Physics Department Seminar

Apr. 11, Friday at 2pm in Science Building Room 250

Estimating Convective Heat Transfer Coefficients from Experimental Data

A Model-Based Approach

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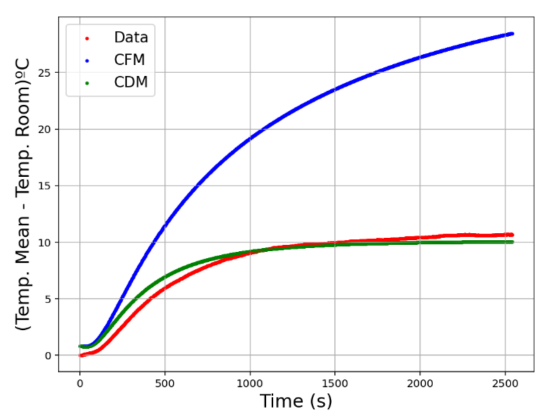
Modeling heat conduction in solids is essential for numerous scientific and practical applications, from electronics cooling to industrial processing. The classical heat equation, based on Fourier's law, provides a fundamental description of heat transfer but fails matching experimental results due to unaccounted convective losses. This discrepancy highlights the need for an improved model that better represents the physical system.

This work proposes a new model of the heat equation that incorporates a convective loss term which is linked to Newton's law of cooling. We introduce a set of effective parameters $\boldsymbol{\beta}$ that capture the influence of material properties and geometry on heat dissipation. These parameters allow us to estimate the convective heat transfer coefficients $\boldsymbol{h}$ defined by the Newton´s law of cooling, reducing the gap between the model and experimental results.

We used the Nelder-Mead optimization algorithm to get the ideal values of $\boldsymbol{\beta}$ and performed experiments on a heated copper rod to validate this method. Our results demonstrate that the modified heat equation, which captures heat dissipation effects, significantly increases the agreement between theoretical predictions and experimental results. This approach offers a practical and adaptable framework for refining heat transfer simulations in controlled environments. This method could be expanded to include more materials and geometries in future research, making it more applicable to a broader range of thermal analysis problems.



Dynamic analysis of the heat transferred over time through a cylindrical copper rod.