COMSOL As an Aid in the Teaching (Learning) of Heat Transfer

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Abstract

Several undergraduate programs include the "Heat transfer" subject and, in our experience, it is hard for the students to grasp the concepts that are presented in the course. With this in mind, we designed and constructed an apparatus for the experimentation of heat transfer in a short bar. It was observed, however, that the time required to perform the experiment was so long, that the didactic aim was lost in time-consuming activities, such as the setting of the instrumentation, the data registration and processing, and the software calibration. We also noticed that we were constrained to a single experiment within a limited set of possible variations. Therefore, we decided to explore the virtual approach by means of a multiphysics software, namely COMSOL. The experimental facility is aimed to study a short bar heated on one end, maintaining the bar itself in quiescent air. The simulation using COMSOL was set for a short bar in an enclosure, to fix the boundary conditions required.The results are presented in graphic format. The time taken to run the program is considerable smaller as compared to the physical experiment. Several crucial points are highlighted to the student such as the usefulness of the simulation, the easy introduction of the "what if…" scenario and the reduction of the associated costs as compared to the experimental facility. The dimensions of the bar are set as A, constant transversal area, length and perimeter, which is immersed in a liquid at constant temperature, T_0. The chamber is surrounded by water at ambient temperature, T_∞ . The bar is manufactured using a material with a constant thermal conductivity, k, and the convection heat transfer coefficient between the bar and the surrounding liquid is h ; the el supply of heat is constant. An example of the distribution of temperature results is presented in Figure 1. Using COMSOL we were able to omit some layers of liquid, aiming for a better understanding of the problem. Students can now clearly notice that the temperature increases gradually from the bar to the fluid as a result of heat transfer. They can also observe that the temperature at the initial portion of the bar as well as the surrounding liquid is higher (Figure 2). We concluded that this new age multiphysics software efficiently gives the students a new tangible perspective of this complex subject and enables them to apply powerful tools such as "what if…" scenarios to grasp the full mastering of heat transfer theories.

Figures used in the abstract

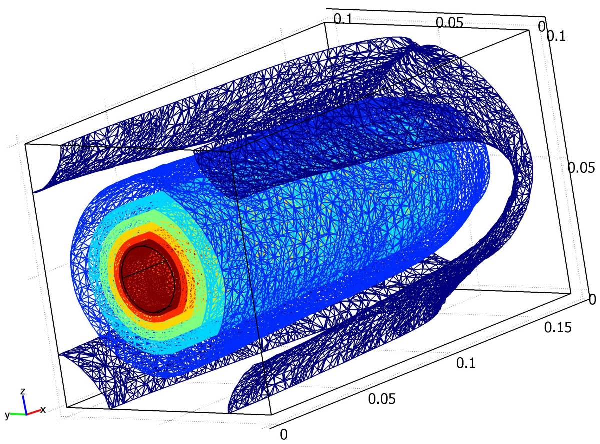

Figure 1

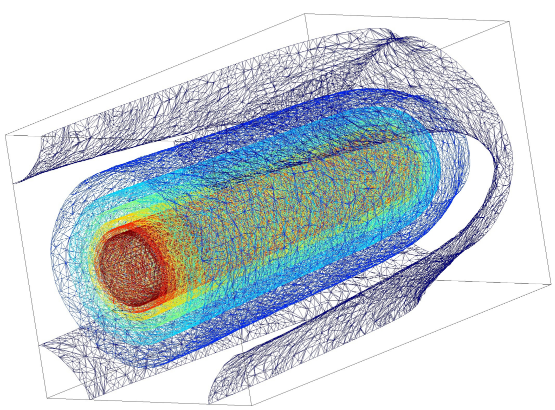

Figure 2