Application of Hot Wire Technique and Comsol Multiphysics in the Heat Transfer Monitoring in Solids.

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Introduction: The hot wire technique is an absolute, non-steady state and direct method which is considered an effective and accurate procedure to determining the thermal conductivity of a variety of materials, including ceramics, fluids, food and polymers [1-2]. However, this technique is based in a conventional mathematical model which is an approximation of the physical reality in the experimental setup because the complexity of the mathematical problem has been an obstacle to obtain a more realistic theoretical model [3, 4]. Fortunately, nowadays the development of the advanced numerical methods and computing systems allow the application of high level software for obtain an approximate solution to a complex mathematical problems with a boundary conditions congruent with the physical reality.

Governing Equations: Considering a cylinder of radius ***a***, with a concentric hole of radius ***b***, to which a power density is applied over the symmetry axis of the sample to produce a radial heat flux that diffuses in the medium.

$$\rho C_p \frac{\partial T}{\partial t} + \rho C_p u_{trans} \cdot \nabla T = \nabla \cdot (k \nabla T) + Q + W_p$$

If only the Laplacian operator and the transient term is needed, the diffusion equations give

$$\rho C_p \frac{\partial T}{\partial t} = k(\nabla^2 T)$$

The boundary condition in ***r = a*** *(Neumann Condition).*

$$-n \cdot (-k \nabla T) = q_o$$

And at ***r = b***, the boundary condition is given by (Dirichlet Condition):

$$T = T_0$$

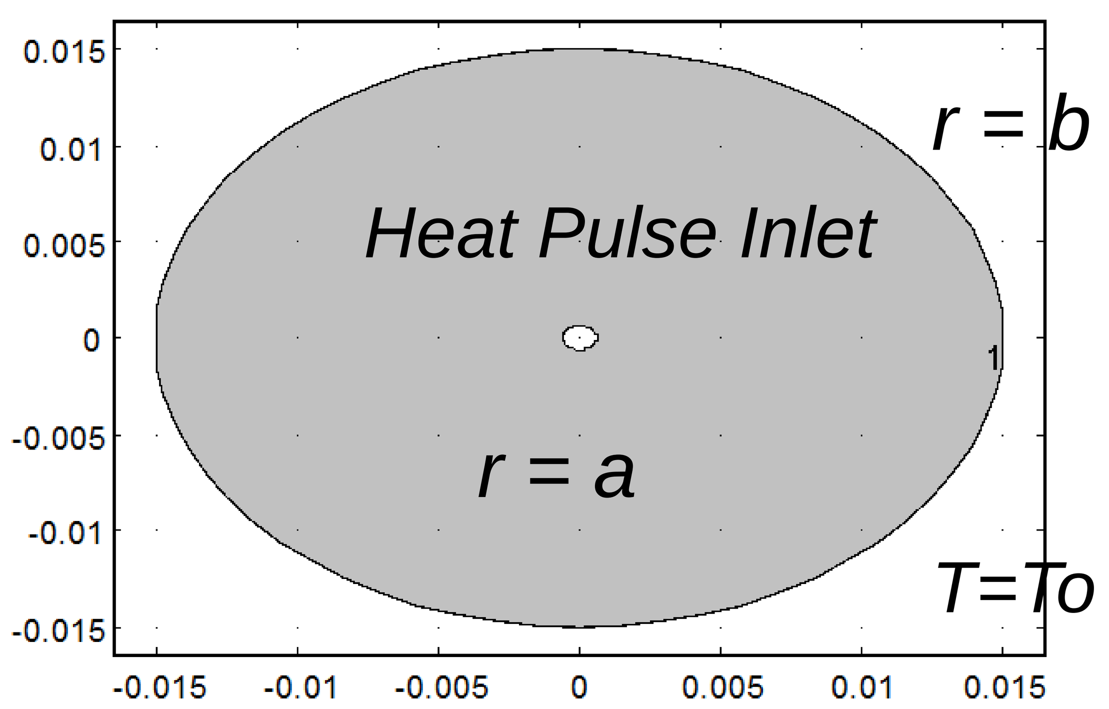
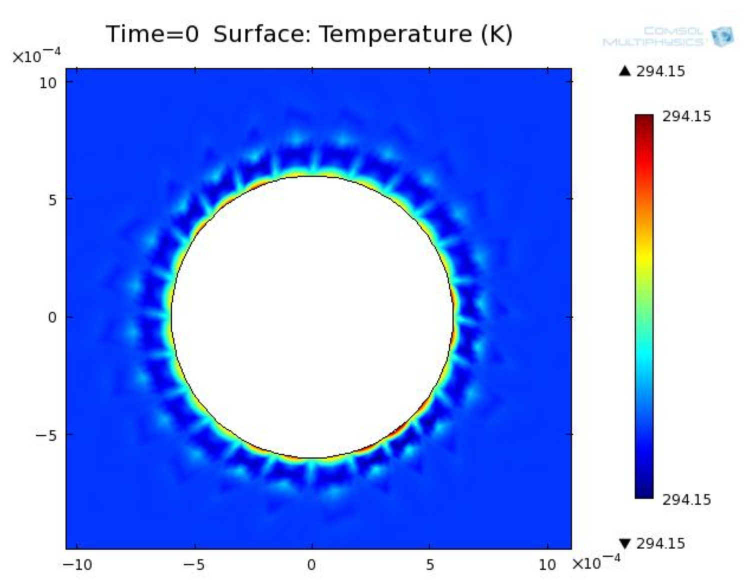


Figure 2. 2D Geometry

Results:

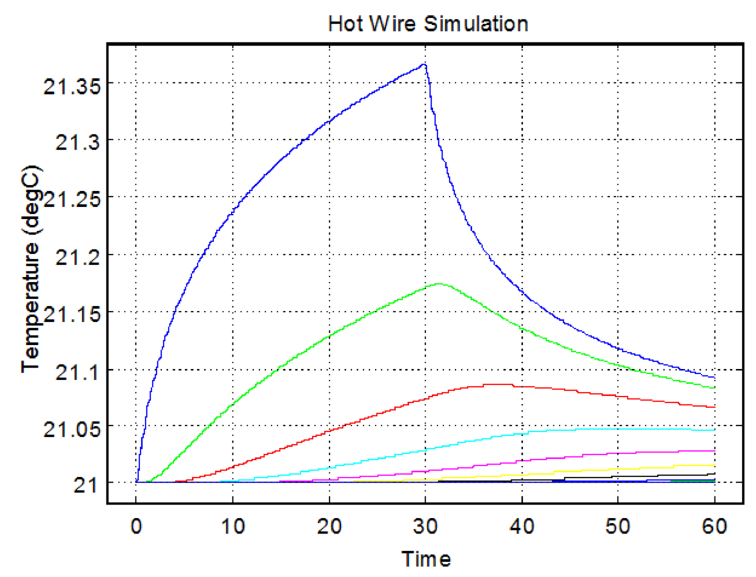
Variable	Value	Units
Density	1261	Kg/m3
Thermal Conductivity	0.285	W/mK
Heat Capacity	2470	J/kgK

Table 1. Thermophysical properties of Glycerin



These results show that the Comsol simulation is an important tool for investigate the heat transfer in solids which can be used like complement in the application of the hot wire technique.

Figure 2. Temperature Diffusion in the media



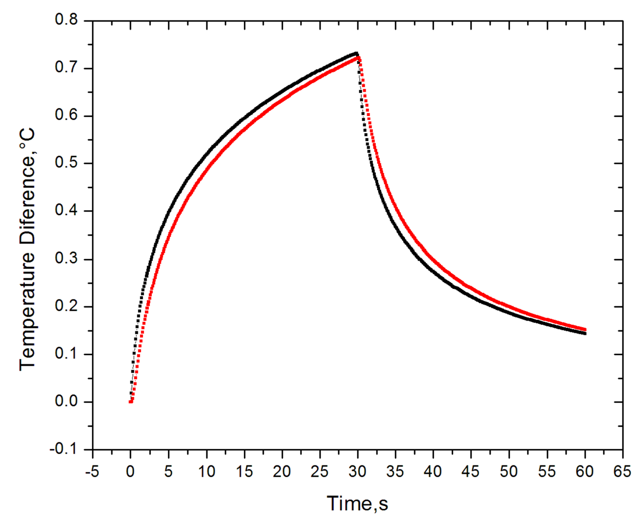


Figure 3. Temp Vs Time **Figure 5**. Comparison of conventiona Model Vs Comsol Simulation

Conclusions: It has been found that the finite element simulation has a remarkable reproducibility with respect to the physical experiment and the theoretical models. Besides this type of analysis provides a substantial advantage, being able to vary the different parameters of the experiment, such as the radial distance, the heat flux, the initial temperature, among others, and thereby optimize the results.

References:

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