

## Heat transfer in fluids, external flows

1. Consider flow over a flat plate. Compute an average  $h$  for a number of different cases just to get a feel for the order of magnitude. Consider a plate the size of a piece of paper. Compute  $h$  for 0.1, 1, and 10 m/s. Compute for both air and water. It would be easiest to write a little MATLAB script or spreadsheet where you can put the formula in once and recompute the result. Provide your results for  $h$  as a table for each fluid.
2. Use Comsol to confirm the empirical formula for  $h$  at a few select conditions and to visualize the temperature field, for the previous problem. Note that you will need to keep the Reynolds number from being too large in order to get an accurate solution from Comsol. It is probably easiest to compute the flow between two parallel plates and make the spacing large enough (but not too large that the computation takes a long time) that the thermal and viscous boundary layers don't interact much.
3. Consider a cylinder in cross flow. Compute  $h$  for a number of different cases just to get a feel for the order of magnitude. Change the diameter from 1, 10, and 100 mm. Change the flow speed from 0.1, 1, and 10 m/s. Consider both air and water. It would be easiest to write a little MATLAB script or spreadsheet where you can put the formula in once and recompute the result. Provide your results for  $h$  as a 3x3 table for each fluid.
4. Use Comsol to confirm the empirical formula for  $h$  at a few select conditions for the previous problem. Note that you will need to keep the Reynolds number from being too large (keep  $Re$  less than about 100 based on cylinder diameter) in order to get an accurate solution from Comsol.
5. Consider a heated cylinder in air cooled by natural convection at room temperature. Consider a cylinder of 1, 10, and 100 mm in diameter. Consider the cylinder is held hot at 10, 50, and 100 C above room temperature. Compute an average  $h$  for each case. It would be easiest to write a little MATLAB script or spreadsheet where you can put the formula in once and recompute the result. Provide your results for  $h$  as a 3x3 table.
6. Estimate  $h$  for a pizza fresh from the oven cooling on the counter.