix Heat Treating's continuous furnace runs itself from customer programs that are stored in the data system. Time, temperature and atmosphere are controlled from start to finish by the programmable controls, and the electronically documented process is stored in the logic center and printed out for verification of processing. Hushek said the furnace can be remotely controlled from a laptop anywhere in the world to make adjustments in any of the variables.

The fastener manufacturers who are using the new "intelligent heat treating," as Hushek calls it, are reaping the rewards of traceability and verifiable data that show load characteristics and proof that the processing meets industry certifications. SCADA systems (Supervisory Control and Data Acquisition) are known for providing quick access to this information and a foundation for plant automation.

"There's not enough manufacturing capacity to produce fasteners for the aerospace industry today," said Bob Herber, Arizona operations manager for Pilgrim Screw. "Most companies are quoting one to two years for delivery. We're quoting 26 weeks, and when our shipment arrives, it has to meet AMS-H-6875 (Department of Defense) certifications. With Phoenix Heat Treating's automated processing, we receive electronic documentation with time-dated traceability that guarantees the consistency and quality."

Peter Hushek verifies automated processing control set points before heat treating a fastener job. The programmable logic controllers automatically run every system in the continuous cast link furnace.

The goal of these systems is to provide a user-friendly environment to enter data associated to the load and make the process of gathering this information quick and easy. Scanning technology, computers and loading systems provide a method of automating this process.

The other benefit to SCADA systems is the reduction of paper. With control and sensor technology available today, data is logged using direct communications to controllers and accomplishes the same thing as a paper recorder with a significant amount of additional functionality. The data that is logged can be viewed by many people throughout the plant and is very easy to retrieve. When valuable information is accessible to multiple parties, others can take advantage of it. Maintenance, quality and production planning all have quick and easy access to information. The direct benefit comes with reliability and integrity of the data as well as a reduction in maintenance labor to support the equipment. Information, both real-time and historical, is accessible at your fingertips, and there is no more changing paper stock on the recorders.

With automated processing, heat treating of fasteners can be simulated on a computer, with your variables programmed in memory, before the job is actually run. The computer simulation will determine if the recipes need to be adjusted in advance of running the job. Once the variables are logged in, the programmable controls drive the automated process, and each processing step is tracked and time-stamped with an electronic record that retains all the process data. With one operator and computerized automation, your next processing job will be a duplicate of the previous job.

For fastener manufacturers, automated control of your heat treating processes will guarantee higher quality, quicker turnaround and more competitive costs. ■

Phoenix Heat Treating, a leading heat treating company in the southwest U.S., is located in Phoenix, Arizona. Peter Hushek, president of the company and a metallurgical engineer, is a fourth-generation family heat treater. The company has been a leader in the development and implementation of state-of-the-art automation, computerized modeling and programmable control systems. For more information on automated heat treating, contact Phoenix Heat Treating at 602.258.7751, or visit www.phoenix-heat-treating.com.