Summer, 2015

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DEFORM™ News

Training:

- August 11-14, 2015: DEFORM training will be conducted at the SFTC office in Columbus, Ohio.
- October 13-16, 2015: DEFORM training will be conducted at the SFTC office in Columbus, Ohio.

Events:

- August 18-19, 2015: The annual Die Stress Analysis Workshop will be held at the SFTC office in Columbus, Ohio. Professor Joe Domblesky, from Marquette University, will co-instruct this very popular workshop.
- August 20, 2015: A one-day training class on the DEFORM setup details related to die stress analyses will be offered. This first time offering will be held after the Die Stress Analysis Workshop. This training workshop will cover die stress analysis setup and simulation options from a DEFORM user perspective.
- November 3-4, 2015 (tentative): DEFORM UGM in Columbus, Ohio.

Induction Heating

Induction heating is popular for its speed, efficiency, and controllability. Applications include through heating a billet prior to forming, localized through heating of a long bar prior to localized forming operations and surface heating for hardening.

Induction generates heat in a part through electromagnetic effects. The part is placed inside or near copper coils. When an alternating current is passed through the coils, a secondary current is “induced” in the workpiece. This induced current results in electrical heating of the workpiece for some depth below the surface. In magnetic materials, the reversing magnetic field creates a hysteresis effect which contributes dramatically to the heat generated.

Controlled Heating

Induction can be used to locally heat a small region of a workpiece. The power and AC frequency in the coils, the shape of the coil, and the use of “flux concentrators” all control the area and depth of heating. For hardening, high power is applied very quickly to heat the workpiece surface. The part is then quickly cooled before heat conducts into the core of the workpiece.

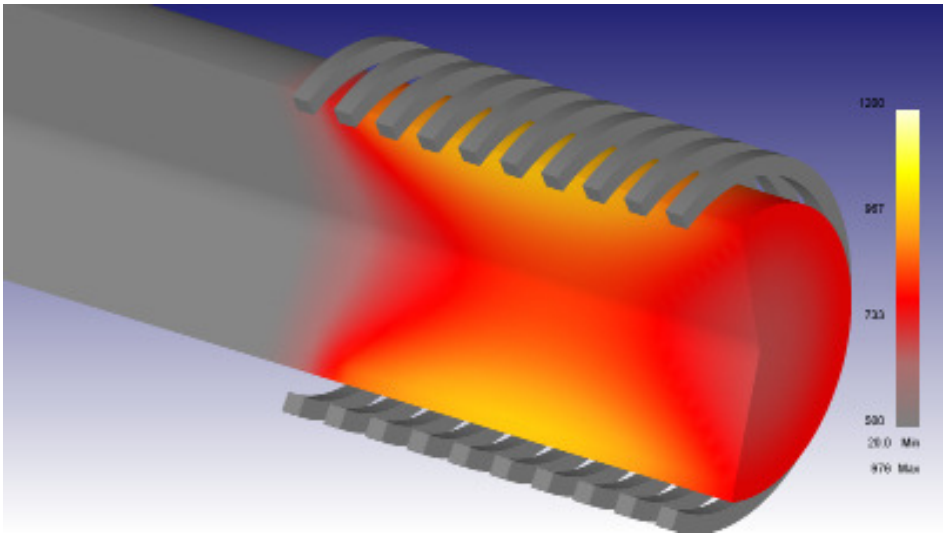
The Need for Simulation

In both through and surface heating, it is straightforward to measure workpiece surface temperature with a pyrometer. However, since much heating occurs below the surface, understanding internal part temperature can be much more complicated. Cut-ups are often used to evaluate induction hardend parts. For through-heated parts, there are no easy equations or test methods. Engineers often rely on recipes developed years ago, and may lack confidence in the internal temperature of the part.

DEFORM induction heating models account for many of the complexities of electromagnetics. Changing magnetic response of the workpiece with temperature, electromagnetic field shape and strength, and various skin and corner effects are considered. When used with pyrometer data, it can be an extremely helpful tool in validating heating recipes and predicting and controlling hardened case depth.

Large Bar Heating

Obtaining a uniform heat distribution in a large diameter bar can be challenging. The surface and near sub-surface of the bar are heated by the electromagnetic



DEFORM™

Design Environment for FORMing

field, while the center of the bar still must be heated by conduction. For large bar heating, standard practice is to apply heat in steps, followed by periods of reduced power to allow heat to conduct to the center of the bar. Pyrometers or surface mount thermocouples can only report surface temperature.

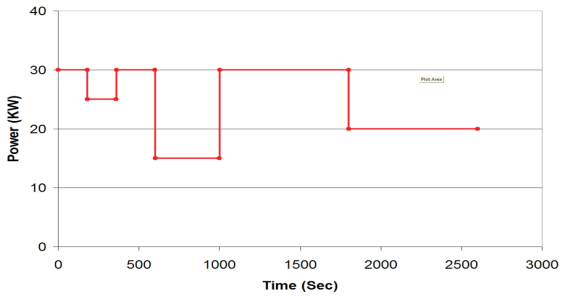
DEFORM was used to study the heating of the end of a 150mm diameter, 750mm long AISI 1045 diameter bar to 1100C. A 10 turn coil was used, with a maximum power of 25KW and a frequency of 1KHz, using the power profile shown below.

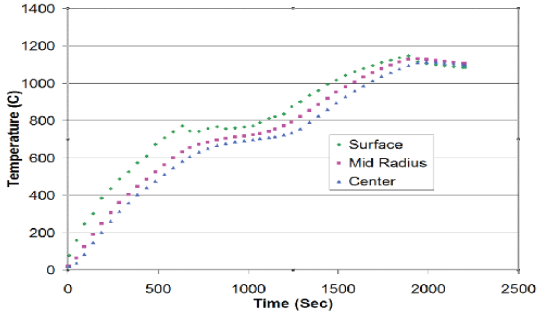
The surface temperature can be correlated to pyrometer results, and point tracking data, below, shows the temperature uniformity between the surface and the center.

Scanning Induction Hardening

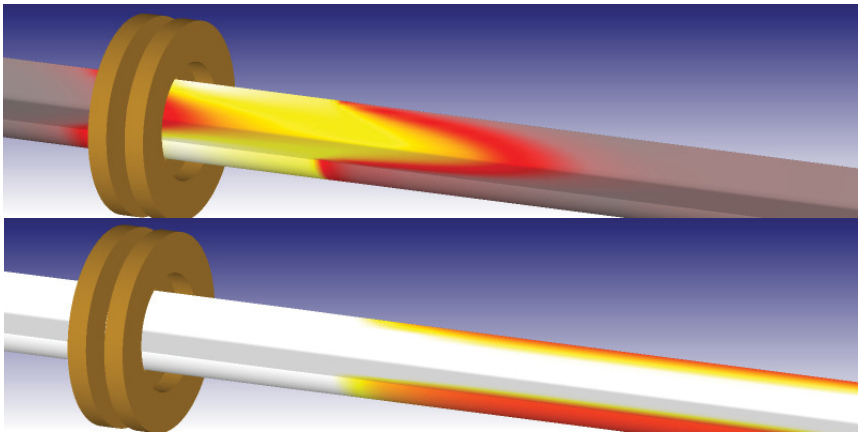
Induction hardening is used to harden the surface of a part, while maintaining a more ductile interior. The surface is rapidly heated above the austinization temperature, followed by rapid quenching of the workpiece, typically using a water spray.

A scanning induction process was used to harden a 23mm bar. A 2 turn coil, with a power of 20KW and a frequency of 20KHz was scanned along an AISI 1045 bar at a speed of 10mm per second. The coils were followed by a water spray (modeled as an environment window with a convection coefficient appropriate for water).





Input power profile and workpiece temperature response



Temperature (top) and martensite distribution (bottom) in induction hardened shaft

Conclusions

Induction is efficient because there is little heating of the environment compared to other processes. Heat is generated within the workpiece rather than transferred to it. But this makes prediction of internal temperatures difficult. DEFORM offers a powerful tool for understanding temperature distributions within a workpiece. 2D simulations often run in a few minutes to an hour, and can provide information that is difficult or impossible to obtain expimentally.

DEFORM V11.0.2 Release

DEFORM V11.0.2 was released in December, 2014. Improvements and enhancements include:

- Target volume calculation is available in FORMING EXPRESS 3D.
- Added features and controls were added the report generator.
- PIP (picture-in-picture) in the post-processor allows the user to view multiple database files.
- Quarter symmetry shape rolling rotation is now supported in ALE.
- Bug fixes and stability improvements were made throughout.
- Geometry reference point updating has been improved.
- MTS (multiple time step) coupled die stress analysis supports EP objects.
- Hyperelastic analyses with substepping improves accuracy.
- Friction heating involving multiple deforming objects was enhanced.

New Features in V11.1

DEFORM V11.1 is being targeted for winter 2015 release. Some of the new features include:

- Shape rolling, cutting and inverse HTC modules rewritten in new MO environment with numerous enhancements and bug fixes.
- Copy/mirror functionality is available in the MO environment.
- Enhanced PIP and multiple viewports will be implemented in the postprocessor.
- Brick remeshing improvements support more complex shapes.
- Rotational symmetry enhanced
- A dual mesh system was implemented to improve speed.
- Taguchi sampling, multiple simulation server support and CAD integration were added to DOE.

DEFORM V11.1 will contain the integrated 2D/3D and the F2/F3 GUI. These will be phased out and replaced by the Multiple Operations GUI over time.

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