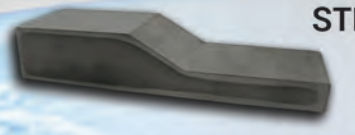
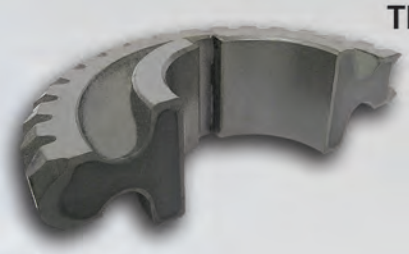
BREAKTHROUGH CONTOUR HARDENING



STEPPED FLAT

TRANSMISSION GEAR



AUTOMOTIVE JOURNAL CROSS

PINION GEAR

LEAF SPRING ASSEMBLY

THROUGH SURFACE HARDENING "TSH" TECHNOLOGY

TSH TECHNOLOGIES, INC., A SUBSIDIARY OF ERS ENGINEERING, CORP., EXCLUSIVELY OFFERS THE INNOVATIVE TSH TECHNOLOGY TO THE GLOBAL MARKET.

TSH TECHNOLOGIES INC.

BREAKTHROUGH TECHNOLOGY FOR INDUCTION CONTOUR HARDENING OF COMPLEX GEOMETRY PARTS

SPIRAL BEVEL PINION

- Faster, Simpler, Cheaper
- More Reliable, Green & Lean Manufacturing
- Materials Technology
- Replaces Gas Carburizing

SPIRAL BEVEL RING GEAR

ERS Engineering Corp.

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TSH TECHNOLOGIES INC.

WHAT IS TSH TECHNOLOGY?

- Synergistic combination of controlled low hardenability (LH) advanced steels and superior induction hardening techniques.
- TSH Technology serves the Automotive, Commercial Vehicle, Agriculture, Mining, Industrial, and Railroad Industries as an alternative steel/heat treat technology for case hardening (carburizing, carbonitriding), through hardening and conventional induction hardening of heavy duty alloy steel parts.
- TSH = Through Heating for Surface Hardening, Parts are through heated by low or medium frequency induction heating and then rapidly water quenched resulting in a surface hardened layer profiling the part.

- Parallel axis gears
- Differential bevel gears
- Spiral bevel gears
- Track bushings
- Transmission shafts
- King pins, diff pins, piston pins, ball Joints
- Leaf springs
- Journal and differential crosses
- Camshafts and crankshafts
- Tillage tools
- Grinding mill balls
- Bearings

AUTOMOTIVE JOURNAL CROSS

LOCOMOTIVE BEARING

TSH TECHNOLOGY BENEFITS

1. Cost Effective Alternative Process

Uses low cost TSH steels

- Expensive alloy elements (Ni, Mo, Cr, V) are not required

Replaces carburizing or conventional induction hardening for many alloy steel parts

- TSH cycle times 1-5 minutes versus 8-20+hours for carburizing

Lean and green process allowing individual gear traceability

2. Superior Metallurgy / Improved Durability

- Produces fine-grain to ultra-fine grain martensitic structures within the surface hardened layer
- Improves surface metallurgy by eliminating grain boundary oxidation or nonmartensitic surface layer associated with gas carburizing
- Heat treated core structure (bainite and pearlite) resulting in a good combination of core ductility and strength.
- Develops high magnitude of the desirable compressive surface residual stresses (600-1000 MPa)
- Significantly improved static and dynamic properties

3. Simple, Repeatable and Robust Process

- Parts are through heated or partial heated and then rapidly water quenched
- Hardened depth is controlled by the steel's hardenability
- Low steel hardenability allows the formation of well defined hardness pattern when hardening complex-geometry parts
- Uses low or medium induction hardening frequencies (1kHz to 15kHz)
- Reduced equipment capital cost
- Dramatically reduces probability of overheating edges, tips and corners
- Improves overall repeatability and robustness. reduces process sensitivity
- Eliminates stress shot peening

CARRIER PIN - SIMULTANEOUS OD & ID HARDENING

PUMP GEAR SHAFT

TSH TECHNOLOGY CASE STUDIES

CASE STUDY: HYPOID DRIVE PINION – TSH PROCESS VS GAS CARBURIZED

The conventional heat treat process for hypoid drive pinion is gas carburizing. Conventional induction contour hardening is not practical due to the complex part geometry. The TSH technology makes induction contour hardening of this part possible.

TSH BENEFITS	TSH PROCESSED	GAS CARBURIZED
Lower Cost Steel	60LH	8625H
Reduced Cycle Times	3 minutes	12 hours
Superior Metallurgy Finer Grain Size No Grain Boundary Oxidation No Nonmartensitic Surface Layer	Fine grain martensite GS# 9-12 None None	Coarser grain high carbon plate martensite GS# 5-8 10-25 microns 10-25 microns
Enhanced Compressive Residual Stresses	High Compressive (600-1000MPa)	Low Compressive (140-300 MPa)
Improved Fatigue Life	2-3X	1
Eliminates Shot Peening	Not Needed	Needed
Environmentally Friendly	Minimal Emissions, Energy Efficient, Water Quench	Exhaust Gases, Energy Intensive, Oil Quench
Lean Process	In line single part process	Stand Alone, Batch Process

CASE STUDY: HELICAL BULL GEAR – INDUCTION HARDENED BY TSH PROCESS

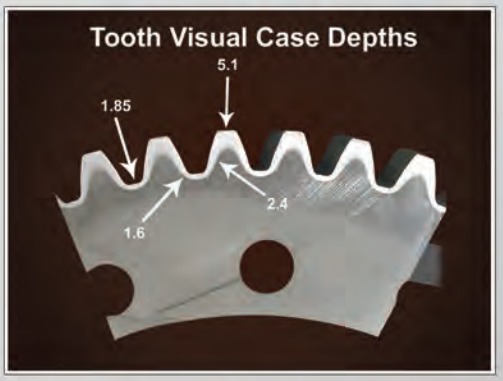
Induction contour hardening technology can be used for this 13" helical bull gear to replace gas carburizing. TSH technology is the best contour hardening process for these larger parts. The TSH process utilizing lower power, low frequency induction heating reduces equipment cost and makes the process more repeatable and robust. In addition, the core of the gear tooth is heat treated.

Helical Bull Gear

- Outer Diameter = 330 mm (13")
- Number of Teeth = 47
- Module = 6.8 mm
- Weight = 13.8 kg (29#)

C	Si	Mn	Cr	Ni	Mo	S	Ti	V
0.79	0.08	0.06	0.17	0.06	<0.02	0.015	0.079	<0.008

Helical Gear Chemistry

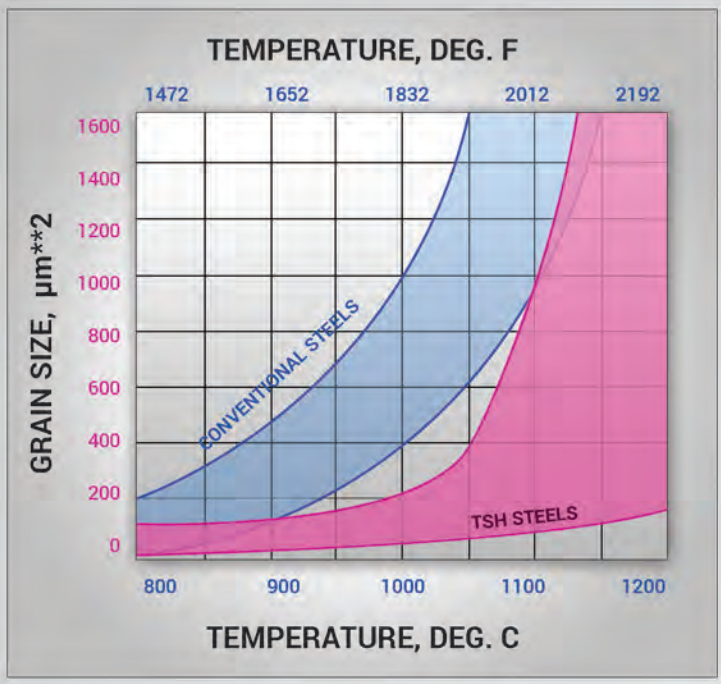


SUPERIOR METALLURGY → ENHANCED PERFORMANCE

ADVANCED TSH STEEL TECHNOLOGY

Characterized by

- Low or no alloy content
- Reduced tendency for grain growth during heating
- LH steels control harden depth capability
- Capability to develop high compressive residual stresses



	Gears, Spiders, Springs		Gears, Bearings
C	0.55-0.63	0.62-0.67	0.77-0.83
Si	0.10-0.30	0.15 max	0.10-0.25
Mn	0.20 max	0.20 max	0.10 max
Cr	0.15 max	0.10 max	0.10 max
Ni	0.25 max	0.10 max	0.10 max
Mo	-	-	-
S	.04 max	0.04 max	0.04 max
P	.04 max	0.035 max	0.035 max
Ti	-	0.06-0.12	0.06-0.12
V	-	<0.40	<0.40

TYPICAL LH STEEL CHEMISTRIES

MEET THE STEEL COST CHALLENGE UTILIZING TSH STEELS

STEEL	Mn	Cr	Ni	Mo
TSH Steel	-	-	-	-
9310H	0.40/0.70	1.0/1.45	2.95/3.55	0.08/0.15
4817H	0.40/0.70	-	3.2 / 3.8	0.20/0.30
4320H	0.40/0.70	0.35/0.65	1.55/2.0	0.20/0.30
8822H	0.70/1.05	0.35/0.65	0.35/0.75	0.30/0.40
8620H	0.60/0.95	0.35/0.65	0.35/0.75	0.15/0.25
4118H	0.60/1.0	0.30/0.70	-	0.08/0.15
5120H	0.60/1.0	0.60/1.0	-	-

REDUCED ALLOY → LOWER COST

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TSH TECHNOLOGIES INC.

ERS / TSH TECHNOLOGIES INC. ASSUMES *"TOTAL APPLICATION RESPONSIBILITY"* FOR YOUR PARTS

Part Selection and Evaluation

- Customer specifies part
- TSH feasibility and LH steel selection by ERS/TSH TECHNOLOGIES, INC
- Cost savings evaluated by ERS/TSH TECHNOLOGIES, INC and customer

Process Development for Prototype Parts

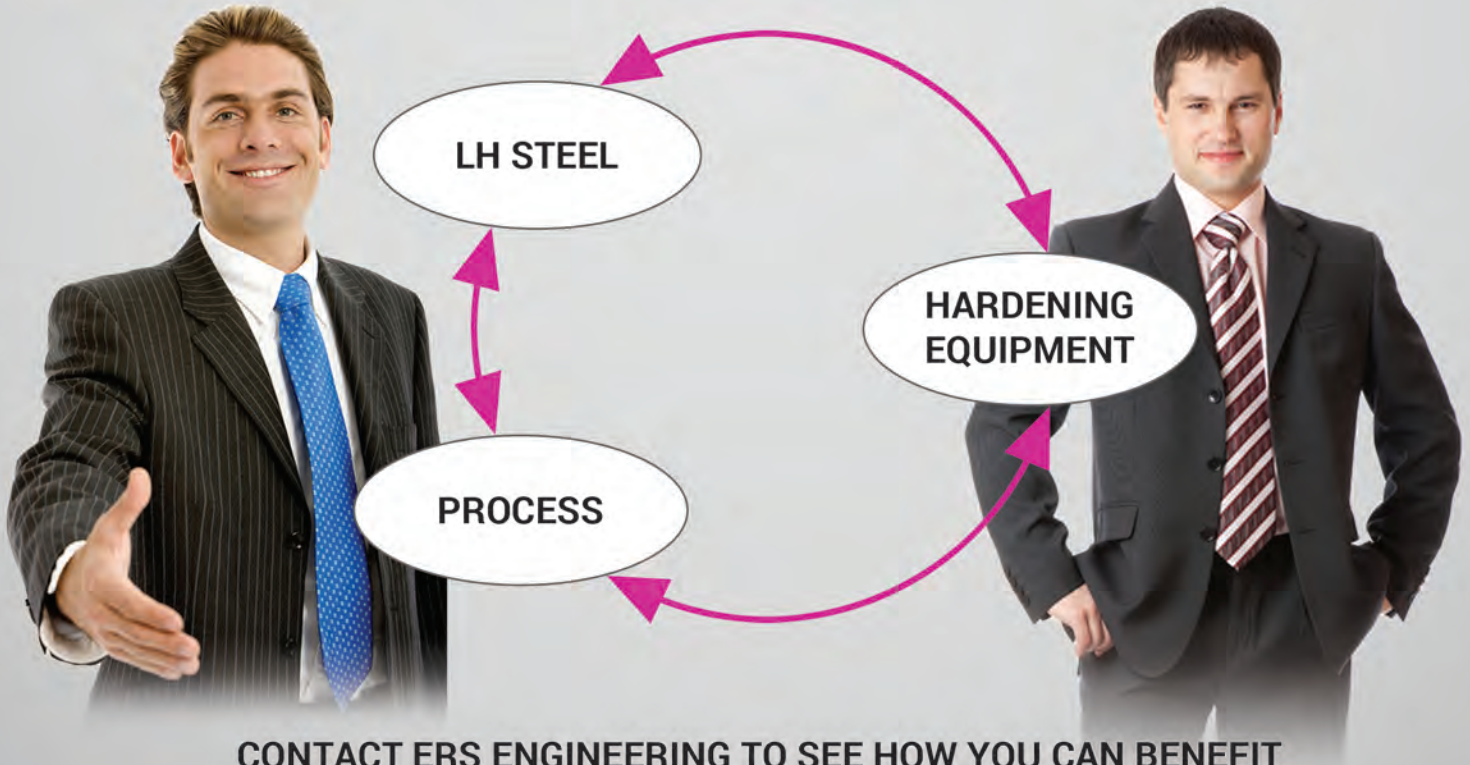
- ERS/TSH TECHNOLOGIES, INC supplies LH steel to customer
- Customer manufactures part from supplied LH steel
- ERS/TSH TECHNOLOGIES, INC develop the TSH process and heat treat prototype parts

Prototype part evaluation and testing

- Customer verifies quality of prototype parts
- Customer tests prototype parts

Part qualification for production

- Technical support provided by ERS/TSH TECHNOLOGIES, INC
- LH steel produced by North American steel supplier developed by ERS/TSH TECHNOLOGIES, INC



CONTACT ERS ENGINEERING TO SEE HOW YOU CAN BENEFIT BY UTILIZING THE TSH TECHNOLOGY

TSH PROCESSED PART CROSS SECTIONS

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