HOTSEAT

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Pusher furnaces have many advantages over others, as long as the handling system moving trays through the hot zone is properly designed. Remember the KISS principle!

WHEN ANYONE FAMILIAR WITH THE HIGH PRODUCTION carburizing of gears is asked to offer an opinion about pusher furnaces, they inevitability say "what else is there?" or "they're way too complicated, the whole idea is just too much." It's a common misconception that pushers are very complex furnaces that can only be considered as a last resort. After all, batch furnaces are pretty simple, aren't they? However, we as furnace manufactures see it differently: Ever hear of the KISS principle?

Operating uptime and reliability are all about simplicity of design, and that is defined by the type of handling system used to move trays through the hot zone. When moving trays we would much rather push a tray than pull one. When pushing you always know where the tray is, but blind faith is the operative description when pulling a tray; you hope the mechanism has latched onto the tray. Obviously any push/pull mechanism must be maintained to assure proper function. Pushers are intrinsically more reliable when pounds per hour and cost per pound are considered, because you always know where the tray is. When a rare jamb does occur in a pusher, it's generally not due to a pusher malfunction, but the trays. Carburizing and quenching trays takes a toll through distortion and eventual cracking if not routinely monitored. When maintenance monitors the condition of the trays, pusher furnaces operate for years without incident, only shutting down for planned maintenance. And the single most important maintenance function next to trays is air burnout, or admitting air to remove soot (carbon) from the hot zone.

As with any commonsense design philosophy, over the years we have simplified the mechanics of the pusher furnace. However, due to the continued effort to comply with the ever-increasing demand for continuous improvement and quality, the process control systems have developed in the opposite direction—a designed oxymoron: design more-complex control systems in order to make the process easier.

Many decades ago, when all of the car company OEMs did their heat treating in-house, their goal was to make furnace operations easier to control by taking decisions away from the operators. In those days the push was to have less-educated operators, to dumb down the furnace operation, and that led to the contrary thought expressed by the cliché "if you make the furnace idiot proof, you'll have idiots running it." But just the opposite has happened. As the process control systems have become more complex, not only have the operators had to become more educated but the maintenance personnel have had to make quantum leaps in knowledge with the adaptation of PLCs and computer assisted trending and data archiving, not to mentioned the associated SPC and terms such as Cpk. Now we even have systems that throw a photo image of the area of the furnace onto the LCD touchscreen display that caused an alarm with procedures to address the problem. All of this has created a need for a more-educated heat treater, not less.

One of the many advantages of pusher furnaces, no matter the production requirement, is the ability to carburize the pinion and ring gear sets in the same furnace. Typically a two-row pusher with pinions in one row and rings in another can produce slightly different case depths and free quench the pinions while press quenching the rings, usually with automation. We've sold this type of equipment all over the world from a simple one carburizing chamber to five chamber cells. Although some automotive ring gears applications have gone the LPC and HPGQ way, heavier-duty drivetrains like that for GMC, Ford, Chrysler, MACK, Kenworth, Peterbilt, and others have no choice but to endo carburize and press quench for two big reasons: dimensional control, and lower material cost. Even though these pinions and ring gears are very large, lower-cost materials can be carburized oil and press-quenched achieving excellent results. In operation today after many decades there are six-row pushers pumping out hundreds of thousands of press-quenched ring gears.

In addition to pusher and batch carburizing furnaces—which I'll address again in upcoming columns—continuous furnaces fall into many categories: cast belt, mesh belt, roller hearth, and rotary hearth, to name a few. For gears, however, rotary hearth furnaces are very popular for reheating gears in preparation for press quenching. Many high precision aerospace gears for commercial and military aircraft are endo carburized in pushers or batch furnaces, slow cooled and reheated in rotary hearth furnaces, and automatically press quenched, achieving unmatched dimensional control. Some manufacturers require that the gears be quenched twice, once after the initial carburizing and finally via press quenching. Since double quenching can cause additional distortion, pressing during the quench can bring the gear back into conformity. It's felt by many that the final quenched microstructure is improved by double quenching, thus improving overall mechanical properties.

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