Flat Plate Boundary Layer - Part 2: Flat Plate Convection

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Part 2: Flat Plate Convection

Pre-Analysis

Model Setup and Solution

Post Processing

**Nusselt Number Variation**

Note 1: When you create graphs of the Nusselt number in Excel, you need to transfer the data points from the exported CSV file from ANSYS over to an Excel workbook file (.xlsx). A CSV file is just a flat text file that uses a delimiter to separate the fields (in this case, a comma). It CANNOT save any formulas or plots. A xlsx file is the typical file format for Excel, just as docx is for Word. In a xlsx file, you can save the formulas, graphs, pivots, etc in the file. It was mentioned in the video, but we wanted to emphasize.

Note 2: The purpose of running one iteration here is to ONLY send the values of the heat transfer coefficient to the Post-Processor. This should be done ONLY IF the solution has already converged which typically takes hundreds of iterations. Anytime a new Data File Quantity has been selected to be calculated, at least one iteration has to be performed to send the value(s) to the Post-Processor. In the video, the Professor already has a converged solution so to save time with unnecessary calculations, he sets the number of iterations to one.

Plotting Nux vs Pr

Here are the steps for generating a plot of Nu_x vs Pr for a chosen Re_x (say, 10,000) for selected Pr values (say, Pr= 1,3,5 and 7).

1. For Pr=1, go to the csv file exported from CFD Post and read off the Nusselt number value for Re_x = 10,000 (this process is shown in the Nusselt Number Variation video above). This is the Nusselt number for Pr=1 at that Re_x.
2. Change Air Cp in Fluent under Setup>Materials>Fluid>Air (to get a Pr=2, you need to double the Cp value for air; note that the values below may be wrong, the picture is just for locating where to to change Cp)
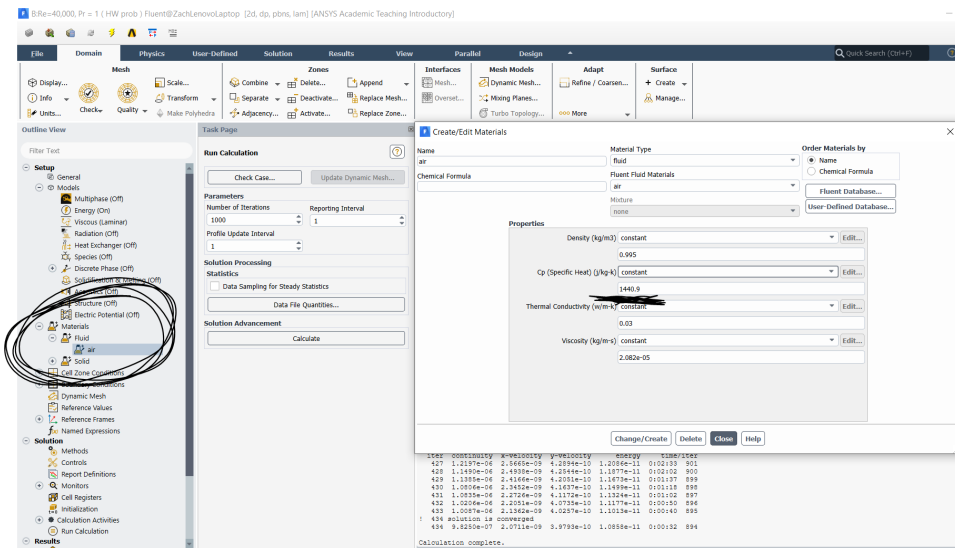
3. Run more iterations until the you get convergence (when the residuals are below 1e-6). Note you don't need to reinitialize the guess values since the velocity and pressure fields remain the same. Cp affects only the energy equation.
4. Export Nu_x vs. Re_x for the new Pr value to a csv file. Read off the Nu_x value for Re_x = 10,000. This is the Nu_x value for the new Pr at that Re_x.
5. Repeat for the other Pr values. Create a list of values in Excel from these runs with the following three columns.

Cp   Pr   Nux
6. Plot Nu_x vs Pr in Excel and add the trend line to get a fit and the exponent m

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