

INDUCTION HEAT TREATMENT CHALLENGES IN A HIGHLY DIGITIZED WORLD

The technology of heat treating by means of electromagnetic induction is advancing at an accelerated rate, addressing new challenges and a rapidly changing business environment. The variety of parts gets larger while product cycle times get shorter. In many induction applications, heating time is less than a few seconds and is only a fraction of a second in some cases.



Factors traditionally used by commercial heat treaters to evaluate induction equipment include technical capability, performance consistency, delivery time, machine longevity, and price. With recent industrial trends, the decision to purchase heat treat equipment also requires consideration of additional factors including equipment flexibility, traceability of component heat treatment quality, digital connectivity, and the ability to store and access process data.

Piece-by-piece processing capability with individual component traceability, readiness for automation, and digitization of process control and monitoring have always been among the most attractive features of induction heat treatment relevant to the fourth industrial revolution (Industry 4.0). Continual advancements in microprocessor and microcontroller technology have resulted in previously unavailable sophisticated control/monitoring systems.

However, such sophistication can add considerable cost to equipment, discouraging some aspects of implementing Industry 4.0 operating strategy. For example, including all possible “bells and whistles” into equipment design to enhance monitoring/control capabilities and digital data collection might result in a price that greatly exceeds what the buyer is willing to pay. That is a reality.

Also, extremely large amounts of data gathered must be analyzed to assess how changes in the process affect the product, which takes time and costs money. It might be more sensible in some instances to use less involved monitoring and control techniques, with appropriate preventive and/or predictive maintenance programs. Therefore, the question for the prudent engineer changes from “What can be done?” to “What needs to be done?”

One of the first steps in implementing industry digitization is applying digital meters that use special integrated circuits as an alternative to analog meters widely used in the past. Used within their rating, digital meters provide accurate measurement of the power supply output electrical parameters. Because the response time of digital meters could still be too slow for rapid induction heat treat processes,

some manufacturers provide a quick-responding bar graph in combination with the slower responding digital readout of the parameter value in the same meter housing. However, more work needs to be done to further reduce response time of digital meters and circuits.

It is expected that signature-type monitoring of the process in real time will continue to be in high demand. The system verifies critical machine settings to provide confidence in processing quality parts. Modern heat-treat systems offer control, data acquisition, and signature monitoring in one package using a computerized front end with human-machine interface (HMI) coupled with PLC control to provide the best of both technologies. Many manufacturers have developed proprietary solutions for digital monitoring circuitry, which increases accuracy and minimizes response time.

According to the Law of Large Numbers, installing an excessive number of sensors, detectors, and related devices/systems could negatively impact equipment uptime and overall system reliability. Therefore, it is imperative to establish a minimum number of truly crucial process parameters for a heat treat application that requires monitoring, which is why the design of modern induction equipment has become holistic. Attempts have been made to design modern induction systems that have a sophisticated, rigid construction, yet a simple design with minimum components making it more reliable, compact, and easier to operate and maintain. Every effort must be made to detect and prevent defective parts from reaching the assembly.

Cyber security has become crucial in our highly digitized world due to the potential risk of hacking, compromising process recipes/protocols/validation and equipment calibration, as well as digital data collection. Electronic records must be created and stored, and measures should be taken to avoid their alteration without detection. This is associated with appropriate programs and implementing safety features, and results in additional cost, which can be challenging for some small-size equipment manufacturers.

In the past, suppliers would often have a particular part contract for many years. Today, contracts can move from supplier to supplier much more frequently. Therefore, winning a contract over the competition could require a supplier to evaluate new induction equipment to ensure it can perform the job, purchase and set up the machine, complete a production part approval process (PPAP), and be production-ready in a short period of time. Modern high-quality, reliable equipment should allow easy retooling and reprogramming to process different parts. Development of innovative power supplies (for example, Inductoheat’s IFP technology) that enable instant, independent adjustment of power and frequency in a preprogrammed digitized manner during the heating cycle represents a significant step forward in enhancing equipment flexibility and optimizing metallurgical quality of heat-treated parts.

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