TEMPO

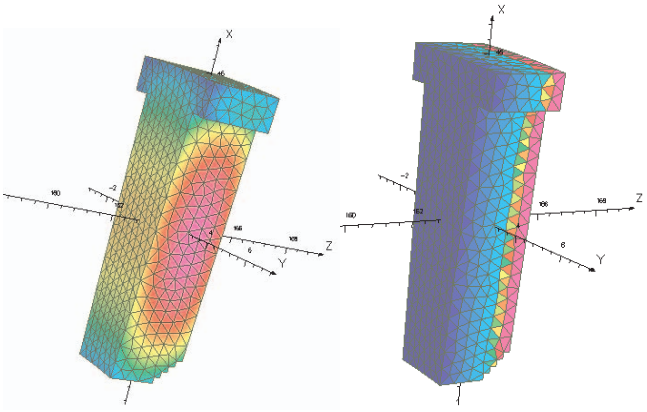
3D THERMAL ANALYSIS

The TEMPO analysis package is a module of the OPERA-3d integrated suite of finite element software for 3D electromagnetic design and analysis. TEMPO computes the three dimensional temperature, heat-flux, and thermal-gradient fields due to electromagnetic heating or external heat sources, using advanced numerical methods for accuracy and speed of computation.

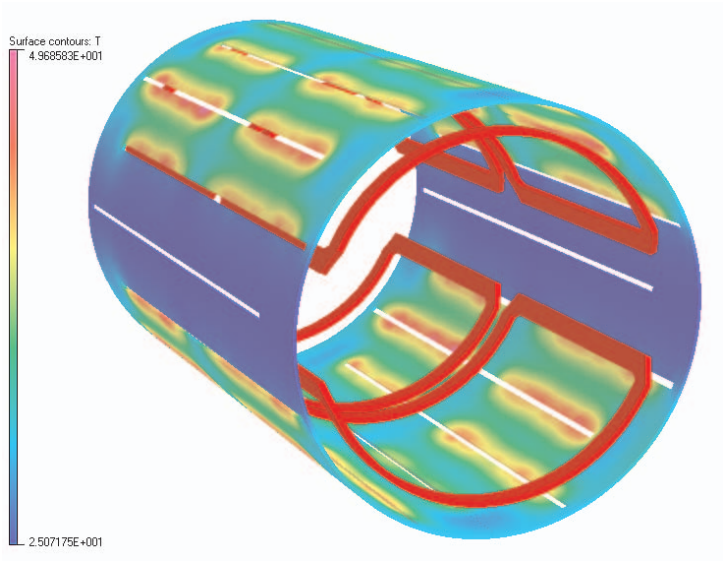
Concepts

In optimizing the design of some electrical equipment the basic electromagnetic conceptual design needs to be enhanced by a detailed thermal analysis using proven software tools.

The detailed computation of temperature fields has been extensively researched by the VECTOR FIELDS development team and the TEMPO package, together with the OPERA-3d Modeler and post processor package, offers a complete environment for thermal analysis and design. Interfaces to major CAD packages enables the TEMPO software to be integrated into an overall computer aided engineering system.



Temperature and heat density in stator tooth of electrical machine



Temperature distribution in eddy current shield

Applications

VECTOR FIELDS outstanding experience in the 3D computation of electromagnetic fields is internationally recognized. The experience of the VECTOR FIELDS development team and application engineers has produced a package that is easy to use, and that extends the capability of the OPERA-3d suite. TEMPO may be used in stand-alone mode with the user defining the distribution of heat input, or can be used in conjunction with the OPERA-3d modules such as ELEKTRA or CARMEN to determine a volume heat distribution. TEMPO then computes the three dimensional temperature, heat flux, and thermal gradient fields for applications including motors, generators and electromagnetic heating.

VECTOR FIELDS
Software for Electromagnetic Design
www.vectorfields.com

Method

TEMPO solves the Poisson equation for final temperature

$$\nabla \cdot \kappa \nabla T = -Q$$

where κ is the thermal conductivity, T is the temperature and Q is the heat density.

The thermal conductivity tensor and heat source density can be specified as a function of position, and can be temperature dependant (leading to a non-linear analysis). The heat generation due to an electromagnetic analysis can be imported using tables. The heat is computed either at the nodes, or the element centroids and then passed to the TEMPO analysis. A table with heat density from multiple sources (for example eddy current and iron losses in a motor) can be produced easily in the post processor.

Boundary conditions are primarily used to specify the coupling of the thermal system to its surroundings. A secondary function is to reduce the size of the finite element mesh in symmetric models. The boundary conditions implemented in TEMPO are: perfect insulator; fixed temperature; heat flux; heat transfer. In addition there is a general non-linear transfer condition that can be used to model radiation from a boundary.

Features

TEMPO has the following features:

- Full 3D modeling
- Automatic mesh generation
- Efficient data input
- Non linear materials
- Interfaces to CAD/CAM
- Various boundary conditions including:
  - perfect insulator
  - fixed temperature
  - heat flux
  - heat transfer to fixed temperature medium
  - radiation
  - general non-linear transfer condition
- Display of temperature and heat flux distribution
- Import of eddy current heat sources from electromagnetic analysis
- Extendible post processing

Modeler and Post Processing

As a module of the OPERA-3d suite of software, TEMPO interfaces to the OPERA-3d Modeler and post processor. This gives the user access to powerful pre and post processing features specifically tailored for electromagnetic and thermal design.

The Modeler is specifically designed for electromagnetic applications by VECTOR FIELDS using the ACIS™ kernel. The Modeler has an easy to use 'windows' interface with clear icons. This enables complex 3D models to be constructed swiftly from primitive solids using Boolean operations and automatically meshed with tetrahedra. Transfer of geometric data between CAD systems and the Modeler is through the industry standard SAT and IGES file interfaces.

The post processor is renowned for its versatility in displaying computation results. It has very comprehensive and flexible facilities enabling the user to display the results in a variety of ways controlled by an easy to use 'windows' interface. The features include:

- 3D model views from any angle with mouse driven pan, zoom and rotation
- Graphs, histograms and contour maps of the solution
- Estimation of the maximum error in the heat flow
- Contours of the results on any surface
- User defined functions

Hardware

All VECTOR FIELDS software runs on PCs and Workstations. It is VECTOR FIELDS policy to always support the latest operating system on each hardware. A list of supported hardware, and suggested minimum configurations, are available on request.

Customer Support

Applications advice and "hot-line" support is an integral part of the VECTOR FIELDS service. Professional engineers with extensive electrical design experience are available to help users in their application of TEMPO. Your main VECTOR FIELDS office or local distributor will be pleased to be of assistance at all times.

Comprehensive user documentation is provided with TEMPO enabling new users to quickly apply the software to their application. In addition, training courses are held regularly to give "hands-on" training in the use of TEMPO.

User group meetings are held annually giving users the opportunity to discuss their applications with VECTOR FIELDS experts and other users in a relaxed atmosphere.

Whatever your application and wherever you are located, you can be sure of VECTOR FIELDS interest and support.

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