

Architecture 4.411
Building Technology Laboratory
Spring 2004

Assignment 8 Airflow measurement and simulation

March 31 and April 1, 2004

The fourth week of our airflow lab is in two phases:

1. Please prepare an occupants' manual for your Chinese apartment. Passively conditioned buildings require occupant involvement, much more than buildings with mechanical systems that ensure thermostat set points are maintained. Your apartment occupants can inhabit any of the rooms and can adjust the balcony openings and apartment windows and doors in a number of ways, for different wind and outdoor temperature conditions. That makes for many combinations! Please write what you think are intelligible instructions, based on your measurements and good physical sense. For example, you might note that the flow through the bedroom varies little (or a lot) if the balcony windows are half closed, quantifying the variation from your measurements. You might also measure how the flow through the bedroom changes if the kitchen window is open or closed. Please note that this task is NOT intended to be a 15-minute qualitative exercise but will require careful thought and measurements beyond what you have taken.
2. Please consider the effect of airflow on the rate at which a miniature structure (even smaller than our elf houses) cools off. This is intended to combine thermal and airflow analysis. Proceed as follows:
 - a. Construct a small structure, large enough to comfortably enclose one provided 705 mL (3 cup) plastic container. Use cardboard, chipboard, wood or leftover insulation.
 - b. Model the water-house system as a one-node system and estimate the time constant. In essence, this repeats the calculation you did for the potato. Alternatively (and better) use our Matlab code, which will give you both water and air temperatures. Let the code plot the temperatures, as before, and estimate a time constant from the water temperature.
 - c. Heat water for the container, using a microwave or other means. Install a thermocouple in the water, insert the container into your mini-house, consider adding a second thermocouple or a Hobo for the air, seal the house and measure the time constant. This may take a while. Give some thought to how often you need to record data.
 - d. Open up your structure with no more than 20 cm² of windows. Locate them wherever you want, with the goal of using wind- and/or buoyancy-driven airflow to reduce the time constant as much as possible. You may add scoops or stacks if you like.

- e. Use a fan, if you wish, to promote airflow. Note airspeed at the window opening(s).
- f. Make at least two runs (beyond the sealed-box run), varying some aspect of the building – window location or sizes, air scoops, or a stack.
- g. Measure air speeds and calculate air change rates. Use the temperature data to estimate the thermal time constant for the water.
- h. Predict the change in time constant you measure, via hand calculations, the solar calculator, or Matlab. Make use of your measured air change rate.

This assignment and the report for the entire ventilation lab are due in two weeks. Next week we will introduce daylighting in Gujarati houses, select a house for modeling, and build a model of the house for testing the following week. You will have time in lab next week to finish the ventilation work or work on your lab report.