Conner Cameron

Project #2

10/18/2018

Task 1

<u>(1) Mesh plot of the outlet surface:</u>

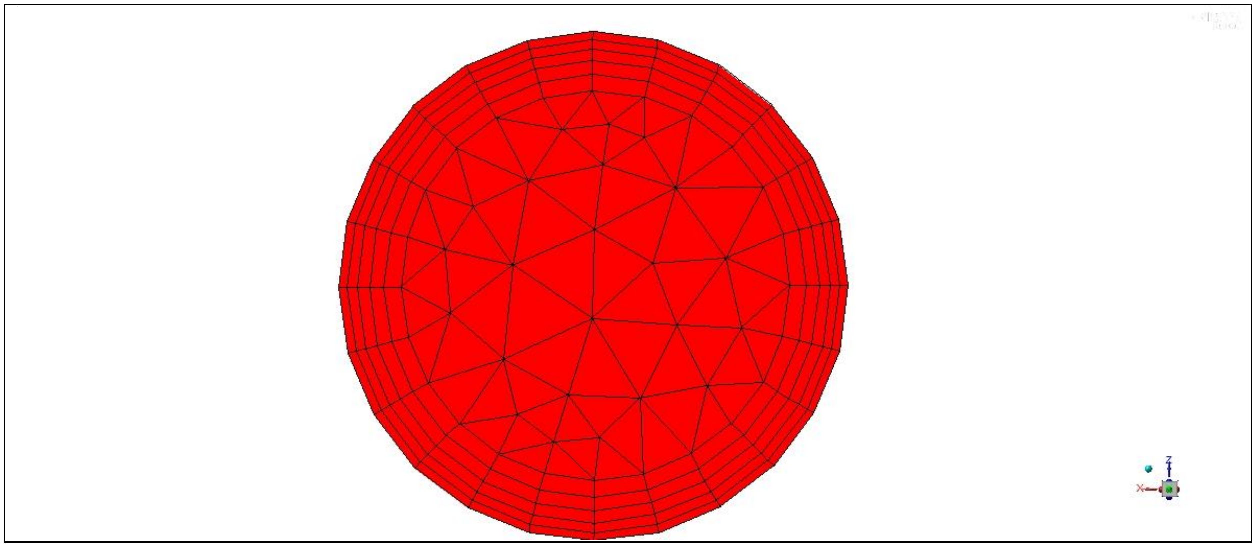

Figure 1: A plot of the mesh on the surface of the outlet.

Element size in ANSYS Meshing was decreased until the element limit was reached, and no further refining was done within FLUENT. All other meshing options are set to the standards defined by tutorial 1 and class demonstrations.

(2) Contour plots on the outlet surface:

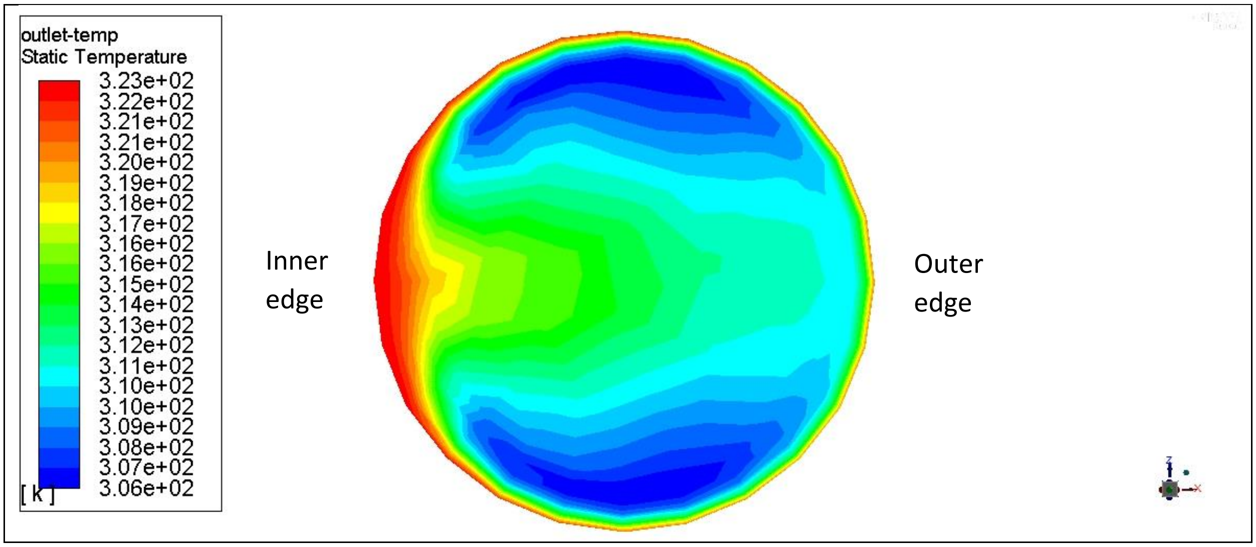

Figure 2: Contour plot of the static temperature on the surface of the outlet for task 1.

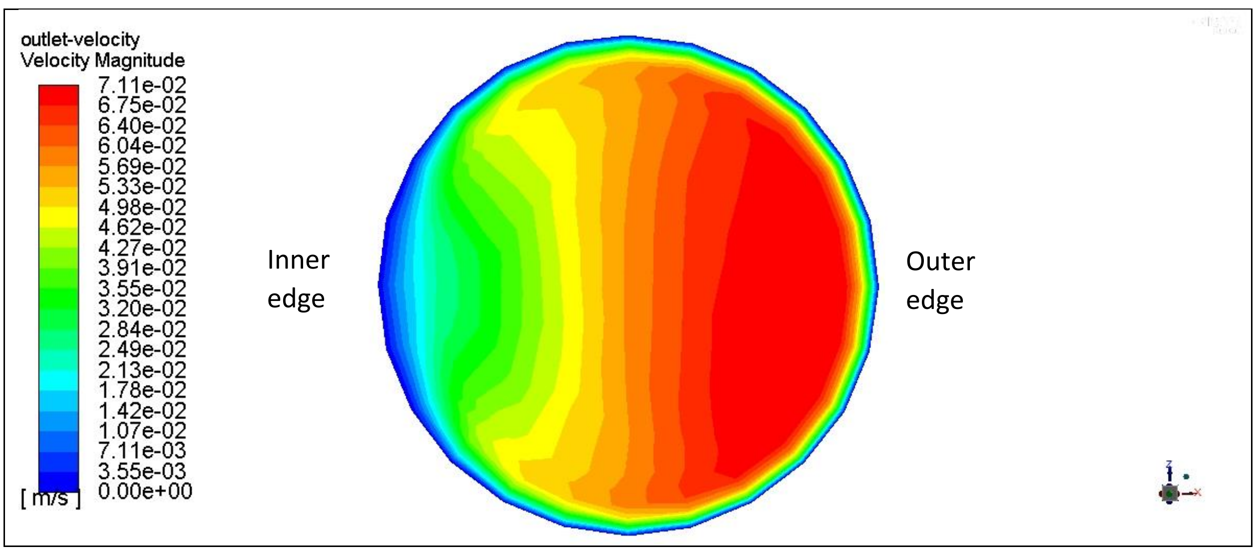

Figure 3: Contour plot of the velocity magnitude on the surface of the outlet for task 1.

(3) Outlet temperature and energy flux:

Area-Weighted Average Static Temperature	(k)
outflow	312.0614

Figure 4: Area-weighted average temperature of the outlet for task 1.

Integral energy-flux	
outflow	-321372.77

Figure 5: Energy flux of the outlet for task 1 in watts.

Note that the energy flux at the outflow is negative simply due to the "negative" direction of the y-velocity used in calculations and has no significance. Additionally, note that the outflow energy flux is in units of watts.

Analysis:

As expected from the in-class demos, the magnitude of the fluid velocity is great near the "outside" of the helix. Additionally, the temperature contour plot shows that the temperatures are greater near the "inside" of the helix and decrease going towards the "top" and "bottom" of the pipe cross-section. This also agrees with the in-class demonstrations. The average temperature of the outlet seems to be reasonable based in inspection of the temperature contour. Additionally, I am aware that the negative sign of the energy flux is merely a consequence of the velocity direction relative to the coordinate system, but there is no clear way of verifying that the magnitude of the value is reasonable.

Task 2

(1) Stretched helical pipe geometry:

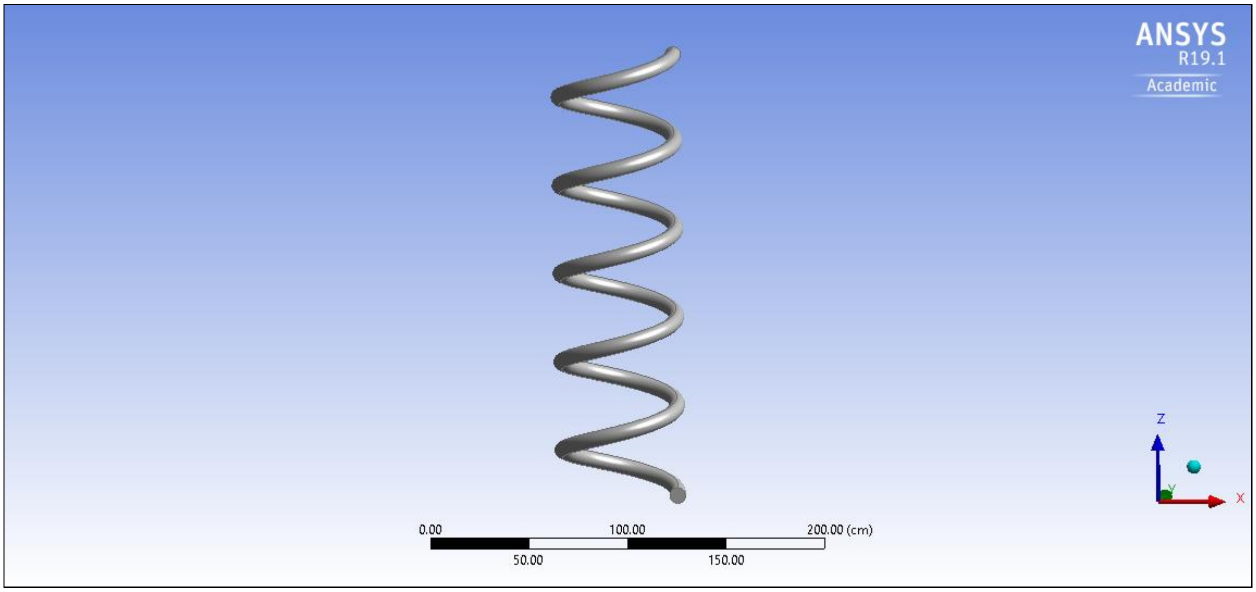

Figure 6: Geometry of the stretched helical pipe for task 2.

(2a) Contour plots for the straight pipe:

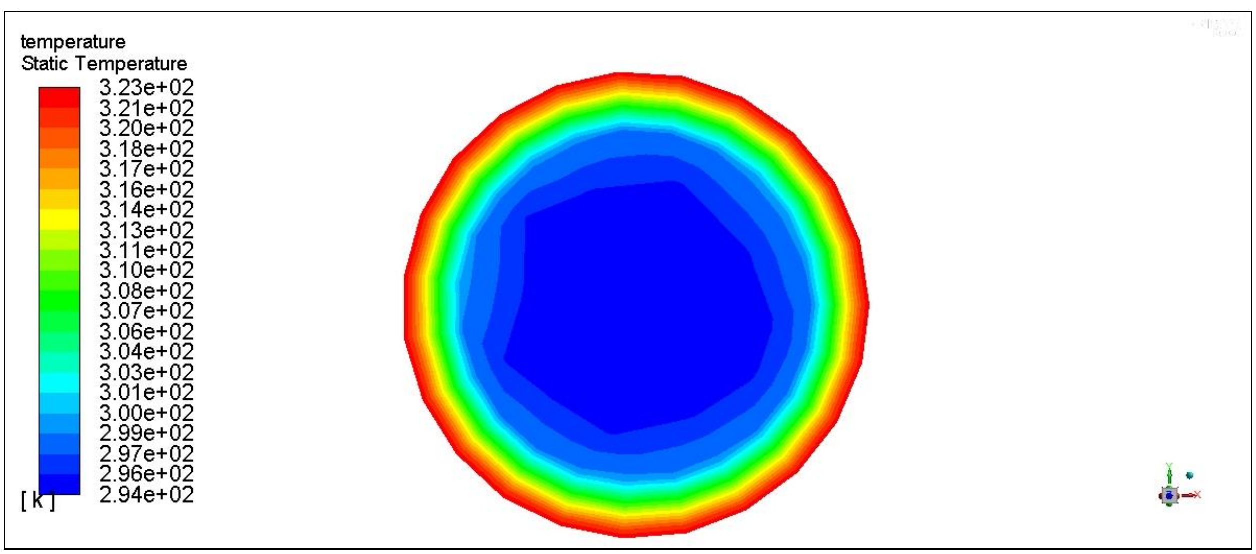

Figure 7: Contour plot of the static temperature on the surface of the straight pipe outlet.

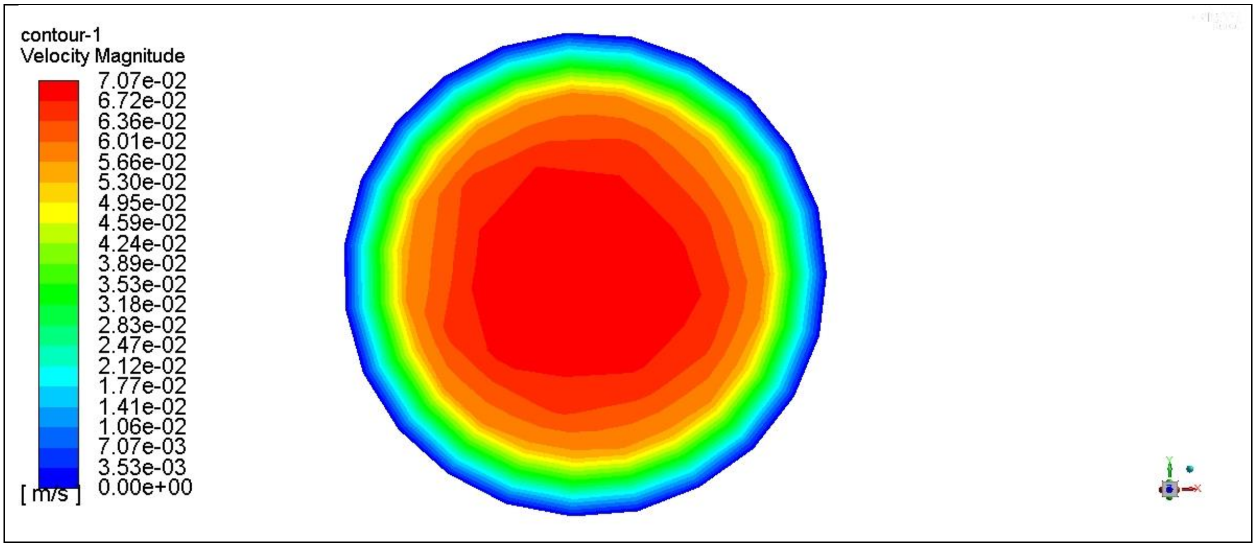

Figure 8: Contour plot of the velocity magnitude on the surface of the straight pipe outlet.

<u>(2b) Contour plots for the stretched helical pipe:</u>

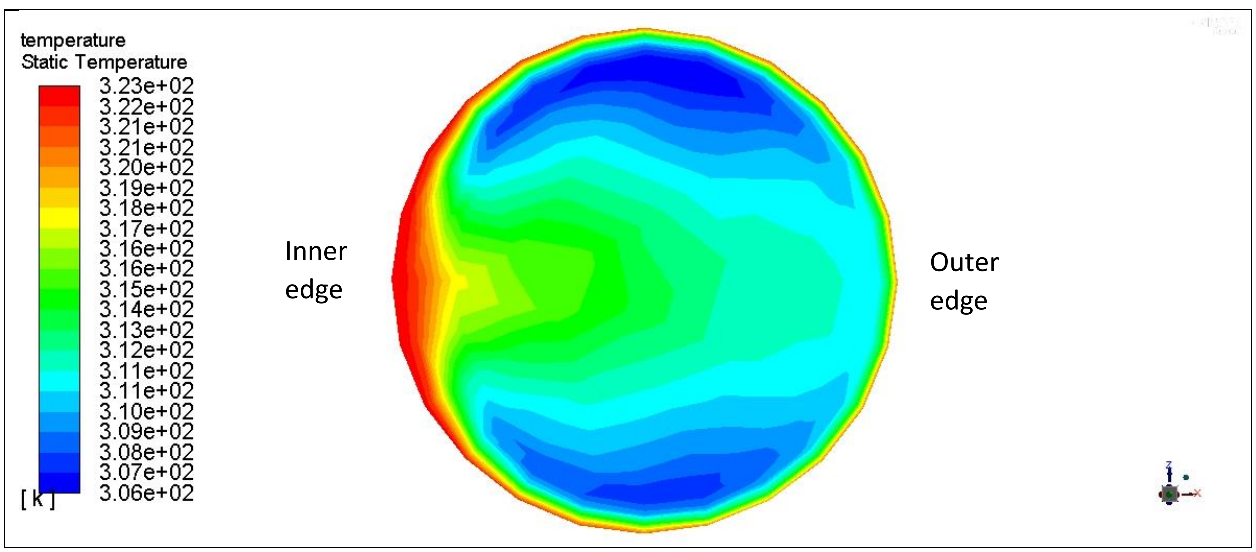

Figure 9: Contour plot of static temperature on the surface of the stretched helical pipe outlet.

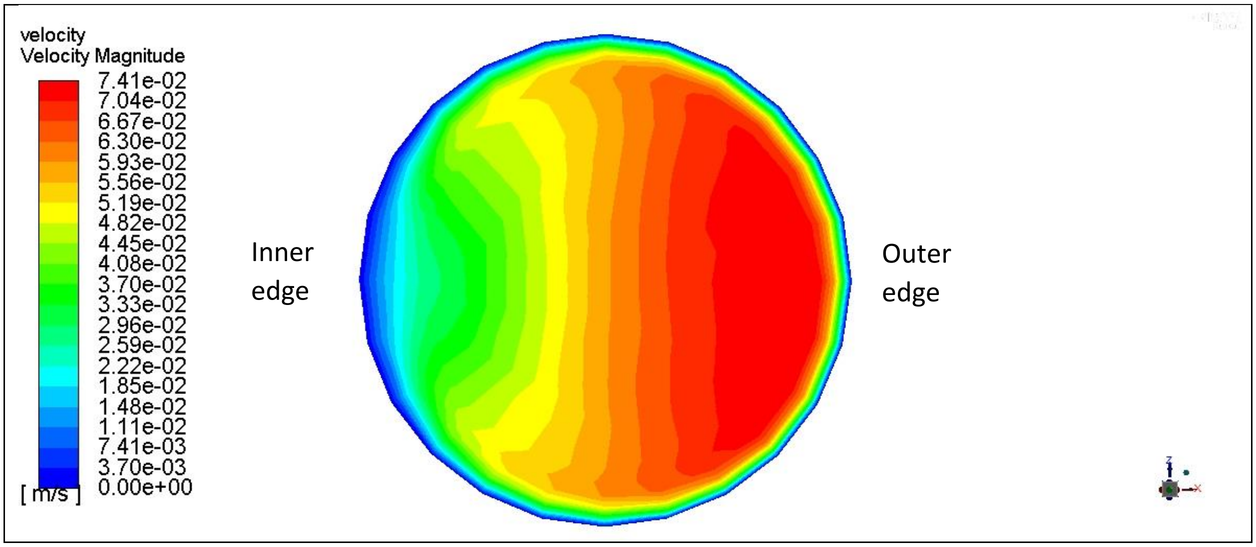

Figure 10: Contour plot of the velocity magnitude on the stretched helical pipe outlet.

(3a) Outlet temperature and energy flux for the straight pipe:

```
            Area-Weighted Average
               Static Temperature                    (k)
-------------------------------- --------------------
                          outflow            302.17183
```

Figure 11: Area-weighted average temperature of the outlet for the straight pipe.

```
                         Integral
                      energy-flux
-------------------------------- --------------------
                          outflow            307551.07
```

Figure 12: Energy flux of the outlet for the straight pipe in watts.

(3b) Outlet temperature and energy flux for the stretched helical pipe:

```
            Area-Weighted Average
               Static Temperature                    (k)
-------------------------------- --------------------
                          outflow             312.1862
```

Figure 13: Area-weighted average temperature of the outlet for the stretched helical pipe.

```
                     Integral
              custom-function-0
------------------------------ --------------------
                      outflow         -321444.74
```

Figure 14: Energy flux of the outlet for the stretched helical pipe in watts.

Once again please neglect the negative sign of the outflow energy flux.

Analysis:

Similar to task 1, the magnitude of the fluid velocity is greater near the “outside” of the stretched helix, and the temperature contour plot shows that the temperatures are greater near the “inside” of the helix and decrease going outward and towards the “top” and “bottom” of the pipe cross-section. Both of which agree with the in-class demonstrations. Additionally, both the temperature and velocity contour plots of the straight pipe are symmetric as one would expect. It also shows that the inside of the velocity contour is the highest velocity, and the inside of the temperature contour is the coldest temperature (once again an expected result). Note from **Figure 11** through **Figure 14** that the average outlet temperature of the straight pipe is approximately 10 degrees lower than the stretched helix, and consequently the energy flux is lower as well. This supports the idea that the helical shaped pipe is better for heating the fluid with a given length of pipe. In addition to this, one can see that the outlet temperature and energy flux for the regular and stretched helical pipes are very close to each other. This leads me to believe that stretching the helix by the amount specified in this lab has little to no effect on heat transfer rates. I suspect that as the helix is stretched it will approach the geometry of a straight pipe and the temperature and energy flux values will eventually converge to those in **Figure 11** and **Figure 12**.

Task 3

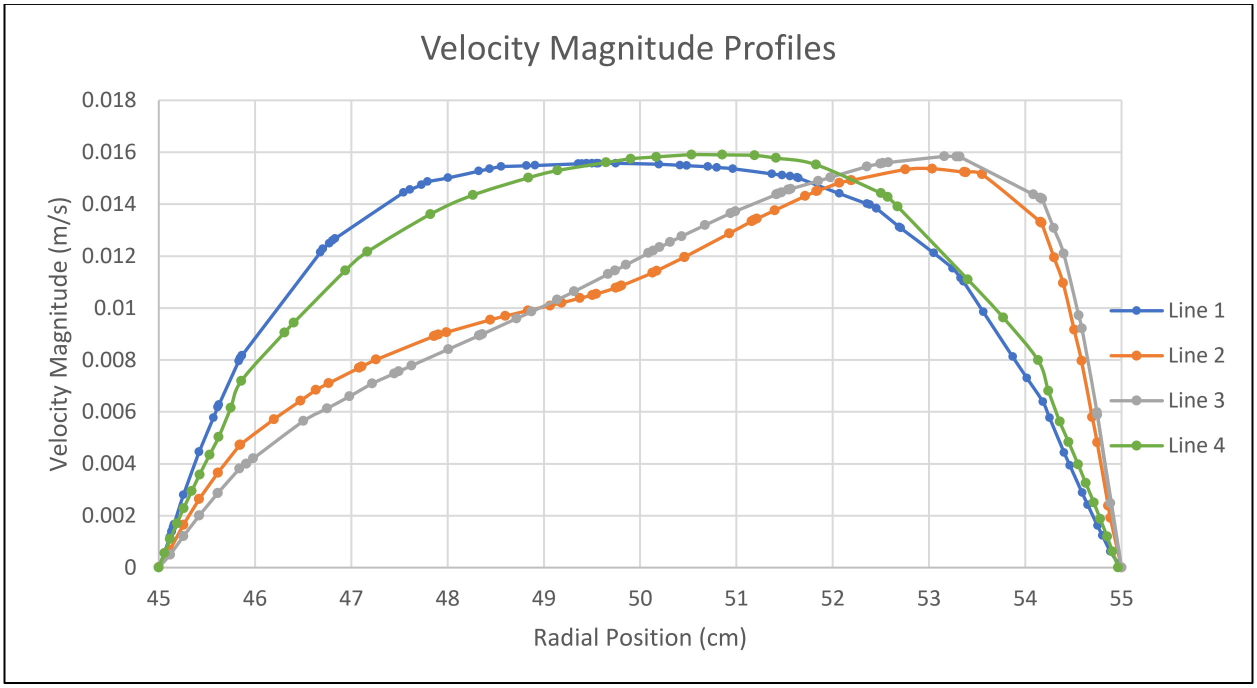

Figure 15: Velocity magnitude profiles along the four lines specified in task 3.

Analysis:

As expected the velocity profile of line 1 (just before the curve) exhibits a fairly symmetric curve with a profile that is generally expected from a straight pipe flow. Then, line 2 shows how the fluid tends to have increased velocity on the "outside" of the pipe as it curves. Once again, this is an expected result from a curved pipe. Line 3 then shows that as the fluid enters the next length of straight pipe that it still has the velocity profile. This serves as a reminder that the velocity profile does not instantly return to the symmetric state displayed by line 1. Line 4 then shows that after some time flowing down the straight pipe the fluid has almost completely returned to the symmetric velocity profile one expects from flow in a length of straight pipe.