Description

Process schematic

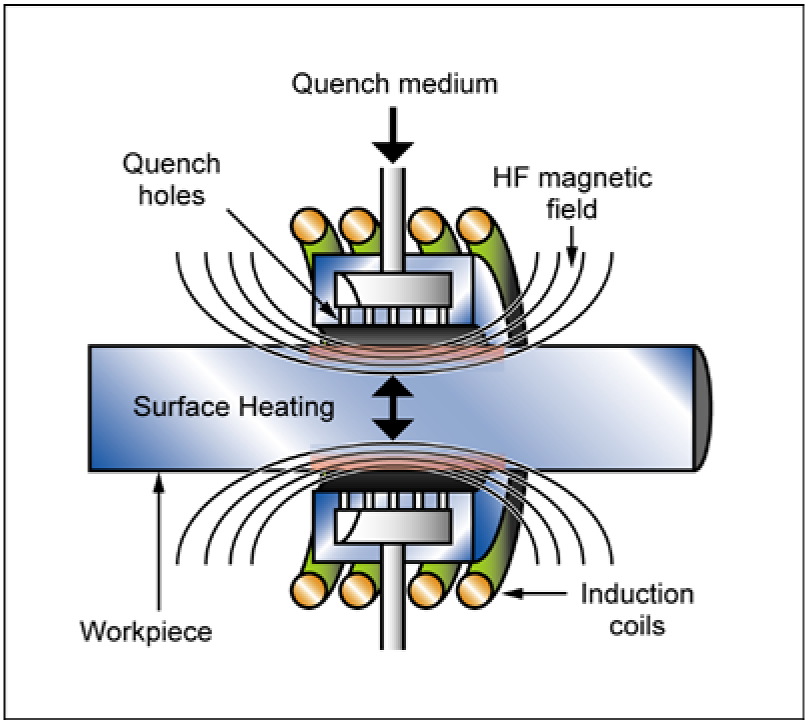

Figure caption

Induction

The process

The idea here is this: take a medium or high carbon steel -- cheap, easily formed and machined -- and flash its surface temperature up into the austenitic phase-region, from which it is rapidly cooled from a gas or liquid jet, giving a martensitic surface layer. The result is a tough body with a hard, wear and fatigue resistant, surface skin. Both processes allow the surface of carbon steels to be hardened with minimum distortion or oxidation. In INDUCTION HARDENING, a high frequency (up to 50kHz) electromagnetic field induces eddy-currents in the surface of the work-piece, locally heating it; the depth of hardening depends on the frequency. In FLAME HARDENING, heat is applied instead by high-temperature gas burners, followed, as before, by rapid cooling. Both processes are versatile and can be applied to work pieces that cannot readily be furnace treated or case hardened in the normal way.

Material compatibility

Metals - ferrous	✔

Function of treatment

Hardness	✔
Wear resistance	✔
Fatigue resistance	✔
Friction control	✔

Economic compatibility

Relative tooling cost	low
Relative equipment cost	medium

Labor intensity	low

Physical and quality attributes

Surface roughness (A=v. smooth)	A			
Curved surface coverage	Very good			
Coating thickness	11.8	-	118	mil
Surface hardness	420	-	720	Vickers
Processing temperature	849	-	970	°F

Process characteristics

Discrete	✓

Supporting information

Design guidelines

Case hardening (the family of processes that includes induction and flame hardening as well as carburizing and nitriding) creates strong, tough components that resist wear, indentation and abrasion, and they do it cheaply. Induction and flame hardening, unlike the others, allow selective hardening of particular areas of the work piece. Both give a surface layer with a hardness that is lower than that of diffusion-based processes like carburizing and nitriding, but the depth is greater. Shapes, however, are restricted: flat, cylindrical and conical surfaces present no problems, but more complex shapes require special equipment.

Technical notes

Both processes can be applied to cast irons, medium and high carbon steels, alloy steels and tool steels. The induction equipment consists of a HF generator (up to 50,000 Hz), an induction coil, a quench ring and a workpiece holder. For thin cases, high frequencies are used, while for intermediate and thick cases, lower frequencies are needed. Internal coils are used to harden the inner surface of the workpieces, while the external coil and pancake coil harden external surfaces and flat surfaces. Frequently, heating coils must be custom-designed for a particular type of part.

Typical uses

The processes are used to harden gear teeth, splines, crankshafts, connecting rods, camshafts, sprockets and gears, shear blades and bearing surfaces.

The economics

High power high-frequency generators are expensive, but they allow precise control of a process that is completely clean. Flame hardening equipment is less expensive by requires sophisticated control equipment. Tooling costs are low and the processes lend themselves to automatic control.

The environment

Compared with other case-hardening processes, these two are heroes: minimum energy consumption, no noxious excretions, clinically precise.

Links

MaterialUniverse
Reference