It is also effective at preventing equipment failures, scheduling necessary maintenance, and identifying problems that occur between scheduled inspections.

In the end, predictive maintenance systems generally carry a corresponding high benefit-to-cost factor, resulting in a specialized solution for the most essential components of a larger system — in this instance, a heat treatment furnace. To fully implement lean manufacturing principles and eliminate unnecessary processes and actions, gear manufacturers should also utilize the latest advancements in low-pressure carburizing technology.

LOW-PRESSURE CARBURIZING (LPC) VACUUM TECHNOLOGY

In addition to the IoT contributing to lean manufacturing objectives, the use of advanced LPC equipment and technology also has a significant impact on refining operations and allowing gear manufacturers to reduce unnecessary processes and actions.

With a focus on utilizing the IoT to optimize operations through data collection, data computation, and production maximization, this mode of operation increasingly requires the use of sensors to adjust the furnace’s operational parameters. Accompanying this shift in operation requirements is a need for vacuum equipment that meets these new criteria — both in equipment design and integrated technology.

When it comes to LPC in vacuum furnaces, the goal is clear: to uniformly carburize all workpiece components within a load to the same surface carbon content and to the same case depth. Overall, low-pressure vacuum carburizing is marked by its ability to provide precise process control, which in turn, contributes to lean manufacturing initiatives as it results in uniform part microstructures, process repeatability, and a reduction in manufacturing and maintenance costs.

The journey that resulted in multi-chamber LPC vacuum systems (e.g., Ipsen’s ARGOS line) and accompanying process technology started in the 1960s when development work began to provide a low-pressure carburizing technology that was fully competitive with gas carburizing. At the time, LPC offered a myriad of benefits with respect to process time, component quality, and minimized fluid burnoff and heat emissions, but it still had a high amount of soot forming in the furnace. In addition, there were high maintenance requirements when propane was used as a carburizing gas with relatively high partial pressures. However, in the mid-1990s, acetylene was discovered to have superior qualities as a reactive gas in vacuum carburizing.

This discovery resulted in Ipsen’s AvaC® process (acetylene vacuum carburizing). This process lends itself extremely well to
utilization in combination with high-pressure gas quenching and is ideally suited for integration into production lines. Overall, the result is heat treatment processes that produce parts with minimized distortion, as well as high load repeatability and uniformity throughout the entire system. In addition, today’s new technology for multi-chamber LPC has resulted in an innovative modular furnace design that allows the heat treatment process to be seamlessly incorporated into the overall production processes.

An added benefit of refining LPC equipment and processes is that companies have the ability to optimize the manufacturing process, which ultimately results in the production of high-quality gears with lower cost per part.

APPLYING LEAN MANUFACTURING TO THE GEAR INDUSTRY

Another main objective of the lean manufacturing movement within the gear industry is to increase productivity by reducing work-in-process inventory. However, as the supply chain becomes leaner, it also becomes more vulnerable to production interruptions caused by equipment breakdowns. In these situations, implementing predictive maintenance systems is an important and necessary element to ensuring seamless gear manufacturing.

Predictive maintenance is emerging as a powerful tool within the heat treatment industry for analyzing performance and efficiency. By integrating a predictive maintenance system with heat treatment equipment, you can monitor equipment in real time and capture data that helps refine furnace operations. For example, rather than replacing hot zone components or checking for discoloration based on how much time has passed, algorithms running in the background can analyze a variety of data points to let you know at the earliest possible time that a negative deviation has started. Other process parameters and furnace conditions that can be monitored include:

- Pumping performance and trending vacuum levels, which are then compared to ambient humidity conditions and the leak-up rate
- Cooling motor vibration, providing early warning of motor bearing failure
- Several hot zone data points, looking for trends that may produce failures or reduced uniformity
- Trend changes of numerous real-time data points that are early indicators of component or furnace problems

In the end, bridging this gap between the new generation of multi-chamber LPC vacuum furnaces and the integration of furnace operations with the entire manufacturing process is the Internet of Things. As companies utilize the IoT in the form of sophisticated software that analyzes key data, gear manufacturers can continue to work toward meeting lean manufacturing objectives, as well as enhancing overall production speed and process quality.

ABOUT THE AUTHOR: Janusz Kowalewski is a well-recognized industry expert in the thermal processing industry who, over the past 26 years, has worked in the United States, China, Europe, and India. Joining Ipsen in 2016 as Director — Business Development for the ARGOS product line, Kowalewski’s valuable insight and global experience allow him to effectively implement new technologies and drive product development. Discover the power of predictive maintenance and how to implement the IoT into your own manufacturing operations at www.IpsenUSA.com/PdMetrics. To learn more about LPC technology, visit www.Ipsen.de/en/ARGOS.