Induction Heating of a Workpiece Past the Curie Point

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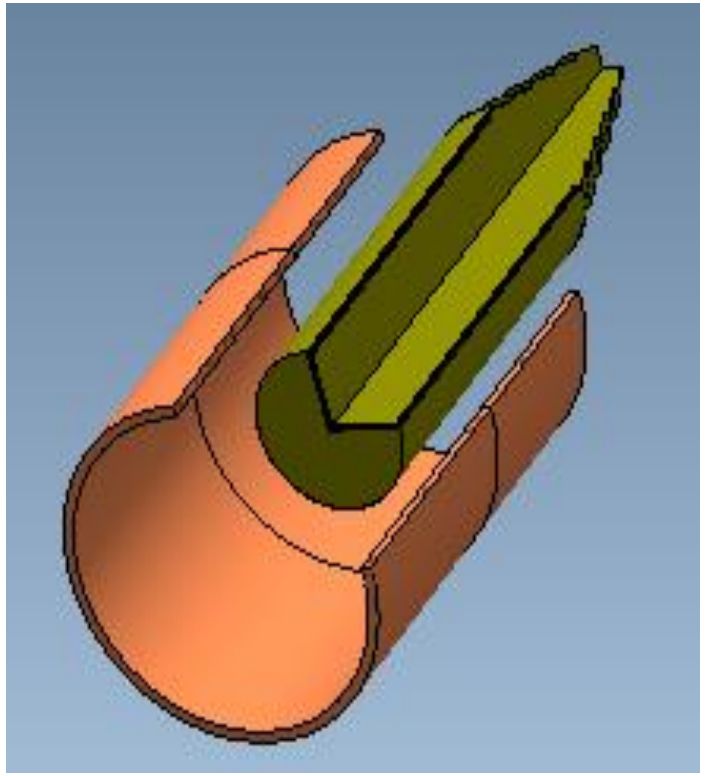
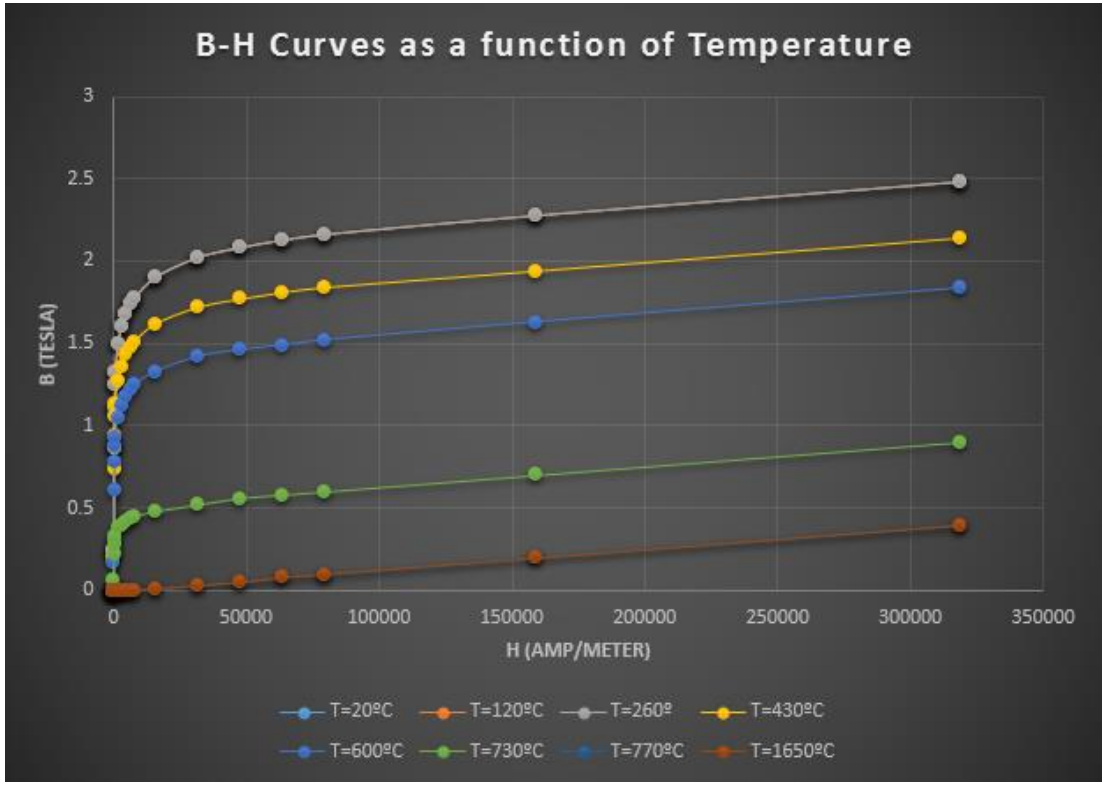
A workpiece is placed inside an inductor coil; the eddy current losses raise its temperature past the Curie point, which in turn affects the distribution of the eddy currents.

To correctly simulate this process, a fully coupled electromagnetic-thermal field solver and temperature-dependent material database are required. This is the case for Simcenter MAGNET and ThermNet.

To increase the speed of the simulation, only the workpiece itself was meshed in ThermNet. In Simcenter MAGNET, the coil and surrounding air must also be meshed.

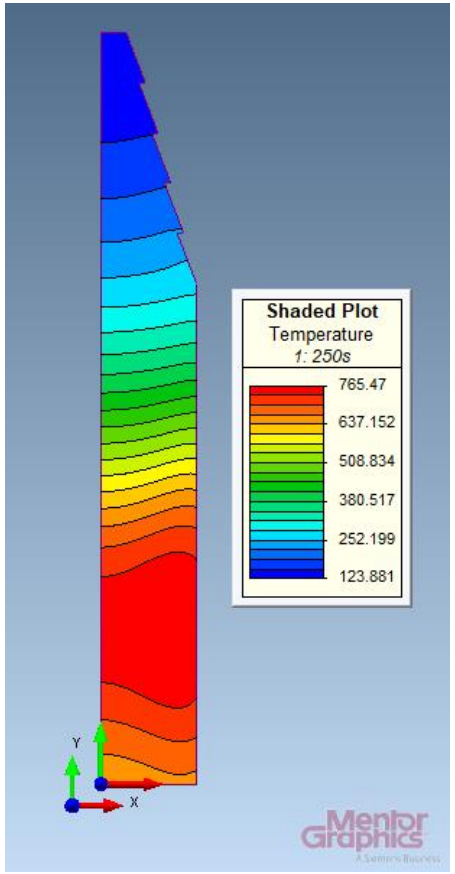


B-H CURVES AS A FUNCTION OF TEMPERATURE



The workpiece is composed of a material whose magnetic properties vary as a function of temperature. The graph shows the B-H curve at different temperatures. ThermNet interpolates these curves at temperatures between those specified.

TEMPERATURE IN WORKPIECE ABOVE CURIE POINT



The temperature of the material closest to the magnetic-field-generating coil eventually increases beyond the Curie point and impacts its magnetic properties. The B-H curve in the hot region corresponds to the red trace in the graph of B-H curves.

PEAK MAGNETIC FIELD

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Here we see that the induced eddy currents cause an increase in the material's temperature which then impacts its properties. As the material heats up, it becomes less permeable and less conducting, thus the skin depth increases. Consequently, as shown, the flux lines penetrate further into the material. This effect can only be modeled if the eddy current distribution is re-calculated at each transient time step, as is done in ThermNet.