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Individual conclusion 2

Analyzing heat conduction using experimental data and analytical models for both transient and steady state temperature distributions showed how accurately we can model heat conduction without experimental data present. Although there were many errors in our assumptions, the initial temperature of the cold end being greater than anticipated, inaccurate voltage and current readings, the thermal conductivity of the material, and assuming all the heat is transferred to the rod. These can be adjusted later to provide an even more accurate analytical model. The effect of these assumptions are shown in both the steady state analysis and in the graphs of thermocouple temperature over time. The slope of the temperature distribution determined experimentally for steel, aluminum and brass are 249.9, 57.27, and 150.2 deg C respectively. Analytically the temperature distributions for steel, aluminum and brass were calculated to be 442.17, 87.25 and 140.4 respectively. The difference between these experimental and analytical calculations is mostly due to how the slope of the temperature distributions is calculated analytically. The analytical slope is heavily dependent on the rate of energy transferred to the rod, and assuming that no heat is lost to the surroundings would explain why all analytical slopes are greater. Now looking at the transient temperature graphs, it is obvious that the assumption of initial temperature of the cold end drastically affects the accuracy of our model. The initial temperature of the cold end was assumed to be 10 deg C for our analytical model when in reality the cold end was around 10 deg C warmer, causing the analytical temperature of each thermocouple at every time step to have a difference around 10 deg from the experimental model. In addition to the initial temperature assumption, thermal diffusivity was also assumed to be uniform throughout the material. By varying the diffusivity of each metal we were able to further improve our analytical model of the transient temperature distribution. For each material an accurate thermal diffusivity was calculated, for steel aluminum and brass these values are 2.43 x 10^−6 m^2 /s, 2.17 x 10^−5 m^2 /s and 3.92 x 10^−5 m^2 /s. After changing both the initial temperature and values of diffusivity the accuracy of our analytical model improved. The biggest take away from the lab for myself was the affect the assumptions in the analytical model affected the accuracy of our calculations. This shows that using an analytical model without further investigating these assumptions will provide completely incorrect data. But this does not render the analytical model useless, in applications where some but not all data is unavailable a relatively accurate model can be created.

To improve the lab it would be interesting to go more in depth in how the material properties affect the accuracy of the analytical model.