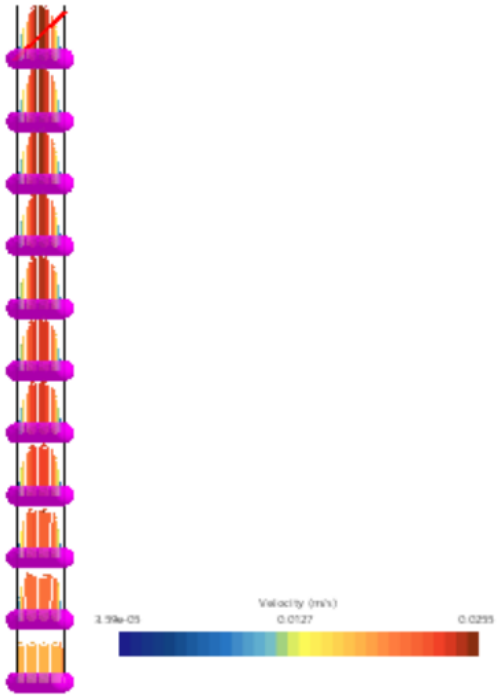
**Laminar Flow**

Velocity Profile


This plot shows the velocity development from plug flow to laminar flow with no-slip boundary conditions. The velocity at the inlet is all at the same velocity, plug flow, and develops to a parabola at the outlet, fully developed laminar flow. The velocity is greatest at the middle and lowest at the walls.

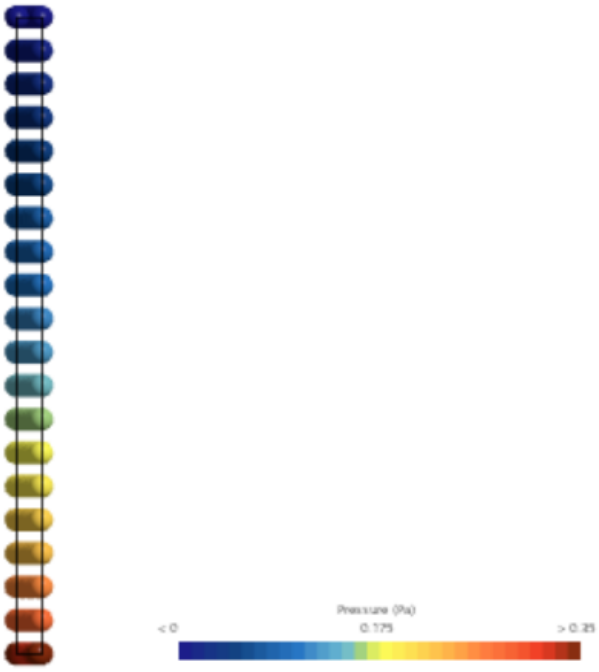
Velocity Distribution




T

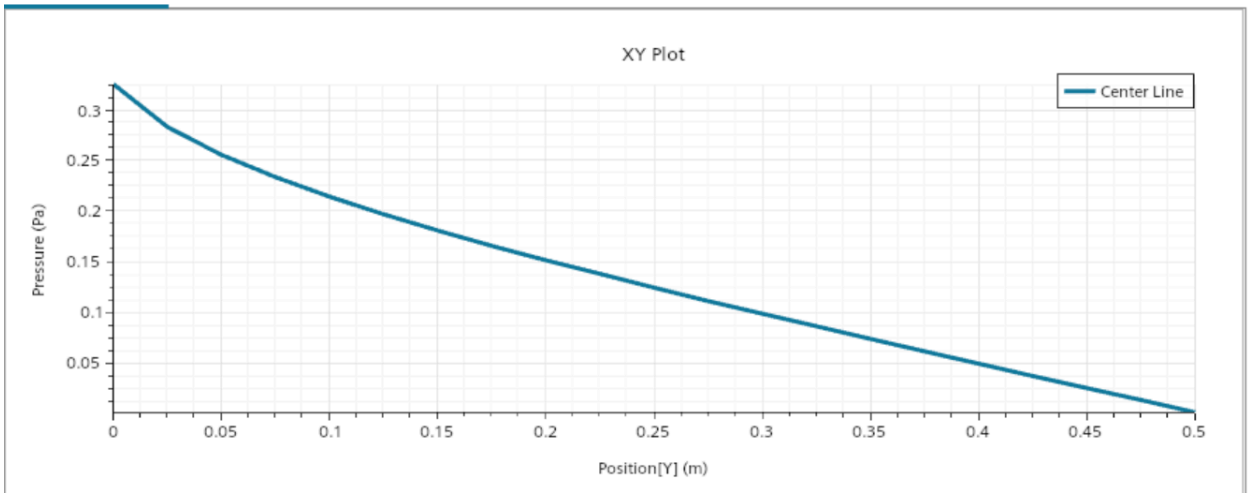
This plot shows the development of the flow from plug flow to laminar flow in the form of vectors. The vectors are all at the same length at the inlet and as the flow develops the vectors form a parabola.

Pressure Distribution



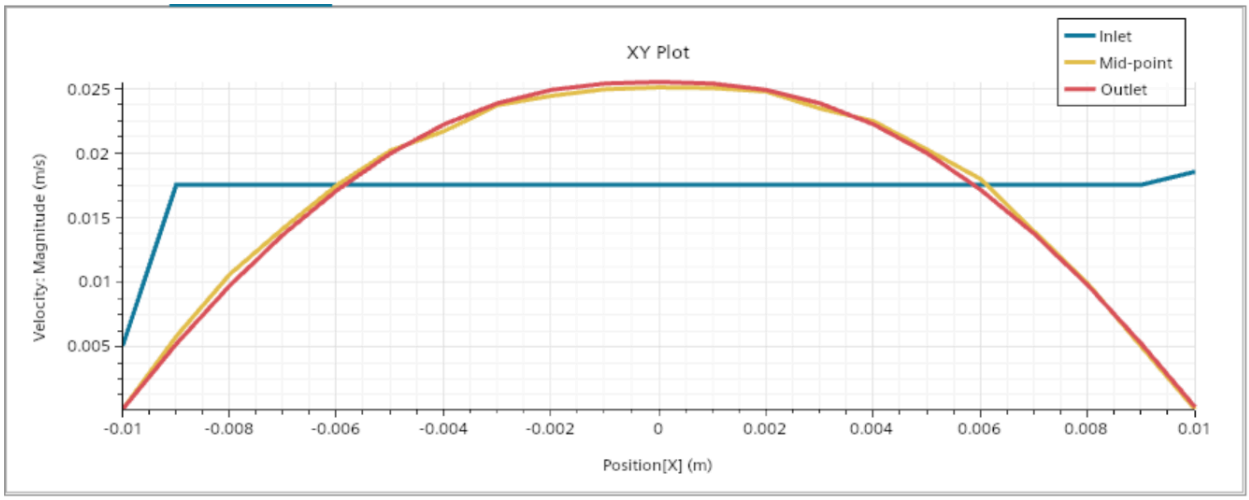
This plot shows the pressure in the flow channel along y. The pressure starts at 0.35 Pa at is 0 Pa at the end.

Pressure Plot




This plot shows the pressure down the center-line of the flow channel. The pressure decreases from 0.35 Pa to 0 Pa approximately linearly down the flow channel.

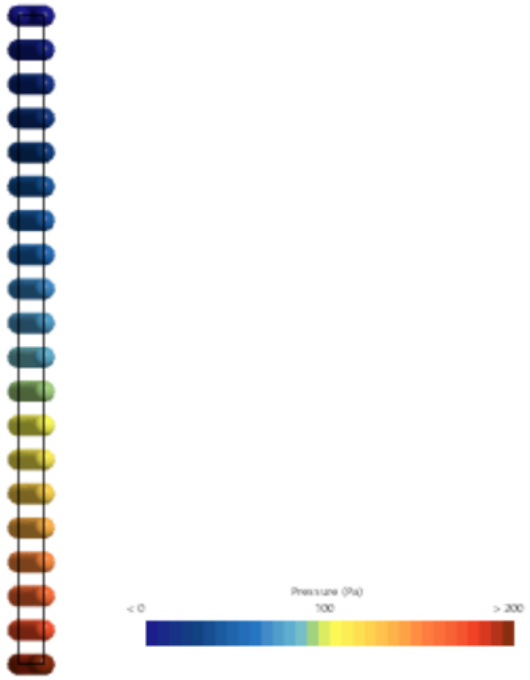
Velocity Plot




This plot shows the velocity at the inlet, outlet, and the middle of the channel. It shows the magnitude of the velocity as a function of the x position at the three points in the channel. At the inlet the flow is approximately plug shaped and as the flow progresses through the channel it becomes a parabola.

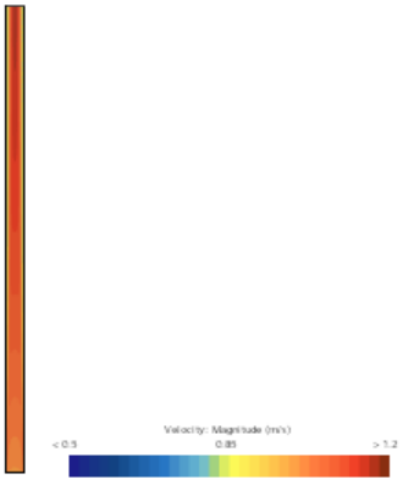
**Turbulent Flow**

Pressure Gradient



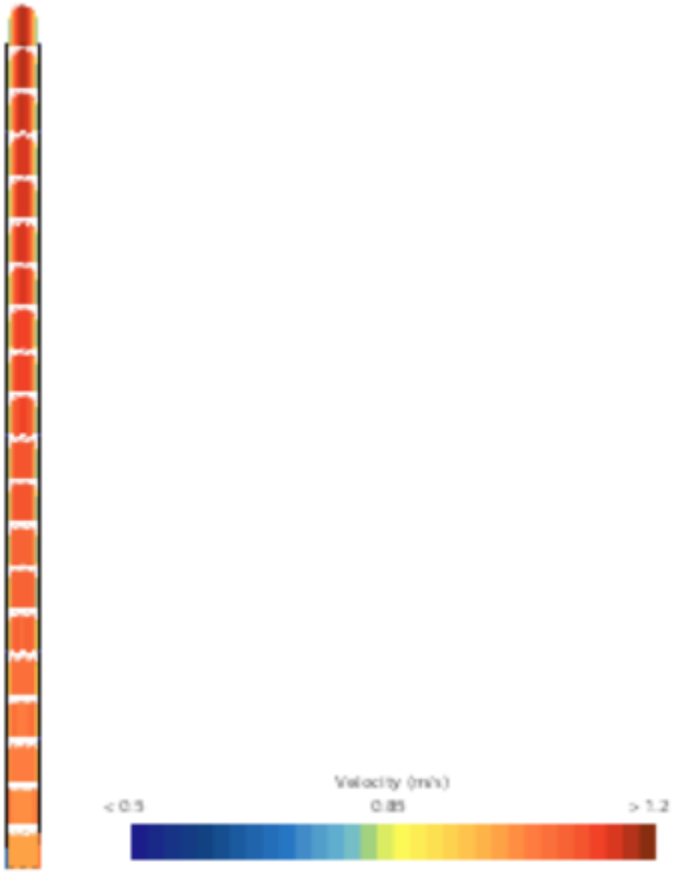

This plot shows the pressure in the channel as it ranges from 200 at the inlet to 0 at the outlet. The pressure gradient in this simulation is much higher than that of the laminar regime.

Velocity Contour



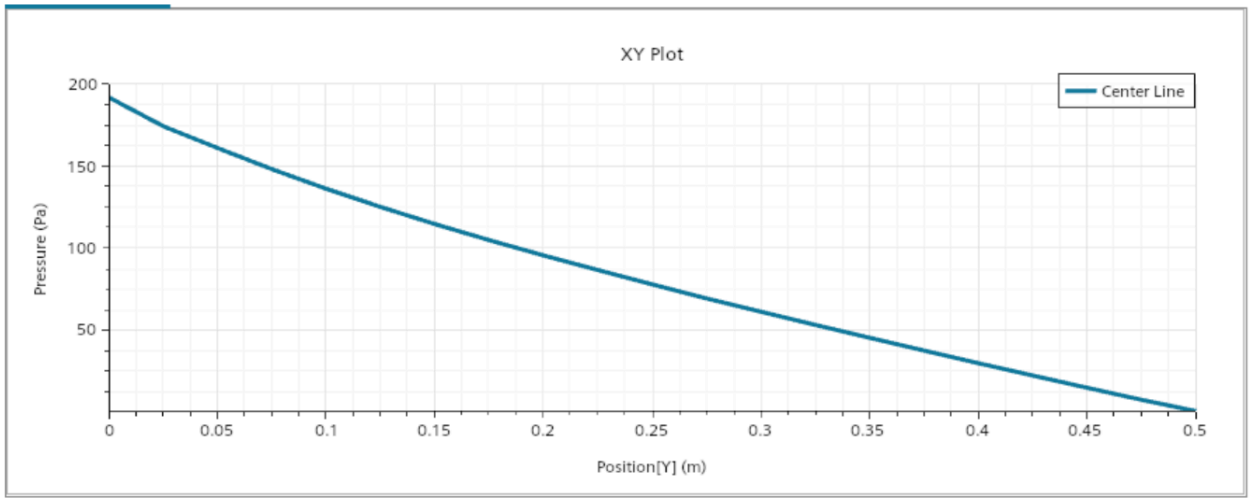
The turbulent flow remains even across x for a long time but eventually begins to form a parabola like in the laminar simulation. The flow is again fastest in the center and slowest at the walls.

Velocity Field



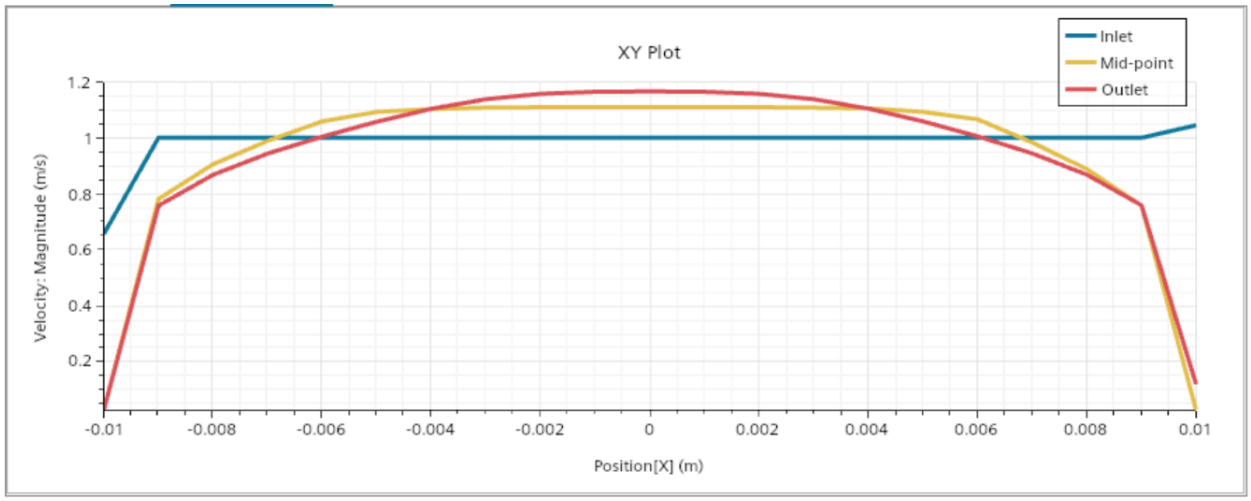

The velocity distribution at the inlet is equal across x and as the flow progresses through the channel the flow forms a parabola but the velocity at the center is still generally equal. The parabola formed here is much less defined than that of the laminar flow.

Pressure Plot



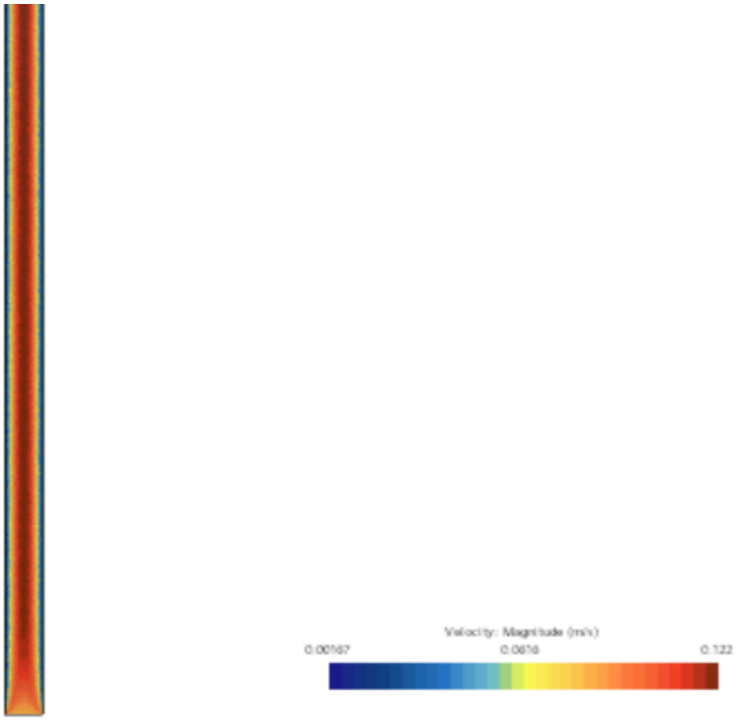

This plot is the pressure down the centerline. It looks similar to the laminar pressure plot but the gradient is much greater. The plot is again approximately linear like the laminar flow plot.

Velocity Plot




Compared to the laminar plot this one seems much flatter since the velocity is constant throughout a part of the center of the channel. Also the line at the center point and the outlet are different which suggests that it takes longer for the flow to reach fully developed turbulent flow.

Velocity Contour

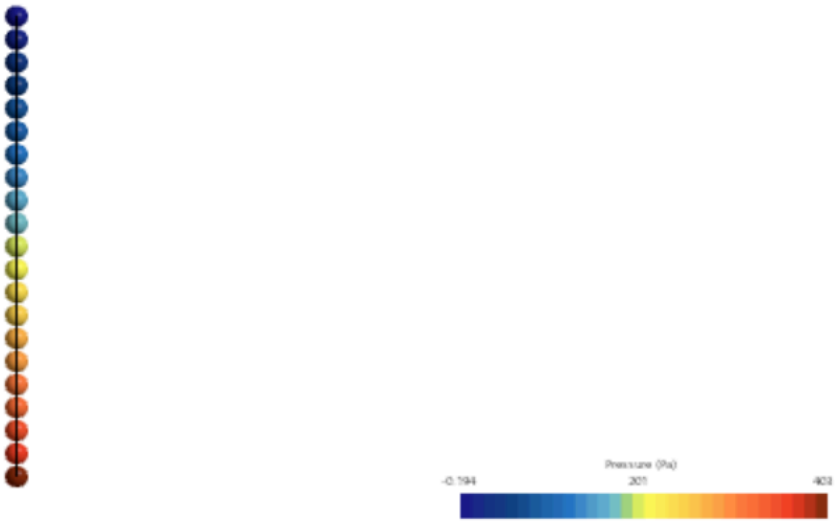



The velocity contour plot shows plug flow at the inlet transition to fully developed laminar flow. The velocity is 0 at the walls due to no-slip BC, and is fastest in the center. The velocity ranges from 0 to 0.123.

Velocity Profile

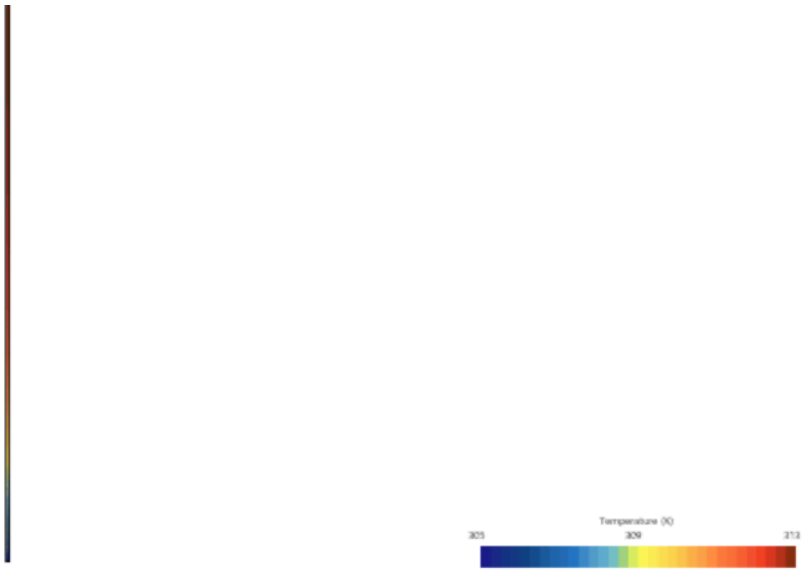
The profile shows the development from plug flow to laminar flow. The vectors are longest at the center since the velocity is highest at the center and the shortest at the walls since the velocity is the lowest at the walls. Toward the middle the flow becomes fully developed laminar flow.

Pressure Gradient



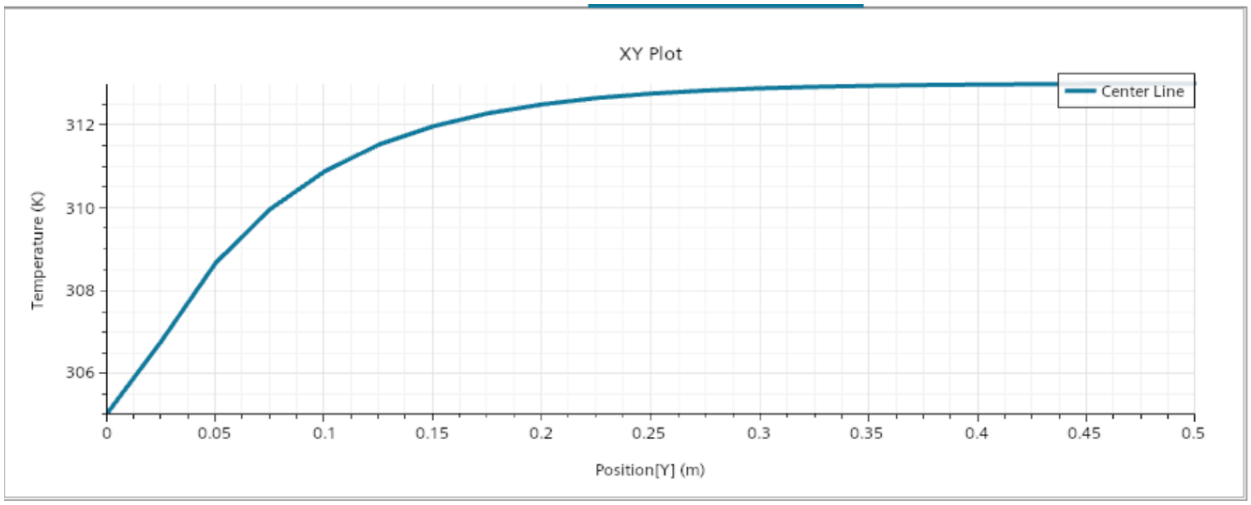
The pressure gradient ranges between 0 Pa at the outlet to 400 Pa at the inlet.

Temperature Contour



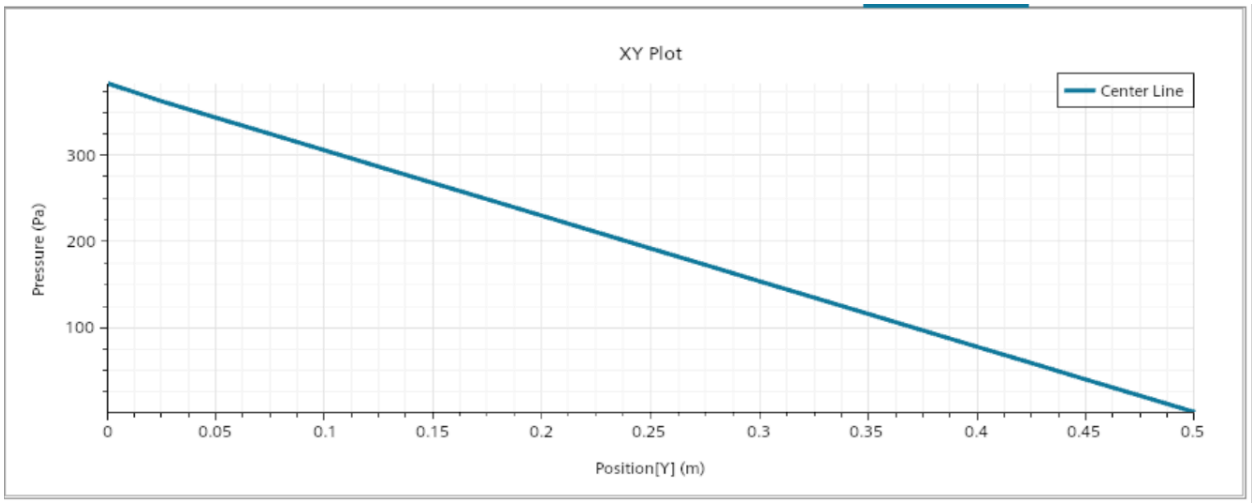
The temperature is relatively constant across x. As the fluid passes through the heat exchanger the fluid heats up to 313K. It reaches  this temperature around ⅔ of the way through.

Temperature Midline Plot



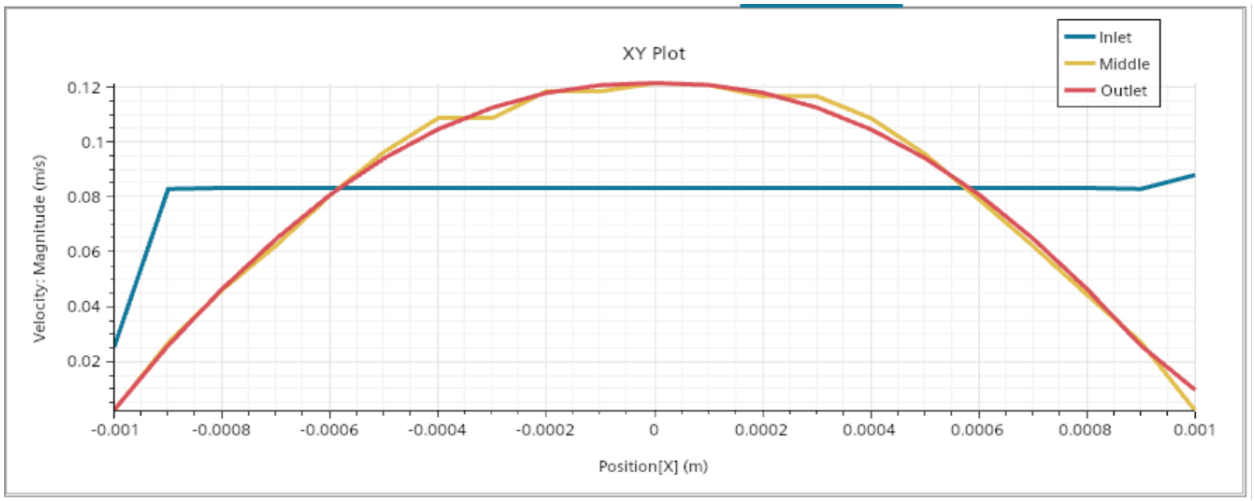

The temperature increases until it reaches a maximum at 311K at around 0.1m. This means that the heat exchanger needs to only be about 0.1m to reach an outlet temperature of 311K.

Pressure Midline Plot



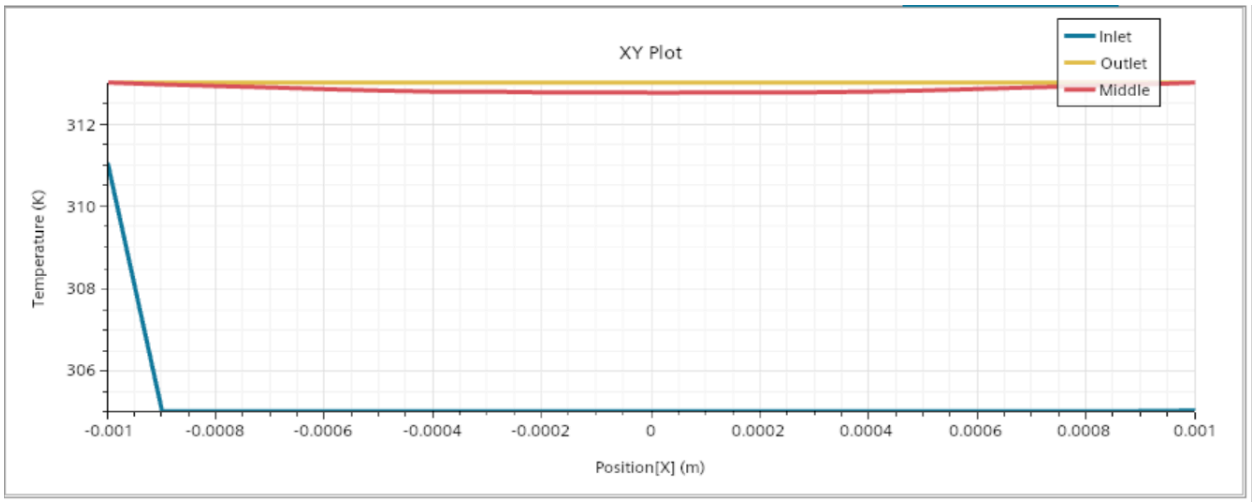

The pressure gradient ranges from 400 Pa at the inlet and 0 Pa at the outlet. This midline pressure is approximately linear.

Velocity Distribution




The velocity plot shows that the the fluid enters the heat exchanger in plug flow, approximately reaches laminar flow in the middle, and has fully developed by the outlet. This is indicated by the parabola which is indicative of fully developed laminar flow.

Temperature Distribution




The temperature as a function of x is approximately constant at the inlet, middle, and outlet. The fluid has almost reached 313K by the middle, and has reached 313K by the outlet. This means the heat exchanger can be reduced to almost half the length and it will still work as intended.