ELTA
Simulation Software

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ELTA Software

ELTA Software

- ELTA is a program for ELectroThermal Analysis of induction systems
- Calculations in ELTA are based on a combination of 1D Finite Element Method for closely coupled electromagnetic and thermal problems inside the work piece and analytical method for account of finite lengths of the part and induction coil. Special 2D numerical method is used for calculation of parameters inside parts with rectangular cross-section.

ELTA Software Features

- User friendly interface with very fast solver
- Electromagnetic + Thermal
- Axisymmetrical (OD & ID) & plane-parallel geometries
- Module for simulating single- and multi-turn internal coils
- Possibility to simulate power supplying circuit (busswork, parallel or series capacitors, matching transformer)
- Possibility to simulate multi-stage processes such as part hardening and tempering in different positions
- Database with non-linear properties of materials and quenching media
- Option of automatic frequency variation during the process of heating
- Multiple graphs and color map for presentation of the results
- Automatic report generation according to selected or created by user templates

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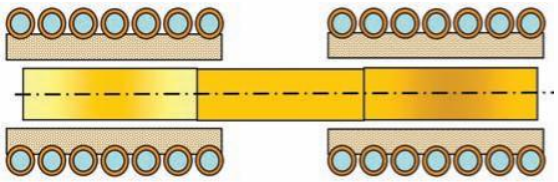
When to Use ELTA

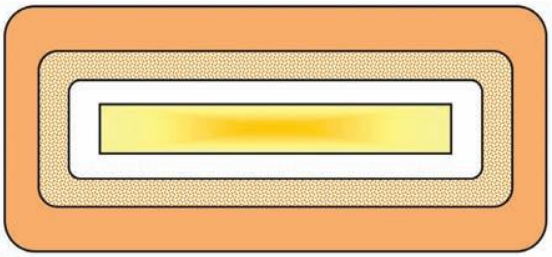
ELTA may be used for design of the whole system (heating time, frequency, power, coil parameters, selection of power supplying circuitry) or as an auxiliary tool for design of systems with complex geometry. Final induction system optimization may be made using 2D (3D) program or experimentally. ELTA is also an important tool for education, training and business presentations.

It is:

- Valuable for almost all cases to determine optimal process parameters (P, f, t, Quenching) and coil style
- A useful tool for coil design in both static and scanning applications
- Very valuable for in-field support, new project evaluation and presentations



Mass heating of billets and tubes in single-or multi-inductor lines



Heating of Slabs and strips in single- or multi-inductor lines

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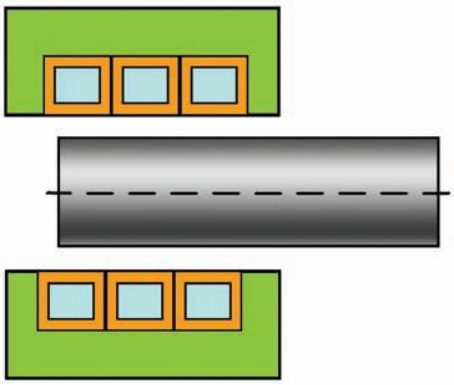
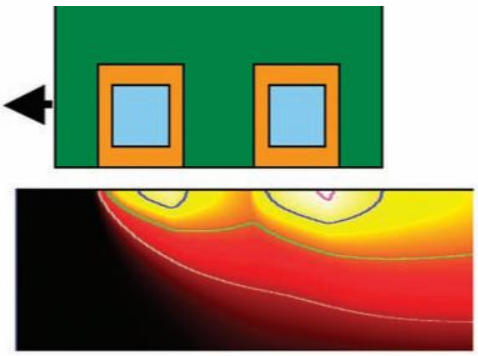
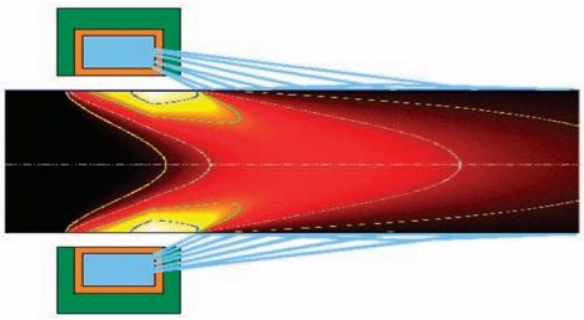
When to Use ELTA (Continued)



Local heating and surface hardening of cylindrical or flat bodies



Scan hardening of flat surfaces



Scan hardening of cylindrical parts

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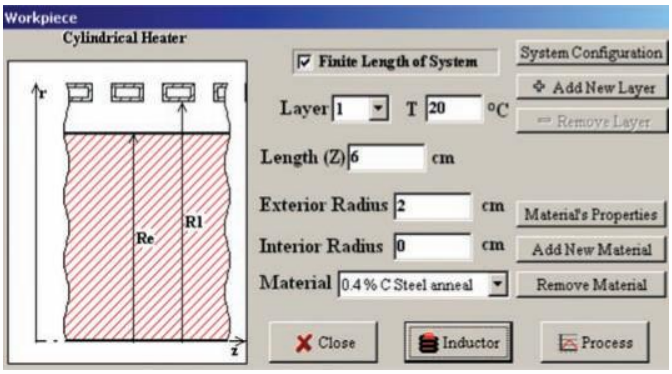
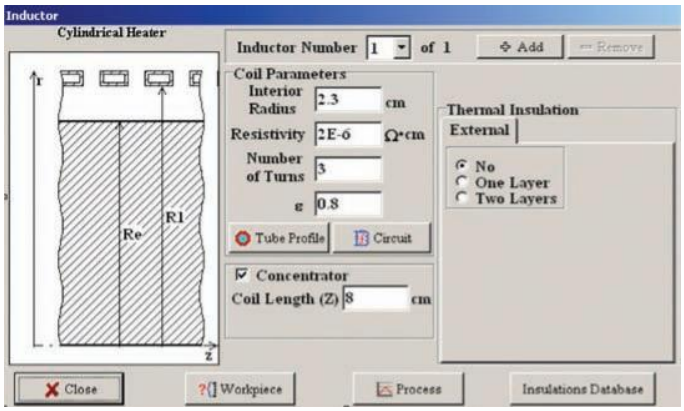
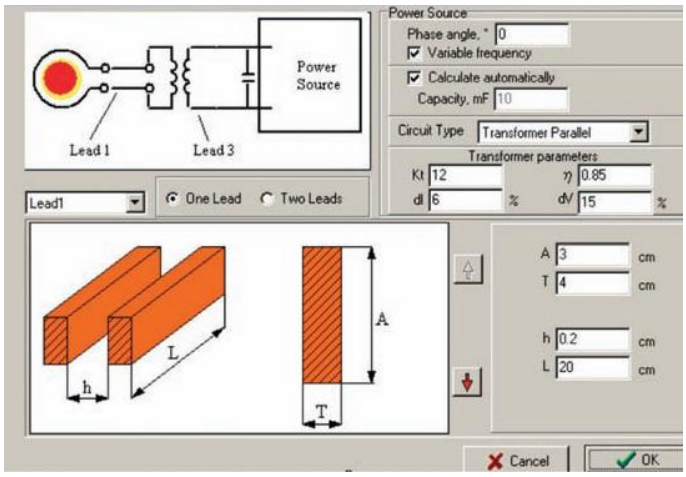
Using ELTA – Software Screen Examples



Screen of workpiece geometry description



Screen of induction coil



Screen of Supplying Circuitry

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Design of In-Line Heat Treating Process

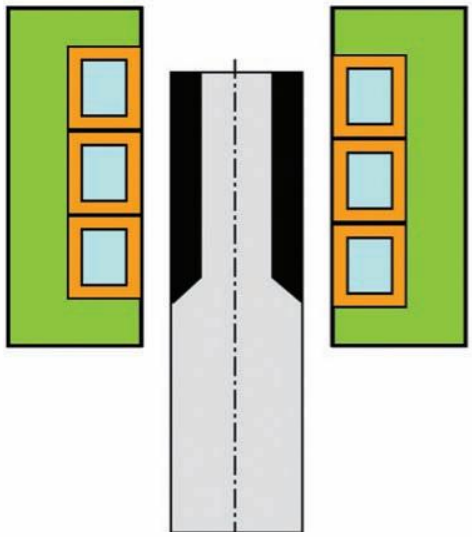
In-Line processes are becoming more popular in industry. In these processes durations of all stages of in-line process (Austenization, Quenching, Tempering and Final Cooling) must be coordinated

Task: *Hardening and tempering of the shaft end*

- Diameter – 40 mm
- End length – 60 mm
- Case depth – 4 mm
- Steel 1040

Simulation showed that minimum time for austenization, heating is slightly under 4 sec. at optimal frequency 3kHz. This time was selected as a base for other stages:

- Austenization 4sec
- Quenching 8 sec
- Tempering 4 + 4 sec
- Final cooling 8 sec



Induction System Geometry

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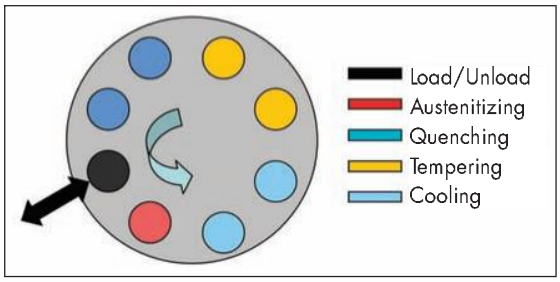
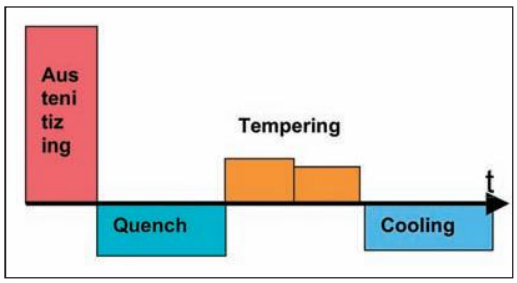
Design of In-Line Heat Treating Process (Continued)

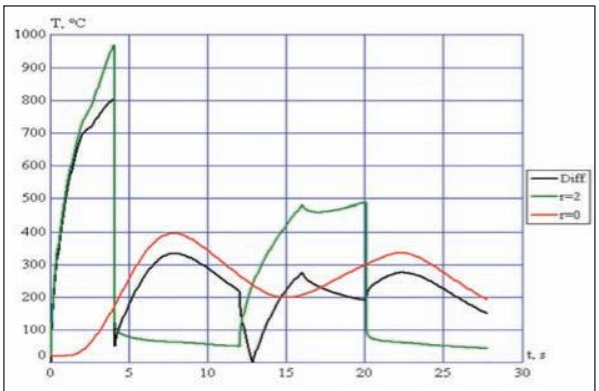
Rotary table machine with 8 positions was selected for heat treating. Two positions were used for tempering.



Rotary Table

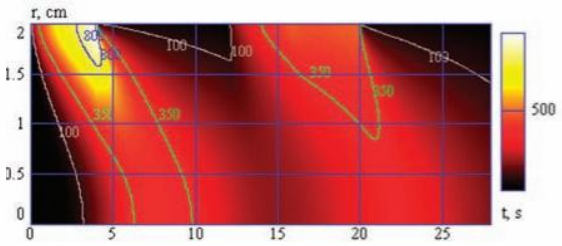


Cycle Diagram



Temperature evolution in optimized process:

Green – part surface
Red – center
Black – temperature differential



Color Map of Temperature Distribution

Color Map of temperature distribution shows that at the end of the first stage a depth of austenitized layer (T> 800 C) is 4 mm as required.

After 8-second quenching, temperature at the depth of 4 mm dropped below 120 C, which is sufficient for complete martensite transformation, while temperature at the center remained around 300 C.

This residual temperature and two-stage heating for tempering provided very uniform temperature in hardened layer during tempering process.

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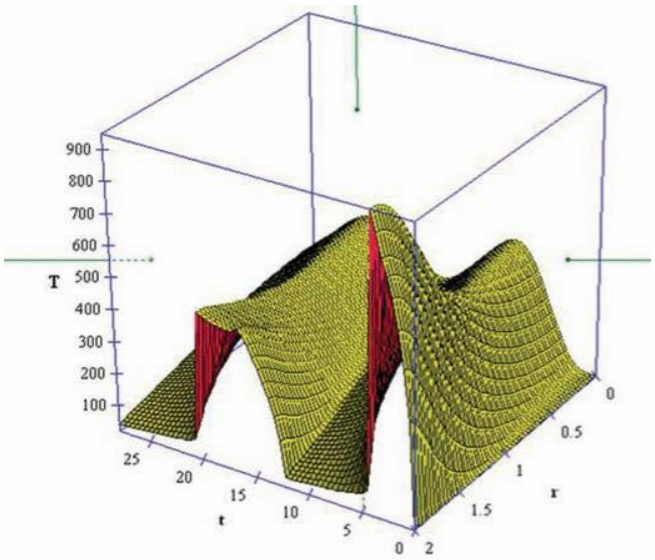
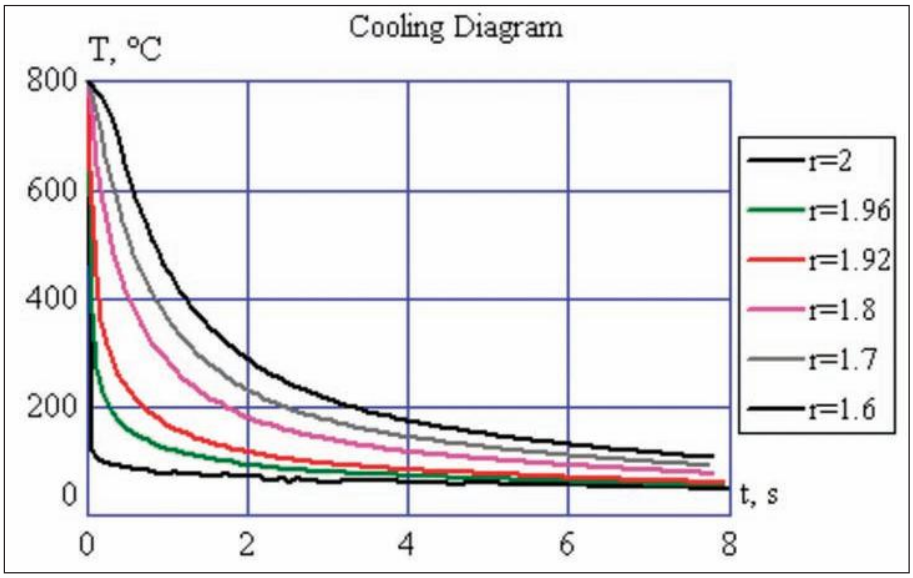
Design of In-Line Heat Treating Process (Continued)



3D presentation of temperature evolution



Cooling curves at different distances from surface

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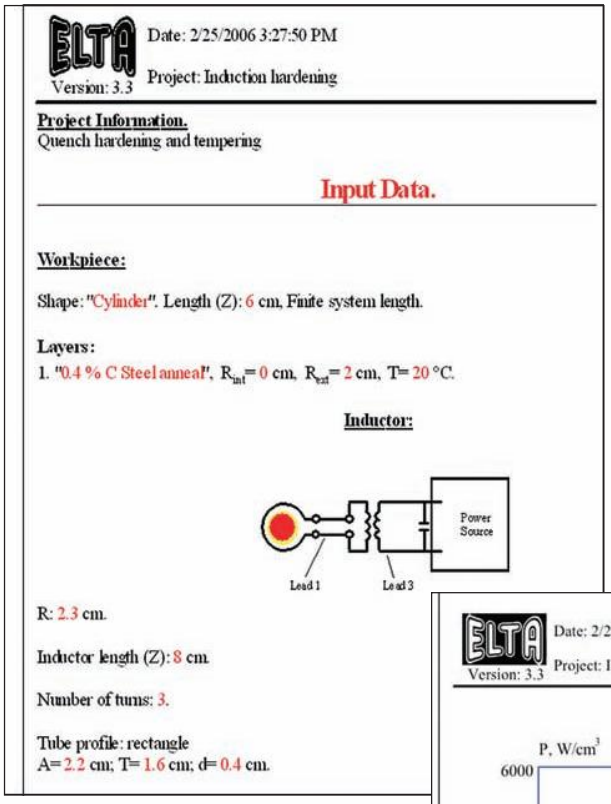
Report Automatically Generated by ELTA



ELTA
Version: 3.3

Date: 2/25/2006 3:27:50 PM
Project: Induction hardening

Project Information.
Quench hardening and tempering

Input Data.

Workpiece:

Shape: "Cylinder". Length (Z): 6 cm, Finite system length.

Layers:
1. "0.4 % C Steel anneal", R_{int}= 0 cm, R_{ext}= 2 cm, T= 20 °C.

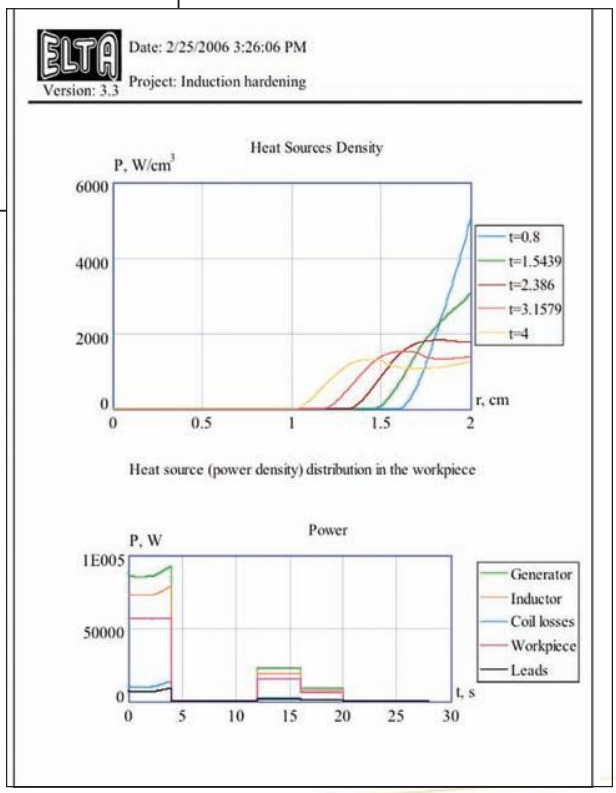
Inductor:

R: 2.3 cm.

Inductor length (Z): 8 cm.

Number of turns: 3.

Tube profile: rectangle
A= 2.2 cm; T= 1.6 cm; d= 0.4 cm.



ELTA
Version: 3.3

Date: 2/25/2006 3:26:06 PM
Project: Induction hardening

Heat source (power density) distribution in the workpiece

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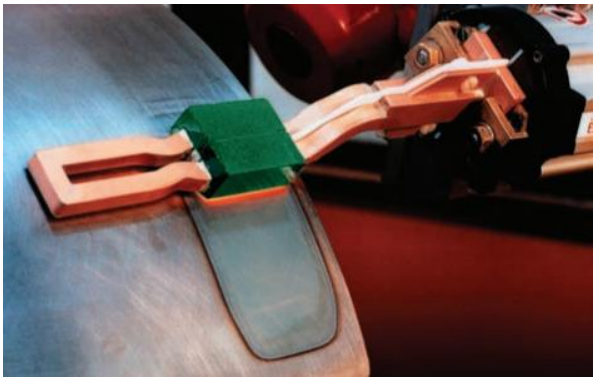
Demonstration Example of Scanning Process Designed with ELTA

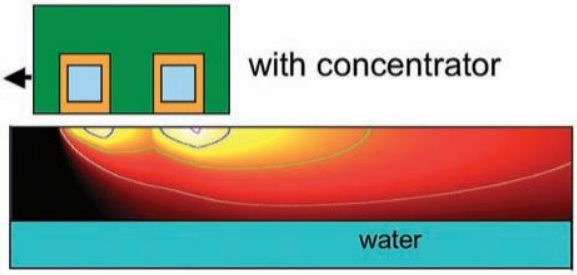
Industrial robot moves hairpin inductor along the curved surface of water-cooled stand made of stainless steel.

Fluxtrol concentrator is installed on one half of the coil. There is almost no heating under the coil part without concentrator.



Example of hairpin Inductor with concentrator on one half of coil

Temperature distribution was accurately predicted by the ELTA program.



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