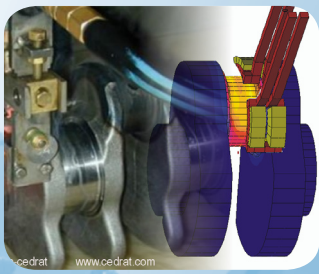


Heat Treatment Simulation



Pioneering the simulation of magnetic and electric heat treatment phenomena, CEDRAT has become a world leader in providing software solutions for the design and analysis of heat treatment processes and equipments.

CEDRAT's range of solutions covers all aspects of heat treatment simulation, from magnetic or electrical to thermal states, including as well all metallurgical phenomena.

From inductive and dielectric heating

Leader in induction heating simulation for more than 10 years, Flux has developed numerous formulations and tools to model precisely inductive, conductive and dielectric heat treatment.

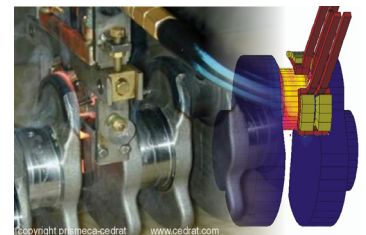
To account precisely for the temperature influence of heating phenomena, Flux features a strong coupling between magnetic and thermal computation, both for 2D and 3D simulations. This strong coupling creates a real interaction between magnetic and thermal fields. All the properties (linear or non linear) may depend indeed on the temperature variation:

- Magnetic and electric properties (permeability, resistivity,...)
- Thermal properties (thermal conductivity, heat capacity,...)
- Exchange conditions (convection, radiation).

Flux will then loop so that both magnetic and thermal characteristics account for the actual temperature in the device.

" Flux (2D and 3D) is a very powerful tool for the design of electromagnetic heating devices and in particular for induction heating applications. "

>>> *Dr Fabrizio DUGHIERO, Padua University, Italy.*

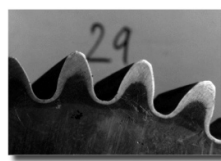


Inductive hardening of a crankshaft. Induced power density (Prismeca).

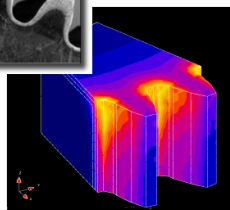
Flux gathers also many other functionalities to enhance the simulation:

- Geometry building facilities such as import of CAD files (STEP, IGES, DXF...),
- Mixed mesh generator to better account for any physical anisotropy (e.g. eddy currents),
- Electromechanical coupling in 2D and 3D to account for the motion of a part during the computation (scanning),
- Advanced electric circuit to model the source for the inductor: voltage or current sources, passive components (resistances, inductances and capacitors), solid or stranded conductors...
- Possibility to define any type of source waveform to model heating and cooling...

Flux is the best tool to optimise the process and device using the multiparametric possibilities. Indeed, Flux multiparametric solver allows any parameter to be varied (geometric dimension, mesh, materials, sources, frequency...) in one computation and then to solve various configurations in only one run.



Contour hardening of an helical gear (Renault Patent).



Flux multiparametric postprocessor gives a direct access to all the results (electrical, magnetic and thermal) with various formats : point values, isovalues, colour maps, 2D/3D curves, AVI animations, export to Word® and Excel®...

WEB LINKS

Scanning

Induction hardening

Inductor design

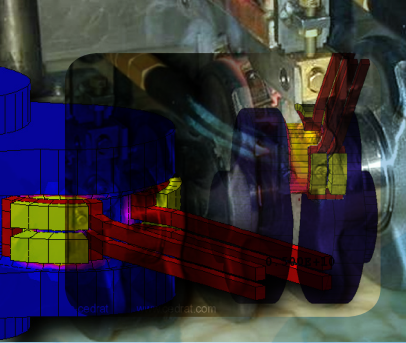
Offshore pipeline

Welding

Aluminium brazing

Dielectric heating

Heat Treatment Simulation



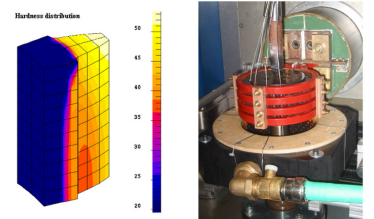
To metallurgical phenomena

Heat treatment may have various goals (superficial hardening, tempering, reheating, forging, welding...) but it always induces changes of the materials: transformations of phases, hardness, grain sizes, homogeneity...

To account for all those changes, METAL7 may be coupled to Flux. From the thermal results computed with Flux (from a simple transient thermal or a coupled magneto-thermal computation), METAL7 computes the different metallurgical transformations using, e.g. for the phase transformations, either a standard model (Johnson-Mehl-Avrami) or a specific model developed by PRISMECA.

METAL7 features numerous tools to:

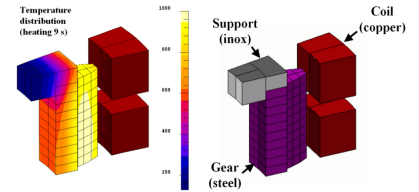
- Build complete and personalised materials database,
- Compute simple thermal cycles,
- Plot TTA, TTT, CCT diagrams,
- Communicate directly with Flux, ABAQUS, Excel®...



“ Calculations of coupled electromagnetic and temperature fields in different electrothermal processes especially induction heating are carried out using Flux package. Programs Flux (2D) with Metal 7 module and Flux (3D) are used in various projects”.

Pr Krzysztof KUREK,

>>> Silesian University of Technology, Poland.



Study of an induction heating gear: temperature (after 9s heating) and hardness distribution.

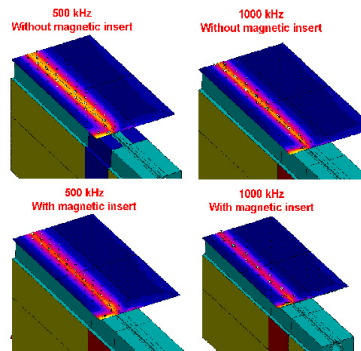
WEB LINKS

Flux for Electromagnetic and Thermal Analysis

METAL7 for Metallurgical analysis

When coupled with Flux, METAL 7 allows the user to postprocess the simulation using Flux postprocessor and its unlimited performances. Percentage maps of every phase or maps of hardness may then be easily plotted, as well as hardness profile in any piece.

Sealing of thin aluminium layers for food packaging. Current densities and filling process (TetraPak).



References

Leader in induction heating simulation since early 90's, CEDRAT gathers many worldwide references:

Arcelor, Bone Frontier Corp, Carbone Lorraine, CEA, CELES, Centre for Induction Technology, CFEI, EFD Induction A.S, GH Induction, Imphy, Electricité de France, Fluxtrol, Inductoheat Inc., Inova, IRSID, IVF, Nexans, NTNU, Prisma, SAET, SCLE, SEB, SFEE, Sintef Energy, Termetal...



www.cedrat.com