Modeling Post Convection Cooling of High Power Waveguide

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Abstract

High power microwave applications, though not as common as the low power ones, are of extreme importance in the defense sector, nuclear power, accelerators, etc. At power levels of few kilowatts(kW), transmission medias like cables, microstrip lines, etc. fail to cater the required performance due to high losses. Hence, different components made of metallic waveguides (rectangular/circular) are used at high power. But even such components, reach to extremely high temperatures(in order of 1000 degree Celsius) when subjected to input power levels of few hundreds of kW CW(continuous wave). Thus, efficient cooling is needed to be performed on such components. One technique is indirect convection cooling using water for copper structures. Copper is generally used for such designs due to its high electrical and thermal conductive properties. In consequence of such heating of the components in high power applications, it is essential to study and validate the cooling technique designed before actually fabricating the components to reduce the risk of failure.

In this paper, the authors present the modeling of a copper waveguide structure subjected to an input power level of 250 kW CW. The results are presented for pre and post cooling and the correctness is validated using theoretical calculations. The modeling is carried out in COMSOL Multiphysics® software using different physics interfaces like Electromagnetics Wave, Frequency Domain (emw), Turbulent Flow and Heat Transfer in Solids. Figure 1 shows rise in temperature for a waveguide structure after cooling lines are added on the broad walls of the waveguide. The maximum rise in temperature is 4.5 degree Celsius.

Figures used in the abstract

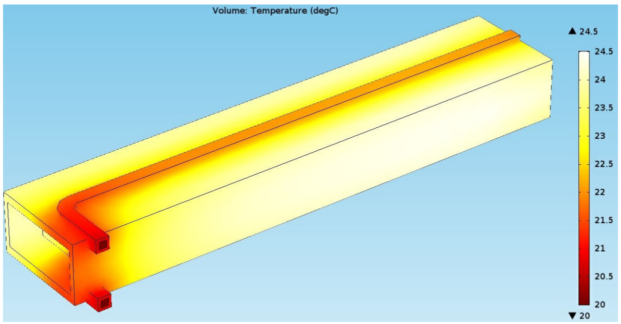

Figure 1: Final Temperature after Cooling.