GEAR HEAT TREATING IN THE 90s: BEYOND BLACK MAGIC

INCREMENTAL IMPROVEMENTS MOVE HEAT TREATING FROM ALCHEMY TO PREDICTABLE PROCESS.

HEAT TREATING—The evil twin of the gear processing family. Heat treating and post-heat treating corrective processes can run up to 50% or more of the total gear manufacturing cost, so it's easy to see why, in these days when "lean and mean" production is the rage, and every part of the manufacturing process is under intense scrutiny, some of the harshest light falls on heat treating.

If heat treating is still not as predictable, consistent and manageable as everyone would like, it's certainly not from lack of trying on the part of the equipment manufacturers.

Some major equipment manufacturers are pushing the envelope on induction hardening and other selective hardening techniques. If there is a single, identifiable trend in techniques, it's the move toward induction hardening. George Welch, Product Manager, Heat Treat Products at Ajax Magnethermic, Warren, OH, says, "Our goal is to replace carburizing in many applications."

Dr. Maurice Howes, Director of the IIT Research Institute's Heat Treatment Center in Melrose Park, IL, concurs. "The future probably lies with selective hardening," he says.

Induction hardening has many virtues. It causes little distortion, and what distortion there is, is predictable. It's an in-line process, seemingly tailor-made for companies moving toward cell manufacturing. Materials can go right from the cutter to heat treatment in the production line.

According to Byron Taylor, President of Inductoheat of Madison Heights, MI, "In the same fashion that various tooling machines have become machining centers, various induction heating applications are now done on one machine."

Furthermore, induction hardening solves many environmental problems. Says Mike Chaplin, Vice President of Engineering at Contour Hardening, Indianapolis, IN, "Induction hardening uses no gases, no copper plating and no chemicals to cause disposal problems."

But induction hardening equipment is expensive, and it's best used in high-volume applications.

*Most gears are still heat treated using car*burizing, and manufacturers of carburizing equipment are not resting on their laurels either. Like their counterparts in induction hardening, they are working toward lowering costs, raising speed and repeatability and addressing environmental concerns.

Says David Hughes, Marketing Director for Surface Combustion in Maumee, OH, "In the future, customers can expect furnace equipment that is more user-friendly, networkable, with lots of good help screens. They can also expect different filtering and processing systems to limit emissions."

But for all the advances companies have made in recent years, it would be a mistake to assume that heat treating nirvana is just around the corner. Much mystery remains and not all of it will be revealed through incremental improvements in current technologies.

The basic metallurgical transformations that define the heat treating process and how they relate to gear design require further study. George Pfaffman, Vice President, Technology & Service Operations for Tocco® of Madison Heights, MI, lists seven issues where further research is needed.

1. Reduction of variation in dimensional change,
2. Prediction and modeling these changes,
3. Control of the carburizing operation,
4. Improvement of process control as an integrated part of the manufacturing operation,
5. Understanding of material behavior,
6. Environmental impact of the process,
7. Evaluation of process cost components.

Research in a number of these areas is an on-going process. John Walenta of Caterpillar's Technical Center in Peoria, IL, says, "Heat treatment simulation is an area of major effort. Caterpillar has had a research program in place for at least three years. The National

Center for Manufacturing Sciences is also working on a program to predict distortion and mechanical properties, as are the Japanese."

The View From the Shop Floor

Equipment manufacturers and researchers may be promising breakthroughs and advances that will make heat treating as trouble-free and predictable as heating coffee in your microwave, but the folks out there actually processing parts see it somewhat differently.

Bill Davis, president of American Metal Treating, Cleveland, OH, believes the technology of heat treating itself will remain relatively stable over the coming years. "Technological advances on the job shop level are more along the lines of installing advanced computer equipment, solid-state power supplies and other auxiliary equipment," Davis says. "The actual heat treating process isn't changing much and isn't likely to change significantly in the near future."

But even with limited advances in heat treating processes and equipment, improved technology has had an across-the-board influence on the ability of heat treaters to produce quality products in at least one area: Controls.

"Most of our furnaces are 20 years old," says Gerald J. Wolf, president of Cincinnati Steel Treating, Cincinnati, OH, "but the technology keeps improving from the standpoint of controls." Many of the furnaces at Cincinnati Steel Treating have brand new controls, and most of those will probably have to be replaced within five years, Wolf says.

Improved controls mean more consistent results. For example, with carburizing, the better you can control the level of carbon in the furnace, the better you can control the metallurgical characteristics of a finished gear and the better you can predict how a gear will distort the next time.

So which type of heat treating is best for you? Unfortunately, there is no easy answer.

Says Bill Davis, "If you sat 50 metallurgists in a room and asked them to decide which was best—carburizing or induction hardening—they'd argue about it for two weeks and then split right down the middle."

Contour Hardening produces a multi-phase induction hardening system that can heat treat a whole gear in less than a second. Many in the industry consider this to be the state of the art. Meanwhile, vacuum technology and nitriding also promise to provide less distortion from the heat treating process. "The biggest bugaboo that heat treaters face is how to heat treat parts without too much distortion," Cincinnati Steel's Wolf says.

Another technology that may be on the rise is the use of fluidized bed furnaces, says Eric Pearson, Marketing and Sales Manager for Dynamic Metal Treating, Canton Twp., MI, a heat treating company with its own patented ferritic carbonitriding process using a fluidized bed furnace. One of the main attractions of this process is also that it doesn't distort the parts, Pearson says.

One thing is clear: Equipment alone won't solve the problem. "Every gear manufacturer is convinced that **you've** caused the distortion in his gears," Wolf says, but with the sophistication of heat treating controls steadily increasing, heat treaters are more and more able to produce consistent results.

Often, he adds, unusual distortions can result from inconsistency in the gear manufacturer's choice of material. "Over the years, I've seen parts grow more than we thought they would, and I've even seen parts shrink. There just is very little information regarding how the processing of the part **before heat treating** affects the way it is distorted. However, they've proven that if you buy consistent material, you get consistent results."

Empirical evidence may suggest that, as George Pfaffman puts it, "Gears are cut in heaven, but the devil does the heat treating," but the fact is that in today's competitive environment, you can't count on black—or white—magic to solve your heat treating problems. We haven't reached heat treating heaven yet, but for gear manufacturers willing to spend the time and effort to sort out the available alternatives, heat treating can be converted from a kind of alchemy to a cost-effective, predictable process that improves your product and contributes to, rather than eats away at, your bottom line. ✪

While no one process is best, there may be a best type of heat treating for a given situation, depending on the type of gear you have, the volume of production and the cost per part you're willing to spend or able to justify.

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