ACFD 2018 Project 2 discussion

Task 1

The typical outlet temperature is around 312 °K. The typical value of H is around 320 kW. This value is slightly sensitive to the detail of mesh, since H depends on both temperature and velocity. Slightly higher or lower values are acceptable. At the outlet, maximum velocity occurs near the outer edge while maximum temperature occurs near the inner edge of the pipe. See reference solutions.

Task 2

Straight pipe: The typical outlet temperature is around 302 °K, much lower than those from Task 1 and the "stretched helical pipe" case in Task 2. The value of H is also lower, with a typical value of 305 kW plus/minus a few kW. (The difference in H is less dramatic than temperature, because in the cases with a curved pipe high temperature is associated with low velocity.) With the straight pipe, we expect the temperature and velocity to be symmetric with respect to the center of the pipe. In the reference solutions, the deviation from the expected symmetry is due to the use of asymmetric (and relatively coarse resolution) mesh. (A further refinement of mesh should make the flow nearly symmetric, although few students chose to do so.)

Stretched helical pipe: The results for this case are very close to those from Task 1. Despite the stretching, the curvature of the pipe for this case is close to that of the original helical pipe in Task 1. (In this case, R = 29.23 cm, compared to 30 cm in Task 1.)

Task 3

At line 1, we expect a symmetric profile of velocity since the pipe is straight up to that point. (If we make the first straight segment of pipe longer, increase viscosity and/or lower inlet velocity, the profile at line 1 will become even closer to a "parabolic profile".) The profiles at line 2 and 3 are about the same, both exhibit a dramatic shift of maximum velocity towards the outer edge of the pipe. At line 4 (the exit), the velocity profile shows partial (but not full) recovery towards a symmetric profile. This profile is slightly sensitive to the detail of the setup (mesh, number of iteration, etc.) Reference solution #1 shows a case with more significant recovery, while reference solution #2 shows a case with a still significant shift of maximum velocity towards the outer edge at the exit. The two solutions represent the acceptable range of the profile at line 4.