

# The APP as a Tool, A First Principles Approach

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**Introduction:** The APP discussed in this paper is based on a COMSOL Multiphysics<sup>®</sup> 1D heat transfer model that analyses the heat flow through a double pane window, with a gas chamber between the two panes. This APP models the calculation of heat loss (gain) under stationary (steady-state) conditions, for a wide range of applied conditions, to identify the appropriate geometry and materials for a given situation.

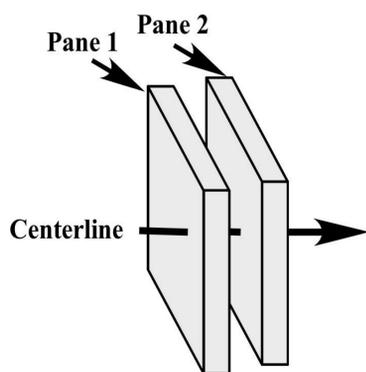


Figure 1. Heat flow through double-pane window

**Computational Methods:** The APP calculates the temperature gradient (differential) along the heat flow path in this 1D model as heat flows from the left-most environment through the left pane, the gas chamber and the right pane to the right-most environment.

The heat flow is governed by the conductive heat flow equation for solids [1]:

$$\rho C_p \frac{\partial T}{\partial t} + \nabla \cdot q = 0 \quad (1)$$

$$\text{where } q = -k \nabla T$$

The Geometry comprises three intervals. Interval 1 and Interval 3 are the Panes. Interval 2 comprises the gas chamber [2].



Figure 2. 1D Geometry: Intervals 1, 2 and 3

All solutions are computed using the Heat Transfer in Solids Module and a Stationary Solver.

**Results:** The results are presented in three 1D graphical presentations, using the units of, degF-in, degC-mm, and K-m. In the resulting 1D plots, the temperature is shown as a function of the distance (location of the measurement point) into the geometry of the Double Pane Gas Chamber Model from the left-most extent (start) of the linear geometry to the right-most extent (end).

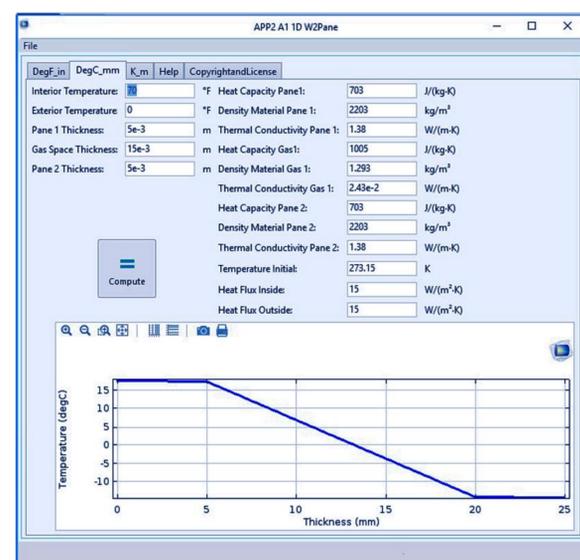


Figure 3. APP Parameters and Resulting Graph(s)

**Conclusions:** This 1D APP facilitates accurate First Principles analysis to show preliminary evaluation results. Building an application (APP) from an exploratory model and running it with COMSOL Server allows non-modeling scientists, engineers and staff to explore combinations of design and material changes.

## References:

1. COMSOL, Heat Transfer Module Users Guide, V. 5.3, p. 143, (2017)
2. R.W. Pryor, Multiphysics Modeling Using COMSOL 5 and MATLAB, p. 37 (2016)