Turbulent Pipe Flow - Exercises

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Exercises

Problem

Use FLUENT to resolve the developing flow in a pipe (same configuration as was done in the tutorial) for a pipe Reynolds number of 10,000 on the following meshes: 100x5, 100x20 with uniform spacing in the radial direction. Plot the skin friction c_f as a function of axial location for each grid. Compare the exit value with the expected value for fully developed flow (e.g., see White pgs. 345-346). Recall that a key question for the integrity of the mesh is the non-dimensional value of the first nodal point:

$$y_1^+ = \frac{\rho u_\tau y_1}{\mu} = \sqrt{\frac{\tau_w}{\rho}} \frac{y_1}{\nu}$$

This should be either less than 4 (so that you resolve down into the viscous sublayer) or greater than 30 (where wall functions can accurately compensate for the poorly resolved viscous sublayer). Intermediate values can lead to greater errors. Calculate the value of y_1^+ for each mesh; use that to help explain (briefly) the trends in the agreement that you observe.

Hints

If you no longer have the 100x5 or 100x20 mesh, you can download them here: pipe100x5.msh, pipe100x20.msh

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