Managing Heat with **Multiphysics**

Multiphysics simulation helps a global company design better electrical products.

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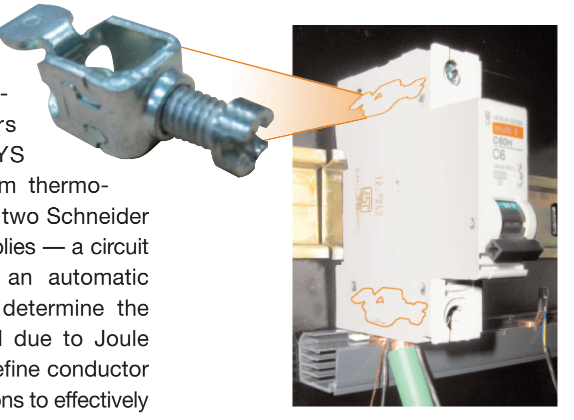
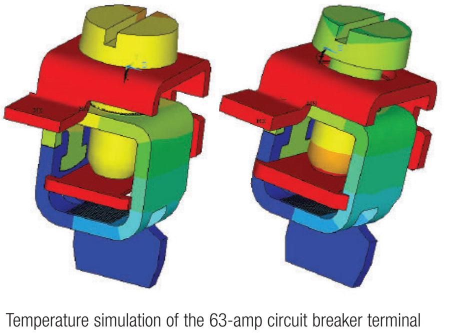
Multiphysics simulation is used in electrical industries to predict product performance and failure conditions and to perform optimization. Product testing is very costly, and repeated trials are not part of the preferred product development process, wherein products are optimized early in the design process using simulation. In addition, simulation assists product designers in these industries to meet standards required by bodies such as Underwriters Laboratories (UL) and the International Electrotechnical Commission. Thermoelectric simulations play a vital role in product development in product areas such as final distribution enclosures, industrial plugs and sockets, protection and control of low-voltage power circuits, electrical network management, energy-efficiency devices, automation and control devices, power electronics cooling, and millivolt switching devices.

Schneider Electric is a global specialist in energy management, with operations in more than 100 countries. The company focuses on making energy safe, reliable and efficient. The organization's Global Technology Centre (GTC) in Bangalore, India, has 460 employees working on product development and resource enhancement, and its resulting innovative products and technologies are available in markets across the globe. To reduce costs and gain time in their product development process, the GTC uses ANSYS Icepak, ANSYS Workbench, ANSYS Multiphysics and ANSYS FLUENT technologies. Researchers there used ANSYS Multiphysics to perform thermoelectric simulations on two Schneider Electric product assemblies — a circuit breaker terminal and an automatic transfer switch — to determine the temperature generated due to Joule heating as well as to define conductor and insulator specifications to effectively manage heat. The study extended into analyzing the effects of convective cooling by varying the convective film coefficient, and the results from the ANSYS Multiphysics simulations were compared with test results.

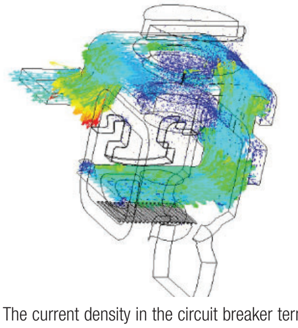


Test rig of circuit breaker showing approximate location of terminals inside the casing

Miniature circuit breaker (MCB) terminals are subassemblies of the Schneider compact circuit breaker series. The terminal connects the circuit breaking device with external circuitry. An automatic transfer switch is an electromechanical switching device used widely in Schneider Electric low-voltage products. For both the terminal and switch, the CAD model was developed in Pro/ENGINEER® and imported directly into the ANSYS Multiphysics environment. Engineers meshed the geometry with direct coupled-field elements,



Temperature simulation of the 63-amp circuit breaker terminal original design (left) and new design (right). The design improvement caused a 9-degree Celsius temperature reduction.



The current density in the circuit breaker terminal

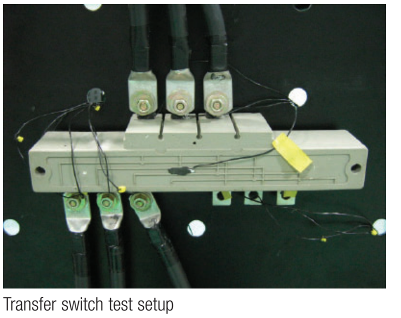
"The Global Technology Centre uses multiphysics technologies from ANSYS to reduce costs and gain time in their product development process."

which automatically account for the bi-directional coupling between electric Joule heating and temperature in either steady-state or transient analyses. These elements accept both thermal and electric boundary conditions and excitation. Electric boundary conditions were used to prescribe the net DC current passing through individual solid conductors. Thermal boundary conditions consisted of thermal convection coefficients defined on surfaces exposed to 25-degree Celsius (C) air.

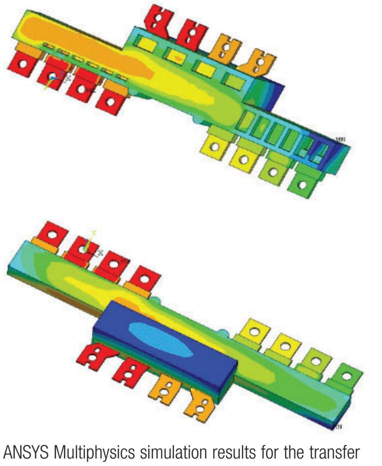
The team modeled two MCB terminals: a 63-amp terminal and a 25-amp terminal. The design for the 63-amp terminal was modified in thickness to reduce the temperature by 9 degrees C. Correlations between simulation and experimental lab results were impressive, with only a plus or minus 2-degree C deviation. For the 25-amp terminal, temperature results confirmed the safety of the product and also corresponded well with experimental results.

Similarly, using simulation, design improvements in insulation material were applied to the transfer switch terminal model that resulted in a temperature reduction of 6 degrees C in the assembly. Once again, the simulation results compared well with the experimental results, with a plus or minus 4-degree C deviation.

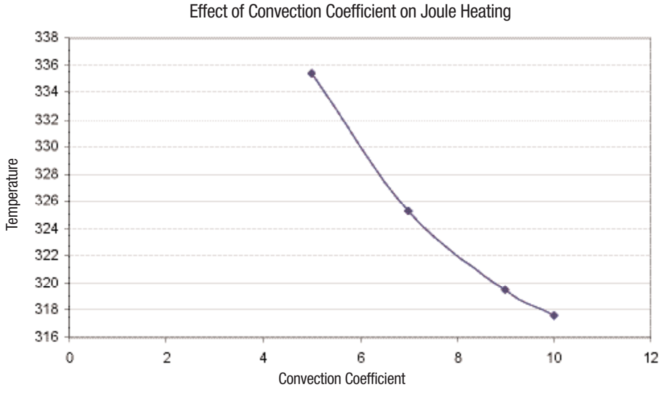
The R&D experts then studied the current flow path and the variation of the convection coefficient with the maximum temperatures obtained. These simulation results gave researchers confidence that the same modeling approach could be applied to all products in these families. Electrical conductor thickness and insulation material selection can be optimized using simulation to reduce the need for prototyping at the beginning of the design cycle and save valuable development time and costs. ■



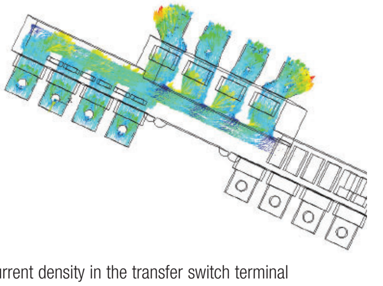
Transfer switch test setup



ANSYS Multiphysics simulation results for the transfer switch terminal: original design (top) and new design (bottom) showing temperature reduction



Effect of convection coefficient on Joule heating for the transfer switch terminal



Current density in the transfer switch terminal