Hardening of small gears

A guide to the benefits of induction heating

How to reduce distortion and costs when hardening small gears

Induction is the cost-cutting alternative to furnace case hardening of small- and medium-sized gears. Key features of induction hardening are fast heating cycles, accurate heating patterns and cores that remain relatively cold and stable. Such characteristics minimize distortion and make it more repetitive, reducing post-heat processing such as grinding. This is especially true when comparing induction to case carburizing.

Induction hardening also reduces pre-processing, as the geometry changes are less than those caused by carburizing. Such minimal changes mean distortion does not need to be accounted for when making the gear. With gears destined for gas carburizing, however, 'offsets' that represent distortion are often introduced at the design stage. These intentional offsets compensate for distortion caused during the lengthy heat soaks typical of carburizing.

Induction can heat precisely localized zones in gears. Achieving the same degree of localized hardening with carburizing can be a time- and labor-intensive procedure. When carburizing specific zones such as the teeth areas, it is usually necessary to mask the rest of the gear with 'stop off' coatings. These masks must be applied to each and every workpiece, and removed following the hardening process. No such masking is necessary with induction hardening.

Induction hardening is ideal for integrating into production lines. Such integrated hardening is more productive than thermochemical processes. Moreover, integrated hardening minimizes costs, as the gears do not have to be removed for separate heat treatment. In fact, induction heating makes it possible to create one seamless production flow through the machining, hardening, quenching, tempering and storage stages.

EFD Induction's patented simultaneous multi-frequency hardening in action. The process achieves true contour hardening of small gears in well under a second. Note the absence of through hardening in the teeth.

EFD Induction—the induction hardening specialists

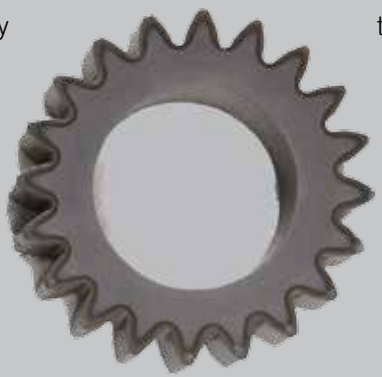
EFD Induction is the world's largest induction hardening company, with a particular strength in integrated hardening solutions. Such 'total solution' expertise is essential. For example, to achieve a specific case hardening pattern, it is necessary to determine the correct power/frequency/time parameters—a process requiring computerized simulation tools and expertise in metallurgy, electronics and coil fabrication.

Correct coil geometries are critical, as the relationship between gear surfaces and coils influences the hardening process. Most induction-hardened small- and medium-sized gears undergo 'gear spin hardening', where the gear rotates at high speed within an encircling coil. It is vital that the gear rotates concentrically as any eccentricities will overheat part of the gear. Specialist skills are also needed to design and implement the quenching system.

Quenching of a small gear that has been heated by the simultaneous multi-frequency method. EFD Induction specializes in customized total hardening solutions that can include workpiece loading/unloading equipment and integrated tempering.

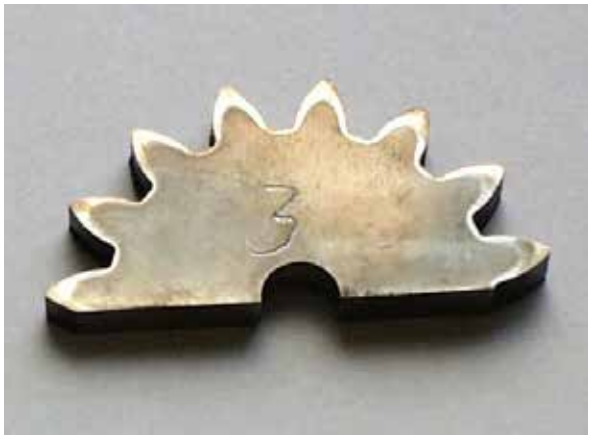
MULTI-FREQUENCY CONTOUR HARDENING

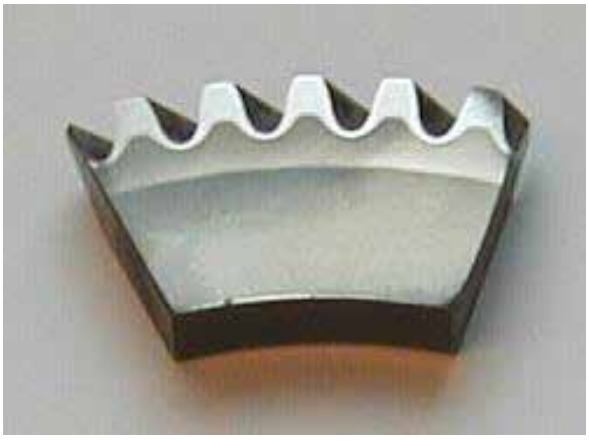
EFD Induction's patented simultaneous multi-frequency process results in true contour hardening. The contour is achieved by simultaneously feeding a medium and high frequency into a single inductor. The medium frequency ensures correct heat penetration in the root area, while the high frequency heats the tip and flange to a precisely prescribed depth. Induction contour hardening of small gears can also be achieved by the intermittent application of different frequencies. As with the simultaneous method, the results are fatigue strength and wear resistance that are superior to those achieved with through hardening. Induction contour hardening is also faster than induction through hardening—which is itself an extremely fast process. Typically, the simultaneous multi-frequency method heats the gear in well under a second. Productivity can be further increased by integrating tempering into the process. This is done by applying a medium frequency to the workpiece while it is still encircled by the inductor.



Get more from your equipment

When you choose a solution from EFD Induction you choose security and peace-of-mind. As one of the world's largest induction heating companies we offer a full range of maintenance, logistics, training and spares services. Make the most of your heating system—with a little help from the people who built it.





Just two examples of the wide range of hardening results possible with EFD Induction solutions. The small gear on the left has been heated with a single frequency. The helical gear on the right has been heated with a single frequency to obtain a symmetrical profile.

EFD Induction has to date installed thousands of heating solutions for a vast range of industrial applications—bringing the benefits of induction technology to many of the world's leading manufacturing and service companies. EFD Induction has manufacturing plants, workshops and service centers in the Americas, Europe and Asia.

Learn more about EFD Induction and our solutions that are boosting productivity for companies around the world. Visit: www.efd-induction.com

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