Checking Up on Your Heat Treater

What Quality & Performance Characteristics Should You Look For?

Matthew Jaster, Senior Editor

"On the left, you'll see our state-of-the-art heat treating facility that includes two carburizing furnace systems and a large, custom-designed quench press." Over the years, I've toured many a gear manufacturing facility where the heat treat department stole the show. Maybe it's the massively deep pit furnaces, the Star Trek-esque control rooms and the large overhead cranes moving components around the facility. Perhaps it's simply all the pyrotechnics remind me of a really great rock concert. Regardless, heat treating is such a critical step in the gear manufacturing process it's no surprise several manufacturers have brought it in-house.

Others continue to outsource the work to a heat treat provider that provides stability, quality and a trouble-free end product. Why do they work with the same companies time and time again? How do these relationships form in the first place? What steps should you take to determine what heat treat company you should work with? We asked gear manufacturers, heat treat providers and consultants to weigh in on these and other related issues.

Three important factors when selecting a heat treater include technology, material handling and technical knowledge and expertise (photo courtesy of Dreyfus + Associates Photography).

The Manufacturers Perspective- Nordex

Nordex Inc. manufactured standard components in the 70s and early 80s before turning to custom work giving the company's engineers more freedom to design new products and bring innovative ideas to its customer base. Nordex's custom components have appeared in aerospace, marine and medical applications to name a few. By combining electro-mechanical expertise with clean room capabilities, the company now performs manufacturing systems integration for semiconductor and analytical equipment as well as precision machining, gear design and production.

Nicholas Antonelli, senior engineer at Nordex Inc. provided *Gear Technology* with some insight on outsourcing heat


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treatment services. "The first thing Nordex would look for is accreditation by an outside agency such as Nadcap for process specific certification as well as general quality system certification to an ISO or AS standard," Antonelli said. "We would also need to ensure that the supplier has the equipment needed to perform the desired operation, as well as verify that the process has been performed correctly."

Auditing a supplier to verify that they are qualified to perform the processes you have specified is always a good idea, according to Antonelli. "The auditor should be experienced and have a good working knowledge of the heat treating process as well as general process control, inspection and verification, calibration and record keeping."

At the very minimum, Antonelli believes a certification of conformance is required (all the required responsibilities and heat treat services are met and recorded in a certified document). "Depending on the requirements of the end customer, we might also request an inspection report detailing actual hardness readings," he said.

Reviewing the heat treater's preventive maintenance program is another important step. Antonelli believes the heat treat provider's preventive maintenance program should mirror the gear manufacturer's program. "Our own equipment is maintained with a comprehensive preventive maintenance program and our equipment is calibrated to known standards on a regular basis. We would require our heat treating sub-contractors to have the same level of control on their own equipment," he said.

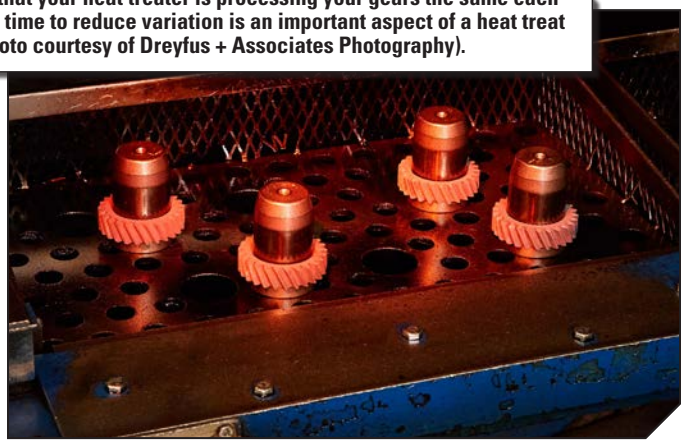
"The primary concern when heat treating the gears is the possibility that the gear will distort or change in size," Antonelli said. "To allow for this, the gear manufacturer needs to ensure that sufficient extra material is left on the part so that the post heat treatment machining can bring the features back into specification."

Sounds pretty straightforward, right? Of course, things don't always go according to plan and miscommunication can cause a number of problems.

Problems may arise from time to time; however, technology is doing its part by making it easier to collect and process data for each part a heat treater works with. "I don't know if heat treating itself is changing as much as the materials that are being used," Antonelli said. "There are many 'new' stainless and alloy met-

Auditing a supplier to verify that they are qualified to perform the processes you have specified on your part is a key step in the process (photo courtesy of Nordex).

Knowing that your heat treater is processing your gears the same each and every time to reduce variation is an important aspect of a heat treat audit (photo courtesy of Dreyfus + Associates Photography).



als that require specialized treatments. What *is* changing is the data and the information this data yields as well as the ability to track individual parts in each heat treat lot," he added.

The Manufacturer's Perspective-Forest City Gear

Forest City Gear manufactures custom gears in a variety of industries including aerospace and defense, medical, off-highway, transportation and many more. The company recently invested in several systems that allow FCG to prototype, qualify and produce gears in a wide range of sizes and volumes. Jeff Mains, director of technical operations, Forest City Gear, shared what his organization looks for from a heat treat provider.

Mains' first step is going over the basics before shipping the parts. "You need to verify the heat treater's quality system and make sure it's certified and current. If they need to be Nadcap certified this should also be current. It's also important that they have a full-time metallurgist on staff and can perform the heat treat specifications you're asking for. Additionally, can their lab perform the necessary tests in order to certify the product?"

If an audit takes place (and it should), Mains believes it's a good idea to audit all the services you're asking the heat treater to perform. "This should involve the QC manager, purchasing, a process engineer and a quality engineer. If *you* have a metallurgist on staff or have one as a consultant, they should also be asked to attend."

A list of additional capabilities and guidelines necessary when choosing a heat treater include the following according to Mains, "Can they produce their own tooling if necessary? Do they have the capacity to fulfill delivery dates? Do they have the ability to mask if required? How do they handle parts? What kind of work instructions are created on the floor? How well do they stand behind their work if there are problems?"

To keep all heat treating records documented and verifiable, FCG utilizes Kwiktag, a document management system that provides one integrated solution that coordinates every document, department and business process (*www.kwiktag.com*). "Records for heat treating must be retained in case there is a field/test failure and they need to verify the heat treat was performed correctly," Mains said.

The Heat Treat Perspective-Paulo Products Company

Paulo Products Company saw a need for commercial heat treating in 1943. They've built the company on custom systems that can trace every order from receiving through production and shipping. Notably, the company designed its production information and customer service system in-house with help from its own metallurgical experts and engineers. Bob Innes, sales manager, engineered projects at Paulo, discussed considerations that should be made before selecting a heat treat provider.

Three important factors according to Innes include state-of-the-art technology (furnace controls, PLC controls with bar-coding, electronic monitoring and data recorders), material handling systems to prevent damage and the technical knowledge and experience needed for each unique job and application.

"We believe it is critical to audit your heat treater-you are releasing your gears into the control of a supplier," Innes said. "You want to see how they handle your gears to prevent damage, how their furnace controls and inspection procedures

ensure you meet print specifications for case depth and hardness. How you know you'll get the same process time-after-time to reduce variation."

At Paulo Products, every lot has a computer-generated shop order with process recipe instructions, loading/handling criteria (with photographs) and inspection requirements. Shop orders become permanent records with operator sign-offs as verification of completion. These are scanned for electronic retrieval, including remotely. Furnace permanent records are also electronic and retrievable remotely. "This is crucial for repeatability and traceability," Innes said. "We keep records for at least seven years and for many customers we keep records for longer periods."

Training and re-training is also pivotal to stay ahead of the competition. "We have a training program that includes Metal Treating Institute (MTI) courses, classroom training, mentoring with existing operators and training with our staff of metallurgists. On the operator level, we have high screening standards, and have a great deal of success using referrals from current employees," Innes said.

Quality control is constantly evolving. "Paulo's QMS is registered to ISO-TS16949, which forms the basis. We take it far beyond the ISO/TS requirements through data and technology," Innes said. "We've developed our own in-house system for process control and repeatability."

Beyond these important steps, Innes stressed the importance of seeing exactly how the heat treating facility is organized. "Is it clean and free of clutter? Is product easily identified? Even if you're not conducting a full-blown audit, you'll want a tour of your heat treater."

Paulo has developed its own in-house system for process control and repeatability of its parts (photo courtesy of Dreyfus + Associates Photography).

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HEAT TREAT HORROR STORIES

We've all heard stories of gears gone wild. There are gears that look one way when they leave the shop and look entirely different when they come back. There are gears that never come back at all. There are even gears that can't do what they were manufactured to do and end up on a coffee table or on the bottom shelf of a warehouse with the other misfit toys. The takeaway from a good heat treat horror story? You learn something new each and every time things don't go according to plan.

"We had a case where a customer made a frame for a machine out of A2 air hardening tool steel. The frame walls were two inches thick. The customer mistakenly asked for a hardness of 50 Rockwell C when they actually required a hardness closer to Rockwell 60 in the C scale. The heat treater suggested re-treating the steel, but this time quenching the steel in water to get the required hardness. Needless to say, the cracks in the frames were visible from across the room. This was one case where the parts needed to be remade," said Nicholas Antonelli, senior engineer at Nordex Inc.

Jeff Mains, director of technical ops, Forest City Gear, reflected on a heat treat job that caused some problems in the past. The application in question called for the parts to be quench plugged. FCG had done extensive testing to determine the correct recipe and the time had come to process the order. "All went well until we received the parts back. The parts had exploded in size by almost .050," Mains said. "We discussed our findings with the heat treater. He did not know what went wrong. To his knowledge the parts were processed the same as the test pieces. We asked him to do a little investigating. After he dug a little deeper, he called and said that he had found out from the operator that they were having a difficult time inserting the plug. So to make it fit the operator decided to deep freeze the plug -100 below zero. Of course then the plug dropped in with no problem because the plug had shrunk considerably."

The problem was that when they quenched the part it expanded and caused the part to grow much greater (.050) than the test pieces. The operator took it upon himself to do this before asking for assistance, according to Mains. "We lost the entire lot. Their inspection department did not check to make sure the parts had moved the predicted amount as the test pieces did before they shipped parts to us. The reason why the plugs did not fit on the production run, was that it was found the recipe (time/temp) was not followed as instructed."

Have a heat treat horror story about gears? We'd love to hear about it and publish our findings in an upcoming issue of *Gear Technology*. Contact *mjaster@geartechnology.com* with your anecdotes.